Chapter 10
Using Web 2.0 for Stakeholder Analysis: StakeSource and its Application in Ten Industrial Projects

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Abstract Software projects often fail because stakeholders are omitted. Existing stakeholder analysis methods rely on practitioners to manually identify and prioritise stakeholders, which is time consuming, especially in large projects with many stakeholders. This paper investigates the use of Web 2.0 technologies, such as crowdsourcing and social networking, to identify and prioritise stakeholders. The investigation is based on the application of StakeSource in practice. StakeSource is a Web 2.0 tool that uses social networking and crowdsourcing techniques to identify and prioritise stakeholders. This chapter describes our experiences of and lessons learnt from applying StakeSource in ten real-world projects from six organisations in UK, Japan, Australia, and Canada, involving more than 600 stakeholders. We find that StakeSource can yield significant benefits, but its effectiveness depends on the stakeholders' incentives to share information. In some projects, StakeSource elicited valuable stakeholder information; in other projects, the stakeholder responses were insufficient to add value. We conclude with a description of factors that influence stakeholder engagement via the use of Web 2.0 tools such as StakeSource. If collaborative tools such as StakeSource are to find a place in requirements engineering, we will need to understand what motivates stakeholders to contribute.

10.1 Introduction

Stakeholder analysis, which involves the identification and prioritisation of stakeholders, is a critical step in requirements elicitation. Stakeholders are individuals or groups who can influence or be influenced by the software project [1]. These people include customers who pay for the software system, users who interact

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with the system to get their work done, developers who build and maintain the system, and legislators who impose rules on the development and operation of the system [1, 2]. These people have diverse backgrounds, expertise, interests, and personal goals [3]. Projects with higher stakeholder engagement tend to have higher success [4-6], but omitting stakeholders is a common problem in software development [7]. As stakeholders are the source of requirements, they have to be identified before requirements can be elicited [1, 8]. As a result, missing stakeholders gives rise to missing requirements, causing projects to fail [9, 10].

This work investigates the application of Web 2.0 technologies for stakeholder analysis using StakeSource, a Web 2.0 stakeholder analysis tool developed in previous work [11]. StakeSource uses several Web 2.0 technologies including crowdsourcing, social networking, and tagging, and aims at engaging a large set of stakeholders [11]. StakeSource elicits information about other stakeholders from the stakeholders without requiring the practitioner[2] to be present [11]. Then, it builds a social network of stakeholders, and prioritises the stakeholders using the elicited information. The stakeholders can provide information anytime and anywhere, and the information they provide can reduce missing requirements and improve the quality of the elicited requirements [9, 10]. As such, StakeSource has the potential to effectively manage stakeholder information in projects with a large number of stakeholders, even when the stakeholders are in different locations [12-14]. In addition, it is one of the first Web 2.0 requirements elicitation tool to be widely available to practitioners, providing valuable data for our study. It is anticipated that Web 2.0 technologies will be increasingly used in requirements elicitation, and thus empirical studies of such tools in real-projects are needed to assess their viability [15].

In this chapter we describe the application of StakeSource in 10 real-world projects. These projects are based in 6 organisations in United Kingdom, Japan, Australia, and Canada, involving more than 600 stakeholders. The number of stakeholders per project range from 10 to more than 200. The effectiveness of StakeSource in engaging with stakeholders is investigated in terms of response rate, timing of response, quantity and quality of the response. The practitioners and stakeholders are interviewed, and data is analysed to reveal the factors that influence stakeholder engagement using StakeSource.

The evaluation of StakeSource in real projects is a significant contribution to software engineering research. Web 2.0 applications are difficult to evaluate due to their collaborative nature [16]. Despite the widespread use of Web 2.0 in software development, there are few empirical studies to investigate the adoption and implications of their use [15]. Our lessons learnt and experiences can benefit practitioners and researchers by highlighting the benefits and limitations associated with using Web 2.0 technologies to support software engineering activities [15].

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[2] In this chapter, practitioners refer to the requirements engineers, project managers, system analysts, business analysts or developers who are responsible for stakeholder analysis in their projects.

For example, in StakeSource, the use of Web 2.0 technologies enables stakeholders to provide information without the presence of the practitioner. Nevertheless, the participation of many stakeholders, such as users and legislators, is largely voluntary. Stakeholders with low incentives may not respond, fail to provide a timely response, or provide a low quality response [17].

The rest of the paper is organised as follows. Section 10.2 describes existing stakeholder analysis methods and tools. Section 10.3 describes StakeSource and Section 10.4 introduces the projects and our methodology. Section 10.5 describes our experiences and lessons learnt, Section 10.6 discusses threats to validity and Section 10.7 concludes.

10.2 Background

Existing stakeholder analysis methods rely on the practitioners to manually identify stakeholders. For example, in the *semi-structured approaches* that form the basis of existing practices, the practitioner manually identifies stakeholders by considering broad stakeholder categories, such as stakeholders who interact directly with the system and stakeholders who have interests in the project [7]. In the *interview method* proposed by Pouloudi and Whitley [18], the practitioner manually identifies generic stakeholder roles and stakeholders, then interviews each stakeholder to learn about other stakeholders or stakeholder roles, and repeats the interviews for each newly identified stakeholders. In the *search method* proposed by Sharp et al. [2], the practitioner manually identifies initial stakeholders from project documentation or interviews. Then for each stakeholder, the practitioner identifies other stakeholders who interact with the stakeholder, and repeats this process for each newly identified stakeholders.

Traditional stakeholder analysis tools hold and process the data provided by the practitioners, but provide little support in the actual identification and prioritisation of stakeholders. The practitioners manually elicit information from the stakeholders via face-to-face meetings, workshops or focus groups, and then populate the information in the tools [1, 7, 19]. The main purpose of the tools is to hold information. Except for the project team and possibly the key clients, few stakeholders interact directly with these tools. For example, in Stakeholder Analysis Matrix[3], the practitioner manually compiles a list of stakeholders and plots them against two variables on a matrix, such as power and interest, or importance and influence. The Onion Model developed by Alexander [8] and the Volere Stakeholder Analysis Template developed by Alexander and Robertson [20] consist of a set of generic stakeholder roles. The practitioner refers to the generic roles to manually derive specific roles for the project. Stakeholder Circle[4] is a software

[3] http://www.mindtools.com/pages/article/newPPM_07.htm

[4] http://www.stakeholder-management.com/

package that enables practitioner to enter the stakeholders' information after they have been manually identified, and the tool generates reports based on the information provided.

