Providing a User Forum is not enough: First Experiences of a Software Company with CrowdRE

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***Abstract*—Crowd-based requirements engineering (CrowdRE) is promising to derive requirements by gathering and analyzing information from the crowd. Setting up CrowdRE in practice seems challenging, although first solutions to support CrowdRE exist. In this paper, we report on a German software company's experience on crowd involvement by using feedback communication channels and a monitoring solution for user-event data. In our case study, we identified several problem areas that a software company is confronted with to setup an environment for gathering requirements from the crowd. We conclude that a CrowdRE process cannot be implemented ad-hoc and that future work is needed to create and analyze a continuous feedback and monitoring data stream.**

***Index Terms*—CrowdRE, end-user feedback, user involvement, requirements engineering, user events, monitoring solution.**

I. Introduction

In Crowd-based requirements engineering (CrowdRE) methods and tools are applied to derive requirements by gathering and analyzing crowd data [1][2][3]. First CrowdRE solution ideas exist which allow gathering and analyzing needs and ideas from a large group of (potential) end-users and other stakeholders of a software system [4][5][6][7][8].

One variant to involve end-users for CrowdRE activities is the collection of feedback and monitoring data. While multimodal feedback gathering approaches engage crowd members to report on problems, feature requests, and product improvement ideas, context and usage data from crowd-based monitoring systems can be used to derive further requirements or define the number of affected end-users [9]. Even when crowd members have faked identities, produce intentionally wrong reports, or have low reputation [10][11], monitoring data seems promising to validate feedback received [9].

In this paper, we describe a software company's very first experience on setting up CrowdRE in practice. The aim of the case study was to understand challenges that a software company deals with when setting up an environment for requirements collection from the crowd. In this connection, we focused on the collection of crowd feedback and monitoring data.

Together with the software company, we analyzed its initial situation and identified problems the company has when it comes to feedback gathering and crowd-based monitoring (Section II). Next, a multimodal feedback tool and a monitoring solution were integrated in the software company's web application and evaluated in a pilot study (Section III). We discuss to what extent the feedback tool and monitoring solution has solved the problems (Section IV), and identify what are still open challenges for the software company on their CrowdRE journey (Section V).

II. Initial Situation at SEnerCon

To understand the as-is situation at the software company SEnerCon (see Section A), we realized a case study to analyze and reflect on the limitations and strengths of SEnerCon's current process to involve their end-users by providing them feedback communication channels and analyzing user event data. We conducted an on-site workshop and discussed with relevant stakeholders (i.e., one end-user, the CTO, the helpdesk agent, the manager, and developers) (see also [12][13]) limitations and benefits of the current feedback communication channels and monitoring solution as well as needs and ideas for improvement. Two of the academic authors analyzed the collected data by linking relevant paraphrases to the initial interview questions. SEnerCon reviewed the results and corrected wrong paraphrases and summaries. The workshop was carried out as part of the SUPERSEDE EU project (http://supersede.eu).

A. The Company SEnerCon and the Web Application iESA

SEnerCon, a small and medium-sized enterprise (SME) in Germany, has 25 years experience in engineering and consultancy in the energy efficiency management domain. Currently, SEnerCon has fifteen employees, including one manager, one help-desk agent, one CTO and twelve software architects, developers and engineers. SEnerCon's web application, the "interactive Energy Saving Account" (iESA), is used by more than hundred thousand end-users for monitoring and analyzing the energy consumption of their homes. The iESA end-users are spending in average ten minutes per session to enter their

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consumption data, comparing their data with other households and playing around with statistical diagrams. In average, the iESA has 340 logins per day, depending on the season.

B. The Crowd at SEnerCon

As for many software companies, for SEnerCon it is challenging to fully anticipate all end-user needs and application contexts in advance. This is especially true for SEnerCon, who provides a powerful tool to monitor energy consumption including features also for special cases (e.g., public buildings, large heated living space). Moreover, the crowd is almost unknown to SEnerCon. The German end-users are very sensitive regarding their data, so SEnerCon do not collect demographic data (e.g., gender, age) for registration. However, from a survey conducted in 2014 with 2,500 end-users, SEnerCon forecasts that more than two-thirds of their end-users are 40 years or older and that two-thirds are males.

C. SEnerCon's Initial Strategy to Involve the Crowd

SEnerCon is aware that, if they don't give their end-users a voice, they miss the chance to increase their knowledge about problems users encounter and their end-users' improvement ideas. Thus, SEnerCon decided to involve the crowd for RE activities. For this, SEnerCon started to collect feedback and monitoring data through simple and separate collection mechanism.

1) Feedback Data Collection

SEnerCon's end-users can communicate needs, wishes and problems through *five feedback channels*. For a bilateral communication with SEnerCon, end-users can contact the help-desk agent by *phone*, *email* or *contact form*. In case end-users want to make their feedback public to the crowd, they can post their feedback in the energy saving account *forum*. Forum entries are always public and visible for even unregistered users. The *social networks Twitter and Facebook* are also available to send feedback publicly.