Software projects are becoming more global and involving more stakeholders. As a result, Web 2.0 tools are increasingly used to augment existing development tools, with the aim to support collaboration and increase awareness among stakeholders. Using Web 2.0 tools, emerging forms of software development, such as distributed development, can benefit from access to a large pool of stakeholders [15]. In our previous work, we have developed StakeNet, a method that uses social networks for stakeholder analysis in large projects [9, 10]. In StakeNet, the practitioner prepares an initial list of stakeholders. Then the practitioner manually identifies stakeholders by asking the initial stakeholders to recommend other stakeholders, builds a social network of stakeholders from the recommendations, and prioritises the stakeholders using social network measures. StakeNet was applied in a substantial real-world project, and shown to identify a comprehensive set of stakeholders and prioritise them accurately [9, 10]. Nevertheless, the method is time consuming. The practitioner has to approach each stakeholder to elicit recommendations, convert the recommendations into the appropriate format for the social network measures, compute the stakeholders' priorities using social network measures, and convert the output from the social network measures into a prioritised list of stakeholders [9]. Changes to the recommendations (additions, modifications, removal) require the practitioner to repeat the process [9]. In the previous application of StakeNet [10], more than 150 person hours was spent manually eliciting and processing the recommendations from 68 stakeholders.

10.3 StakeSource

StakeSource is a Web 2.0 tool developed to automate the StakeNet method [9, 11]. To use StakeSource, the practitioner provides StakeSource with the initial stakeholders. StakeSource automatically contacts the stakeholders and asks them to recommend other stakeholders via a web interface. Then, StakeSource converts the recommendations into the appropriate format, applies the social network measures, visualises the network of stakeholders, and produces a prioritised list of stakeholders. The remainder of this section describes the features of StakeSource[5].

StakeSource is a web-based application. The practitioners access StakeSource via a web interface and create their project by entering project details such as name, description, and scope definition. They also provide an initial set of stakeholders from the categories of users, developers, legislators, and decision-makers. Each stakeholder in this initial list has the following information: name, the role in

[5] StakeSource tool demo is available at http://vimeo.com/18250588. For further details about StakeSource, refer to the previous work [9, 11].

the project, and email address. The practitioners can also customise the email template that StakeSource uses to contact stakeholders.

StakeSource contacts the initial stakeholders via email. The email provides a link that brings the stakeholders to the web-based form that enables them to recommend other stakeholders (Fig. 10.1). The recommendation form consists of the project name and scope description as provided by the practitioners. Each recommendation consists of the stakeholder's name, their role in the project, their influence in the project (from Low to High), and their email address. If a stakeholder is aware of a role but is not aware of the individual stakeholders, he can recommend only the role. Stakeholders can also comment on the stakeholders they recommend. Public comments can be viewed by anyone who can access the stakeholder analysis user interface; private comments are only available to the practitioners.

Each time a new stakeholder is identified, StakeSource contacts the stakeholder to invite them to recommend other stakeholders. This technique is also known as the snowballing technique [21], where the set of stakeholders build up like a snowball rolled down a hill. People who are recommended may be "non-stakeholders" or stakeholders who lack time or interest to be involved in the project. StakeSource provides an option for these people to unsubscribe from the project, and nominate other stakeholders.

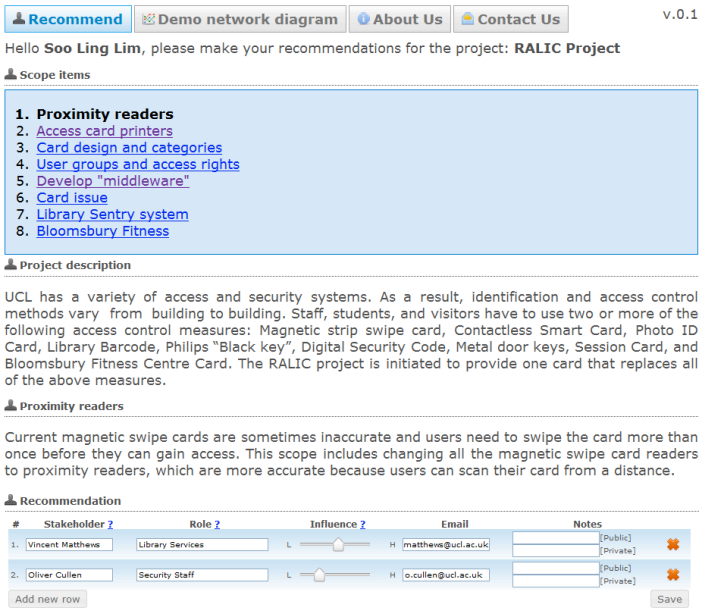

Fig. 10.1. StakeSource web-based recommendation form.

Once the recommendations are collected from the stakeholders, StakeSource provides the following support for stakeholder analysis via a web interface. This

interface is accessible to the practitioners as well as stakeholders who have made recommendations.

Feature 1: Identify and prioritise stakeholders. StakeSource compiles the initial and recommended stakeholders to form the list of stakeholders in the project. To prioritise stakeholders, StakeSource builds a social network of stakeholders with the stakeholders as nodes, and their recommendations as directed links: *S1* links to *S2* if *S1* believes *S2* to be a stakeholder. Then, it prioritises the stakeholders using various social network measures. For example, in-degree centrality prioritises stakeholders who receive the most recommendations, out-degree centrality prioritises stakeholders who make the most recommendations, and betweenness centrality prioritises stakeholders who are widely recommended by disparate groups of stakeholders [11]. Each time a measure is selected, StakeSource applies the measure and displays the prioritised list of stakeholders and their roles in the stakeholder analysis user interface (Fig. 10.2 Panel A). To improve the accuracy of prioritisation, stakeholders are unaware of existing recommendations when they recommend other stakeholders.

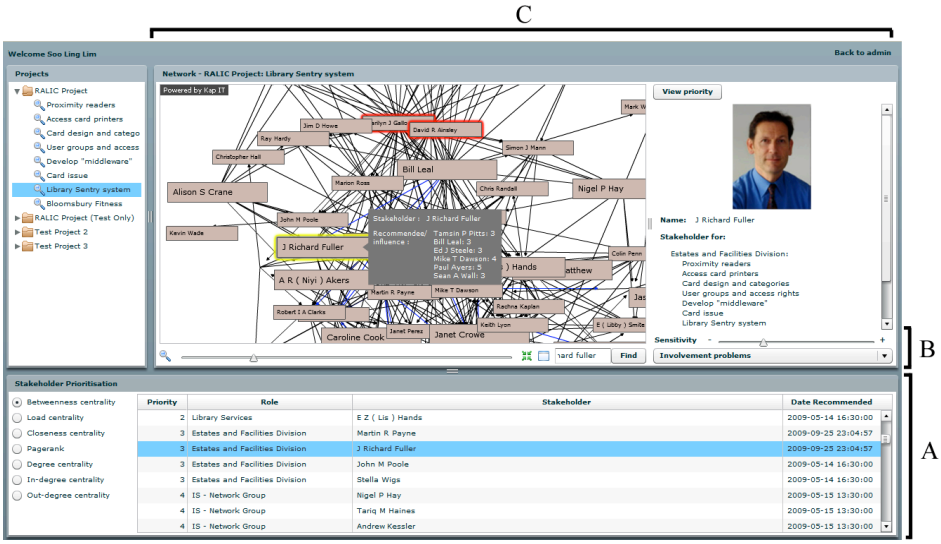

Fig. 10.2. The three panels (A, B, and C) of the StakeSource web-based user interface (refer to [11] for enlarged figure).

Feature 2: Identify stakeholders with potential problems. StakeSource identifies potential involvement or communication problems a stakeholder may have based on the stakeholder's position on the social network (Fig 10.2 Panel B) [11]. When one of the problems is selected, StakeSource highlights stakeholders in the network who may potentially have the problem during the project. StakeSource provides a slider to change the sensitivity of problem detection. This helps the practitioners to decide the right level of problem detection for the project, which is

a trade-off between the risk of the problem affecting the project and the cost to rectify the problem [11].

Feature 3: Display stakeholder social network and details. The stakeholders' recommendations are visualised as a social network (Fig 10.2 Panel C). StakeSource enables practitioners and stakeholders to study a stakeholder's position in the social network, the stakeholder's details, priority, and the stakeholders they recommend. For each stakeholder, StakeSource displays their name, role, photo, the scope items they are recommended for, the stakeholders who recommended them, the stakeholders they recommended, and comments from other stakeholders [11].

10.4 Using StakeSource in Practice

Industrial practitioners were made aware of StakeSource through the demonstration of the tool at seminars and conferences. A StakeSource website (www.stakesource.co.uk) was set up. Practitioners who were interested to use the tool could request an account from the website or contact the authors. The majority of the practitioners who adopted StakeSource did so after the tool was demonstrated to them in seminars. Others adopted StakeSource through word of mouth. For example, two projects used StakeSource after being recommended by higher-level management, and another two projects used it after their colleagues (practitioners or stakeholders) who have used the tool in other projects recommended the tool to them.

10.4.1 Projects

Table 10.1 summarises the projects included in the study. In addition to the ten real-world projects, a student project was included to investigate the differences between industrial and student projects. These projects have completed their use of StakeSource in the one-year-period after the tool was developed (December 2009 to December 2010). In these projects, the project details were entered, initial stakeholders were provided, and invitation emails were sent to stakeholders. Small projects have about 10 stakeholders; larger projects have more than 70 stakeholder groups and 200 stakeholders. For reasons of privacy, the projects, organisations, practitioners, and stakeholders are annonymised in this paper.

Table 10.1. Projects (P for Project, O for Organisation, D for Department)

ID	Short Description	Application Area	Identifying...	Organisation	Country	Size
P1	Develop an enterprise software system	Software	Stakeholders	O1.D1	UK	L
P2	Identify experts in health problems in urban environments	Non-software	Experts	O1.D2	UK	S
P3	Same project as P2 with random initial stakeholders	Non-software	Experts	O1.D2	UK	S
P4	Examine and improve organisational structures, processes, people practices, culture and values, and change management	Non-software	Stakeholders	O1.D1	UK	L
P5	Investigate the adequacy of an existing role in the organisation and create a new role if necessary	Non-software	Stakeholders	O2	UK	M
P6	Identify people who hold information that can help new employees become productive members of the organisation	Software	Experts	O3	UK	S
P7	Develop an enterprise software system	Software	Stakeholders	O1.D1	UK	S
P8	Develop a cloud computing facility	Software	Stakeholders	O4	Japan	M
P9	Identify potential investors and users of an innovative software application	Software	Stakeholders	O5	Australia	S
P10	Increase awareness about an existing access grid system	Software	Stakeholders	O6	Canada	M
P11	Develop a Web 2.0 System	Software	Stakeholders	Student	UK	S

The project characteristics are summarised as follows.

- Projects P1 to P10 were industrial projects led by practitioners. P11 was a Masters project led by students.
- All projects were conducted in English except for P8. In P8, the project description, and invitation email were worded in Japanese in StakeSource, and

stakeholders were able to provide recommendations in either English or Japanese.

- All the projects are software projects except the following. P2, P3, and P4 were policy related projects. P5 was a project to investigate the adequacy of an existing role in the organisation. P8 is a software project but a major part of the project included the design and configuration of hardware devices.
- Most projects used StakeSource to find stakeholders, but P2, P3, and P6 used it to find experts. In these projects, the recommendation form comes with an extra field for the experts to enter their own expertise as tags. These projects were included in our study to investigate if stakeholders are motivated to provide recommendations when it conflicts with their own benefits. In P5 and P8, stakeholders were already identified, StakeSource was used to validate the list of stakeholders and uncover missing stakeholders.
- In all projects, the stakeholders were unaware that their responses were being studied, in order to study their natural response or lack of response. One exception was P8, where the email to the stakeholders stated that the tool was being studied as part of a research project, and the data provided by the stakeholders will be analysed empirically for research purposes and used to improve the software system.
- All projects were set up by the practitioners themselves, except for P11 and P8. P11 was a student project set up by the students; P8 was set up by the second author on behalf of the project manager. In all projects, the first author provided technical support.
- P3 was the same project as P2, but instead of the initial set of stakeholders determined by the practitioner, P3 used the same number of initial stakeholders but randomly selected from the organisation people directory. This project was created to investigate if "non-stakeholders" were equally motivated to engage in the project by recommending stakeholders.
- All the projects were managed by different practitioners, except P2 and P3 (see previous point). P1 and P4 had different project managers but was set up by the same practitioner whose role in both projects was the communications manager.

10.4.2 Methodology

We interviewed the practitioners and stakeholders, and analysed the data captured by StakeSource for each project. A total of 8 practitioners from the real-world projects were interviewed. The practitioner for P6 was unavailable for the interview; P2 and P3 shared the same practitioner. The following questions guided the report of our experiences and lessons learnt:

Q1. Were stakeholders motivated to respond and how timely were their responses?

Q2. What were the stakeholders' responses?
Q3. How useful were the responses to the project?
Q4. What were the factors that influence the stakeholders' responses?

To analyse the stakeholder data elicited by StakeSource, the StakeSource database was accessed and the following information was extracted for each project.

- Initial stakeholders
- Customised email content
- Reminder email content (if available)
- Stakeholders who responded
- Stakeholders who provided recommendations
- Stakeholders who unsubscribed and rationale behind it (if available)
- Recommendations and date of recommendations
- Public and private notes
- Expertise description (if available)

The practitioners responsible for setting up their projects in StakeSource were invited for a face-to-face interview. The interviews were semi-structured, allowing the questions to be modified and new questions to be brought up depending on their response [22]. Some of the questions include:

- What is your previous experience in using stakeholder analysis tools?
- How were the initial stakeholders identified?
- How useful are the stakeholders identified by StakeSource?
    - How do you use StakeSource's output?
    - What is the stakeholders' contribution to the project?
    - Who should not be on the stakeholder list?
    - Who are unexpected stakeholders?
- How useful are the descriptions about stakeholders?
- How do you use the tool? Network view? List view?
- What is the progress of the project after the tool is used? Did you contact the stakeholders identified by the tool?
- What do you think about the response rate? Lower than expected, ok, more than expected? Why?
- Which part of the tool is most useful? Which is the least useful? Do you have any suggestions for improving the tool?

For P1, the first author also attended the board meeting where the practitioners reported their use of StakeSource to their directors. In addition, the practitioner for P2 and P3 allowed the stakeholders to be interviewed. In those projects, phone interviews were conducted with stakeholders who did not respond. The questions include:

- Did you receive an email about the project?
- If so, why didn't you respond? Is it because the tool is difficult to use?

10.5 Experiences with StakeSource and Lessons Learnt

10.5.1 Timeliness and Motivation to Respond

In projects where stakeholders provided recommendations, StakeSource was able to build the social network and produce a prioritised list of stakeholders. However, in some projects, there were little incentives for stakeholders to recommend other stakeholders. In these projects, StakeSource failed to elicit information from the stakeholders.

More than 600 stakeholders were identified, but only about 150 responded, giving an overall response rate of 25%. The response rate for each project was calculated as the number of stakeholders who responded over the total number of stakeholders identified. According to Table 10.2, the response rate for all the projects in this study ranged from 0% to 39%, which was similar to the online survey response rate by Deutskens et al.[6] [23]. The response rate was consistent with the results from survey research: face-to-face and phone interviews have about 40 percentage points higher response rate than online surveys [24]. This indicates a trade-off between manual and automated approaches for eliciting information from stakeholders. Manual approaches may be more time consuming but are likely to elicit more comprehensive information as compared to web-based approaches.

In this study, only two projects had higher response rate than that of online surveys, i.e., P11 (39%) and P8 (35%). P11 was a student project, and the high response rate may be due to the motivation to do well in their requirements engineering course. In P8, the stakeholders were aware they were being studied, which may have led to a higher response rate. In addition, many of the stakeholders in P8 are researchers or research-oriented students, so they may have been interested to participate in experiments.

Four projects have response rates of less than 10%. Among these projects, P4 and P6 had no response. Nevertheless, P6 started with only 2-3 initial stakeholders, which is the main reason for no responses, as 2-3 stakeholders are too few for an effective snowballing process. The practitioner for P4 reported that the project manager decided against using StakeSource as the use of new technologies might be risky for the project. Nevertheless, the same practitioner continued to use StakeSource for P1 and recommended StakeSource to practitioner of P7. P3 and P10 had a very low response rate of 3%. P3 was the project with a random set of

[6] In Deutskens et al.'s study of the response rate of online surveys with different configurations (e.g., short vs. long, donation to charity vs. lottery incentive, early vs. late reminder), they found that the response rate ranged from 9.4% to 31.4%.

initial stakeholders. Interviews with the stakeholders revealed that they ignored or deleted the invitation emails, as it was not relevant to them. The purpose of P10 was to ask existing users of an access grid system to recommend other users of an access grid system. It may be easier for the users to directly ask their collaborators to adopt the access grid system, rather than to recommend them using StakeSource.

In some projects, the stakeholders were already communicating before StakeSource was used. For example, in P9, three out of nine initial stakeholders provided recommendations via email or face-to-face communication before StakeSource was used. As such, StakeSource only managed to engage two other initial stakeholders. Most of the stakeholders who responded did so within the first week receiving the email. For P8, all the stakeholders who responded did so in 2 days, and it also has a very high response rate. Interviews revealed that in P8, employees tend to respond to email within a short timeframe. 10 projects were completed within 2 weeks. Only 1 project was completed in 20 days. The delay was caused by technical issues: the StakeSource server was down and stakeholders were unable to make recommendations. The recommendations restarted when the issue was fixed and an email reminder was sent.

10.5.2 Types of Stakeholder Response

The responses from stakeholders consisted of recommendations about other stakeholders with optional comments about the stakeholders, and unsubscription with optional rationale for unsubscription. Through the use of StakeSource technologies, the stakeholders were able to voice their opinions early in the project. As a result, the projects uncovered missing stakeholders, negative stakeholders (stakeholders who are unfriendly towards the product being developed), as well as stakeholders who lack time or interest to be involved.

Among the stakeholders who responded, 92% of them provided recommendations, and the average number of recommendations ranges between 1 and 7 (Table 10.2). In the majority of the projects, the stakeholders were able to identify other stakeholders that the practitioners were unaware of. The number of new stakeholders identified also depends on the initial list. For P2, only a few new stakeholders were identified. However, this was because the project manager had used an open call to find the initial stakeholders by sending emails to mailing lists.

Most recommendations were valid. Errors were caused by misunderstanding, rather than by malicious intent. For example, a stakeholder entered the stakeholder's surname rather than their role in the Role field for all her recommendations. A few emails bounced (Table 10.2) due to the stakeholders entering incorrect email addresses. Some stakeholders wrote in the public notes field the phrase "visible to everyone," as they misunderstood that doing so would make their recommendations public.

Table 10.2. Summary of Data Collected by StakeSource and in Interviews

	P1	P2	P3	P4 ^	P5	P6 *	P7	P8	P9	P10	P11
No. of initial stakeholders	64	30	30	3	13	2	32	12	9	30	6
Total no. of stakeholders identified º	193	39	31	3	35	2	81	24	11	31	14
No. of stakeholders who responded	37	25	6	0	10	0	20	8	2	1	7
No. of stakeholders who made recommendations	32	10	1	0	10	0	20	8	2	1	7
No. of experts who provided expertise	N/A	22	4	N/A	N/A	0	N/A	N/A	N/A	N/A	N/A
No. of people unsubscribed	7	0	1	0	0	0	0	0	0	0	0
Avg. no. of recommendations per stakeholder who recommended	5.34	1.30	1.00	0.00	3.80	0.00	6.10	7.13	1.00	1	4.71
No. of emails bounced	0	0	0	0	1	0	6	1	0	0	0
Response rate (%)	19	26	3	0	29	0	27	35	18	3	39
Factor increase in stakeholders (total – initial)/total	2.02	0.30	0.03	0.00	1.69	0.00	1.53	1.00	0.22	0.03	1.33
No. of snowballing rounds (round 1 is initial seed)	4	3	2	1	3	1	4	3	2	1	3
Responses completed in (days)	15	15	15	N/A	10	N/A	20	2	4	7	4
Did StakeSource identify stakeholders or stakeholder roles that practitioners were unaware of?	Yes	Yes	No	N/A	Yes	No	Yes	Yes	Yes	Yes	Yes
Was StakeSource useful to the project?	Yes	Not very	No	N/A	Yes	N/A	Yes	Yes	Yes	Not very	Yes
Mentioned using StakeSource in future project?	Yes	No	No	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes
Recommended StakeSource to other practitioners?	Yes	No	No	Yes	Yes	N/A	No	No	Yes	Yes	No

^ The project manager decided to stop using StakeSource before the snowballing process started.

* The practitioner was not interviewed due to unavailability.

º A stakeholder consists of a name and a role; and if the name is not provided, only the role.

Only 8% of the responses were unsubscription. Unsubscription responses were informative, especially when stakeholders provided the reason for unsubscription. These responses uncovered negative stakeholders, and stakeholders who lacked time to be involved in the project. For example, the objective of P1 was to replace the existing paper based system with a software system. A stakeholder unsubscribed to the project with the reason "I find that the 'paper' system as it is, works extremely well. I think that online applications will be more time-consuming than the present system. I feel that I want to avoid anything which suggests sitting at a computer for even longer than I do already." Another stakeholder unsubscribed and provided the reason "Sorry but I don't think I can spare the time (to attend project meetings)." Uncovering negative and unavailable stakeholders early in the project can help the practitioners mitigate the risks because they can monitor negative stakeholders, and find other available stakeholders.

Some unsubscriptions revealed "non-stakeholders" or stakeholders who have changed their roles. These people nominated other more suitable stakeholders in their unsubscription. For example, a non-stakeholder wrote "I am no longer the [role] of [department name]. Please could you send your invitation to [name] [email] and [name] [email]." Another non-stakeholder wrote, "I don't have any involvement with the xxx process. This is dealt with by [name]."

Stakeholders' comments about other stakeholders provided the practitioners with the rationale of their recommendation and additional information about the stakeholders. For example, the following comments described the stakeholder's expertise, "[Name] has been contributing to [another project] on children, disabilities and well-being in informal settlements in India," and "[Name]'s influence is very strong in assisting with the more complex proposals." Another comment revealed suitable representatives of a stakeholder group, "As the central contact point for [group], [name] could be the point of information." Private comments were informative but generally less positive. For example, "In our case this role is not very effective…However, if the role were more pro-active…it might form the basis of a more comprehensive liaison service..."

10.5.3 Value of Responses to Project

The study of StakeSource in real-world projects reveals benefits, limitations, and risks as follows.

Benefits. In general, in projects with more than 10% response rate, the practitioners found the use of StakeSource to benefit their project. An indicative factor of success is continued use of the list of stakeholders identified by StakeSource. For example, P1 and P5 used the stakeholder list as a "contact list" to organise future workshops and meetings with the stakeholders. Additional features to print the

network diagram and export stakeholder list were requested by 3 projects for visualisation and reporting purposes.

The practitioners found the network diagram and the stakeholder list to be useful. According to the practitioners for P1, "StakeSource identified some unexpected stakeholders, and the stakeholder network highlighted the need for communication among clusters of stakeholders for the project to be successful." According to the practitioner for P2, "The experts identified by StakeSource were already involved in the project or haven't been involved anyway. One exception was [name]. He came to meetings after StakeSource identified him. And since then, he has been absolutely invaluable." Practitioner for P7 also compared the importance of stakeholders reported by StakeSource with his own perception. The ratings that did not agree were double-checked and the comparison helped the practitioner view the priorities from the stakeholders' perspective. For P8, StakeSource identified relationships between stakeholders, which the practitioner were unaware of. According to the practitioner, "In a sense it makes us aware of relationships we don't recognise. However, it is not good to accept the results as they are, because some indirect relationships are presented as direct relationships, and some present relationships are lacking. For example, there is no link between NASA and the person who is responsible for collaboration with NASA." The practitioner continued to use StakeSource in the project. He explains, "if you accumulate information, trustfulness of the relationships will be improved. Then it is useful to catch the overall picture of the project."

Interviews revealed that the practitioners were keen to use StakeSource, as the tool was simple to use requiring little time and training from both the practitioners and stakeholders. In addition, the practitioners understand how and why the social networking concept works in the context. Most projects took two hours or less for the practitioners to set up on StakeSource. The practitioner for P1 regarded the automated elicitation of stakeholder information as a significant timesaving and reported that she had, in a previous project, spent weeks to manually compile a list of stakeholders of a similar size. According to four practitioners, the majority of time was spent customising the email, as the content of the email is crucial to encourage the stakeholders' response.

The usefulness of StakeSource was also reflected in the practitioners intention of using the tool in future projects, and their recommendation of the tool to their colleagues. In the interviews, 8 practitioners mentioned the use of StakeSource for future projects, and 2 projects were already in progress. In addition, 5 practitioners recommended StakeSource to their colleagues (Table 10.2). Some recommendations are learnt from the interviews. For example, a practitioner mentioned, "I showed this tool to xxx, his xxx project starts soon", another asked, "How long will this tool be available for? My managers may want to use it." Others are learnt from enquires by the practitioner. For example, enquiries from a defence organisation revealed that practitioner in P9 recommended the tool to them.

Finally, as reported in the previous section, StakeSource enables stakeholders to voice their opinions early in the project. As a result, it detected non-stakeholders, positive and negative stakeholders at the start of the project.

Limitations. As StakeSource automatically elicits information from stakeholders, its use is limited in projects where stakeholders are not incentivised to contribute [16]. Although manual approaches are time consuming for the practitioners, the presence of the practitioners can encourage reluctant stakeholders to provide information [10]. In addition, collaborative software applications such as StakeSource provide different levels of benefit to different stakeholders [16], hence those who do not see the benefit in contributing would be less inclined to contribute, especially when the elicitation is done by an automated tool.

The usefulness of StakeSource's output was dependent on number of stakeholder responses. In projects with higher response rate and higher number of recommendations per stakeholder, StakeSource's output was deemed to be more useful to the practitioners. The practitioners in projects with less than 10% response rate were disappointed with the information elicited by StakeSource. As commented by the practitioner in P3 with only 1 recommendation, "it (StakeSource) didn't do much, did it?"

A practitioner posed a broader concern. If an organisation uses StakeSource for many projects, some individuals may receive an increasing number of emails asking for recommendations in various projects, which will start to take time to complete. Eventually, these individuals may start to ignore recommendation requests.

Risks. The automatic contact of stakeholders was not always favourable to the practitioners. In addition, although StakeSource is open and inclusive, many projects have private information that should not be shared with all stakeholders. In one of the projects, stakeholders recommended potential vendors that were bidding for the project. As the vendors were recommended, StakeSource automatically invited them to make recommendations, and provided them with access to all the stakeholders in the network. This threatened to lead to an unfair bidding process. The practitioners reported, "We deleted potential vendors from the list – they should not be able to see internal stakeholder information. Can we 'approve' the stakeholders before they receive the invitation?" Other practitioners who expressed interest in StakeSource highlighted similar privacy issues. For example, a practitioner from the defence domain requested a feature to restrain StakeSource to only send emails within their organisation. Another requested for StakeSource to allow private objectives with a classified list of stakeholders and information that are only available to certain stakeholders.

According to a practitioner, mistakes are more open using the crowdsourcing technique in StakeSource. If the project is not interesting and there is no response, everyone knows about it. The same goes for mistakes in the invitation email. The practitioner was referring to an incident where a bug in StakeSource caused it to send garble html emails to the stakeholders. In addition, if practitioners continu-

ously ignore the information provided by stakeholders, then the stakeholders may stop contributing in future projects.

10.5.4 Factors that Influence Stakeholder Engagement

The application of StakeSource to multiple projects highlighted the following factors that influence the stakeholders' engagement. (Some factors are common in requirements elicitation regardless of the technology.) We conclude our discussion with a description of these factors.

Factor 1. Number of stakeholders and location. The automated crowdsourcing in StakeSource works best when there are many users. If there are only a few stakeholders and they are co-located, all stakeholders can communicate without needing to use StakeSource. For instance, in P9, informal recommendations were already in progress. In P4 and P6, there were too few stakeholders (2-3) to start the snowballing process. Projects with higher response rate have more stakeholders, and the stakeholders are not available at the same time, in different departments, or in distributed locations.

Factor 2. Stake and benefit. Stakeholders are more likely to respond when they have more stake in the project, or when there is direct benefit associated with their response. For example, in P2, experts were more motivated to provide their expertise description, than to recommend other experts. Although the response rate was high, the majority of responses were description about the person's expertise in the field, rather than recommendations of other experts. Providing their expertise could get them involved in the project but recommending other experts may meant the other experts would obtain the funding. This observation was confirmed by the practitioner, "The context is very important for StakeSource to work: stakeholders must be incentivised to make recommendations. In this project, most respondents may have been more incentivised to provide their expertise than recommend other experts." In P3, the random people in the organisation have very low stake in the project. As such, they may know parties interested in the project, but did not recommend due to lack of benefit for them to do so.

In all projects, the practitioners customised the email that stakeholders will receive, in order to motivate the stakeholders to make recommendations. For example, in P1, the email started with "This project will affect you." In P5, the practitioners realised that recommendations were unlikely to benefit the recommender, hence started their email with "Help! We need your input into…"

Factor 3. Culture. Culture and social conventions affected the stakeholders' recommendations, which in turn influenced the effectiveness of StakeSource. Interviews revealed that the stakeholders in P8 (Japanese project) were polite and more

private. The stakeholders were aware that their recommendations were not anonymous as the invitation email from StakeSource reveals the recommenders' identity. Hence, they only recommended stakeholders that they were familiar and interacted with, as they do not want to "disturb important people." As a result, stakeholders with higher positions in the organisation hierarchy were not recommended and hence omitted in the stakeholder list, although they were crucial to the project. For example, the Director was not recommended, but was responsible to promote the project and make budget decisions. The stakeholders might be more "free in their recommendations" had they been anonymous.

In addition, stakeholders in P8 only provided private comments, even when their comments were positive. Two stakeholders from different projects (one UK project and one Japanese project) provided the same comment about not remembering the exact details of the stakeholder they recommended. But the stakeholder in the UK project put the comment as public, while the stakeholder in the Japanese project put the comment as private.

P8 was also the only real-world project with a connected stakeholder network (Fig. 10.3). A social network is connected when there are no disconnected components. This indicates that the stakeholders who were involved in P8 were aware of one another. All the other real-world projects had disconnected components. For example, P5 had four disconnected components (Fig. 10.3). This finding is contrary to the assumption in the previous work that the stakeholder network is connected [10]. Interviews revealed that stakeholders in disconnected components are responsible for different subsystems or work for different departments.

Factor 4. Availability. StakeSource promises to automatically elicit information from stakeholders even when they are not physically present. Nevertheless, the stakeholders' response depended on their availability when the invitation email was received. If they were away or on holiday, they tended not to respond despite having access to the Internet. For example, P1 had a tight schedule to complete stakeholder analysis by 15th Jan. The response rate was skewed by the time and duration StakeSource was used. According to the practitioners, "it was the time of year where people were particularly busy. We were warned to do it another time, but we had no choice as the meetings started in January." The duration given for stakeholders to make recommendations was just two weeks, excluding the Christmas break. Many stakeholders were on holiday during the recommendation period. According to the practitioners, "There is never a quiet time especially for large projects involving many departments or organisations because different departments have their own busy time. Project managers need to be cautious about the best time to run StakeSource to increase the number of recommendations."

In most projects, reminder emails were used by the practitioners a week after the initial email was sent, to remind stakeholders to respond. The reminder emails were able to encourage more stakeholders to respond. In addition, interviews with some stakeholders revealed that they did not respond because they were waiting for someone else to do it.

Factor 5. Clarity of instructions. The content and clarity of the project description and the invitation email is crucial to encourage response. This finding is consistent with existing literature for manual requirements elicitation approaches [25]. But because StakeSource is web-based, the importance of the clarity of instructions is increased, as the practitioners are not available to clarify or explain their intentions. In some projects, lack of response came from the stakeholders not knowing what the practitioner was looking for. For example, P5 initially received low response. The practitioner contacted some stakeholders asking if the lack of response was due to the tool being difficult to use. The stakeholders responded that they know how to use the tool, but the email description was vague and they did not understand what the project manager was looking for, hence did not make recommendations. Once the email description was clarified, the stakeholders made their recommendations.

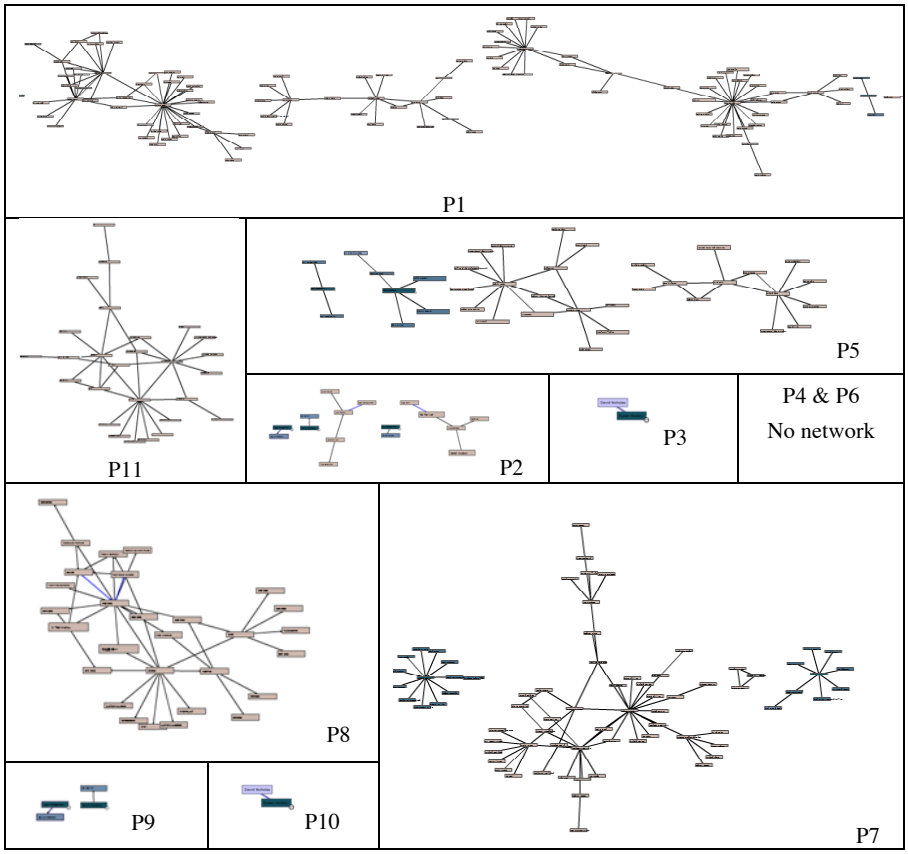

Fig. 10.3. Social networks of stakeholders. Names are blurred for reasons of privacy.

Factor 6. Politics. Politics and conflicts of interest can affect the success of collaborative software applications, StakeSource or not [16, 26]. For StakeSource, political issues affected the recommendations stakeholders made and whether they made recommendations at all. In some projects, none of the stakeholders from higher-level management made recommendations, despite being influential stakeholders. A practitioner explained, "Although StakeSource is open and inclusive, some stakeholders are not. They may refrain from recommending a stakeholder to exclude their involvement in the project." Another practitioner mentioned, "They (the stakeholders) know who the other stakeholders are, but they want us to find it out ourselves." These stakeholders refuse to be engaged as their input benefits the practitioner but brings little benefit to themselves.

The practitioners also mentioned that some stakeholders are reluctant to respond to an automated tool. For these stakeholders, manual approaches using phone calls or face-to-face interviews may still be required to elicit responses. In addition, the recommendations can be biased. Some stakeholders may recommend people who are important to them in their work, regardless of whether these people will be useful for the project. Others may choose not to recommend rather than to omit recommending a stakeholder who is important to them.

10.6 Threats to Validity

This study is based on ten real-world projects that have used StakeSource during the first year of its deployment. Due to the variation in project size, location, and application area, there must be some caution generalising the lessons learnt to other projects. For example, cultural effects on recommendations were observed in one project P8. As more practitioners use StakeSource in their projects, additional studies should be conducted to gain further insights, and the factors that influence stakeholder engagement can be studied in more detail.

In this work, the quality of the stakeholder list returned by StakeSource was evaluated qualitatively by interviewing the practitioners. Future work should follow up with the projects when they have completed, to compare the list of stakeholders identified by StakeSource against the actual list of stakeholders in the project in terms of their pertinence. Future work should also conduct more in-depth analysis of the findings, such as analysing the relationship between project size and effectiveness of StakeSource, the effect of using StakeSource on the quality of the final product, and the properties of the different stakeholder networks.

Finally, the authors of this paper were involved in the development and deployment of StakeSource. Due to social niceties, the practitioners' feedback on StakeSource may be positively biased. Nevertheless, these practitioners have little incentive to make socially desirable remarks, and they have been quite frank (e.g., the practitioner in P3 said that StakeSource did not do much). In addition, it was made clear to the practitioners and stakeholders that the main objective of their

feedback was to improve the work. Also, their interview comments were corroborated with quantitative data and evidence. For example, we considered a practitioner X to have recommended StakeSource to practitioner Y only if practitioner Y enquired about or adopted StakeSource.

10.7 Conclusions

Web 2.0 collaborative tools such as StakeSource are likely to play an increasingly important role in supporting requirements elicitation, especially for emerging forms of development such as distributed development.

This paper reports our experiences of and lessons learnt from the use of StakeSource in ten real-world projects. We learnt that the effectiveness of StakeSource in semi-automating stakeholder analysis is dependent on the stakeholders' engagement. In projects with large number of stakeholders who are motivated to contribute, StakeSource was able to elicit useful stakeholder information with little support from the practitioners. For example, StakeSource was able to uncover missing stakeholders, negative stakeholders, and the stakeholders' opinion about other stakeholders at the start of the project. Yet, it failed to elicit information when stakeholders were not incentivised enough to contribute. The main factors that influence stakeholder engagement via StakeSource include the number of stakeholders and their location, the stakeholders' motivation to be engaged and their stake in the project. The stakeholders' culture, availability, clarity of instructions from the practitioners, and politics in the organisation also affect stakeholder engagement.

Stakeholder engagement is crucial for the success of Web 2.0 collaborative tools such as StakeSource. Future work should address the critical issue of incentives to increase stakeholder response.

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References

1. Nuseibeh, B., Easterbrook, S.: Requirements engineering: a roadmap. In: Proc. of the Conf. on the Future of Soft. Eng., pp. 35 - 46 (2000)
2. Sharp, H., Galal, G.H., Finkelstein, A.: Stakeholder identification in the requirements engineering process. In: Proc. of the Database & Expert System Applications Workshop (DEXA), pp. 387–391 (1999)

3. Zave, P.: Classification of research efforts in requirements engineering. ACM Computing Surveys 29, 315-321 (1997)
4. Macaulay, L.: Requirements engineering. Springer Verlag (1996)
5. Maiden, N., Ncube, C., Robertson, S.: Can requirements be creative? experiences with an enhanced air space management system. In: Proc. of the 29th Int. Conf. on Soft. Eng. (ICSE), pp. 632-641 (2007)
6. Gottesdiener, E.: Requirements by collaboration: workshops for defining needs. Addison-Wesley Longman Publishing (2002)
7. Gause, D.C., Weinberg, G.M.: Exploring Requirements: Quality Before Design. Dorset House Publishing Company, Inc. (1989)
8. Alexander, I.: A taxonomy of stakeholders: human roles in system development. International Journal of Technology and Human Interaction 1, 23-59 (2005)
9. Lim, S.L.: Social Networks and Collaborative Filtering for Large-Scale Requirements Elicitation. University of New South Wales, Australia. PhD Thesis (2010)
10. Lim, S.L., Quercia, D., Finkelstein, A.: StakeNet: using social networks to analyse the stakeholders of large-scale software projects. In: Proc. of the 32nd Int. Conf. on Soft. Eng. (ICSE) -Vol. 1, pp. 295-304 (2010)
11. Lim, S.L., Quercia, D., Finkelstein, A.: StakeSource: harnessing the power of crowdsourcing and social networks in stakeholder analysis. In: Proc. of the 32nd IEEE Int. Conf. on Soft. Eng. (ICSE) -Vol. 2, pp. 239-242 (2010)
12. Cleland-Huang, J., Mobasher, B.: Using data mining and recommender systems to scale up the requirements process. In: Proc. of the 2nd Int. Workshop on Ultra-Large-Scale Software-Intensive Systems, pp. 3-6 (2008)
13. Serrano, N., Torres, J.M.: Web 2.0 for Practitioners. IEEE Software 27, 11-15 (2010)
14. Damian, D.: Stakeholders in global requirements engineering: Lessons learned from practice. IEEE Software 24, 21-27 (2007)
15. Storey, M., Treude, C., van Deursen, A., Cheng, L.: The Impact of Social Media on Software Engineering Practices and Tools. In: FSE/SDP Workshop on the Future of Software Engineering Research, (2010)
16. Grudin, J.: Groupware and social dynamics: eight challenges for developers. Communications of the ACM 37, 92-105 (1994)
17. Oreilly, T.: What is Web 2.0: Design patterns and business models for the next generation of software. (2007)
18. Pouloudi, A., Whitley, E.A.: Stakeholder identification in inter-organizational systems: gaining insights for drug use management systems. European Journal of Information Systems 6, 1-14 (1997)
19. Cheng, B.H.C., Atlee, J.M.: Research directions in requirements engineering. In: Proc. of the Conf. on the Future of Soft. Eng., pp. 285-303 (2007)
20. Alexander, I., Robertson, S.: Understanding project sociology by modeling stakeholders. IEEE Software 21, 23-27 (2004)
21. Scott, J.: Social Network Analysis: A Handbook. Sage (2000)
22. Lindlof, T.R., Taylor, B.C.: Qualitative Communication Research Methods. Sage (2002)
23. Deutskens, E., De Ruyter, K., Wetzels, M., Oosterveld, P.: Response rate and response quality of internet-based surveys: an experimental study. Marketing Letters 15, 21-36 (2004)

24. Yu, J., Cooper, H.: A quantitative review of research design effects on response rates to questionnaires. Journal of Marketing Research 20, 36-44 (1983)
25. Thayer, R.H., Dorfman, M. (eds.): Software Requirements Engineering. Wiley-IEEE Computer Society Pr (1997)
26. Dobson, J., Blyth, A., Chudge, J., Strens, R.: The ORDIT approach to organisational requirements. Requirements Engineering: Social and Technical Issues, pp. 87-106. Academic Press Professional, Inc. (1994)