2) Monitoring Data Collection

SEnerCon collects some monitoring data from the registered end-users that interact with the iESA. To do so, the end-users have been informed and accepted that their data, including usage logs, are used and analyzed by the company, upon anonymization. SEnerCon's current monitoring strategy includes the collection of run-time data derived from different sources. In practice, SEnerCon's strategy includes:

- Monitoring Quality of Service (QoS) through *system logs* of different components at the server side of SEnerCon (e.g., logs from Linux, Apache Server, PHP). These logs are used, for example, to collect errors and warnings, or identify the availability of components.
- Monitoring *hardware statistics* by using Munin (http://munin-monitoring.org/) at the user and server side.
- Monitoring *end-user interactions* (e.g., page views) with the SEnerCon iESA web page by using Google Analytics (https://analytics.google.com).

D. Problems with SEnerCon's Initial Strategy and Need for Improvement

1) Feedback Data Collection

Regarding provision of feedback data, the first and main problem identified in the workshop is that *the crowd activity is quite low*. In 2015, SEnerCon received 332 feedback entries. Compared to over 100,000 end-users, this amount of feedback seems very low. However, SEnerCon experienced that this feedback could include valuable information such as bug reports, but also feature shortcomings, strengths, and requests.

The second problem is that most of the feedback was communicated via *non-public communication channels* including email, contact form and hotline. Only in 80 of 332 cases, end-users chose the public forum to communicate their feedback to SEnerCon – and the crowd. Such a low rate of public feedback makes is cumbersome for SEnerCon to involve the crowd to validate feedback sent by single crowd-members. To overcome this, SEnerCon initiated diverse forum threads to motivate the crowd to provide feedback public in the forum. Nevertheless, end-users use the forum mostly for sharing tips for saving energy and not for providing feedback. Also the social networks are rarely (Facebook) or never (Twitter) used to provide feedback on the iESA.

The third problem with the current feedback communication channels SEnerCon provide is *missing information to understand and interpret the feedback*. For example, if an end-user communicates her feedback via email, but uses an email address not registered in the iESA list, the help-desk agent must ask for the user ID in an answer email. This is time-consuming and could also be frustrating for end-users. Moreover, missing information (e.g., last visited page in the iESA) and text-based feedback are not only hindering SEnerCon to understand the feedback, but also the crowd: unstructured feedback entries in the forum could be very unattractive for other end-users to read and too time-consuming to understand.

Based on these three problem areas, we defined with SEnerCon requirements for a solution. SEnerCon would like to elicit *more* data from the crowd including validated feedback. Furthermore, feedback entries should be *enriched with media* (e.g., annotated screenshots) *and metadata* (e.g., browser data, URL, end-user's ID) to support an easy analysis and interpretation of the feedback. However, as SEnerCon also would like to motivate their end-users to discuss feedback entries, the crowd-members' privacy has to be protected.

2) Monitoring Data Collection

As identified in the on-site workshop, SEnerCon collects monitoring data from the four aforementioned sources. From an operational point of view, the collected data is useful to keep the system under an adequate QoS. However, the first and main problem that SEnerCon experiences is that this data is *not suitable to identify and understand the needs of the crowd* in order to evolve the system successfully. Currently, the identification of evolution needs is obtained only from the feedback provided by the end-users, but SEnerCon is interested to gather monitoring data that can be correlated with the obtained feedback by means of crowd-based monitors (i.e., monitors that obtain data

from the crowd) [3]. This information would help the developers to better understand and decide on how to react to feedback, in particular, when the number of users is increasing and the challenges and difficulties of dealing with huge amount of feedback from the crowd start to emerge.

The second problem that SEnerCon faces and communicated in the on-site workshop is that the current technologies used do not provide mechanisms to add new monitors at runtime (e.g., to gather other QoS data and context information).

Considering these problems, SEnerCon needs a monitoring framework that can be *correlated with feedback* obtained and can be *easily extended* to add new monitors to augment the monitored data. With respect to the latter, SEnerCon currently requires a monitoring of (i) *system data* including number of errors in certain areas, (ii) *user activity data* including page views, clicks, and (iii) *context data* including user location, user attributes, current status of a session, consumption data of the user, environment of the user (browser, device, etc.).

III. SEnerCon's Experience with a Dedicated Feedback Tool and Monitoring Solution to improve Crowd Involvement

After analyzing and reflecting the as-is situation at SEnerCon with the help of the academic authors, SEnerCon decided to improve their activities to involve the crowd for RE. As a first step to reach this goal, SEnerCon deployed a dedicated multimodal feedback tool (see Section A) and a monitoring solution that can be easily managed and reconfigured (see Section B). Both, the feedback tool and the monitoring solution were developed by the academic authors and evaluated in the SUPERSEDE project. The aim of this evaluation was to investigate if the feedback tool and monitoring solution have the potential to overcome the problems identified. The results of this evaluation are presented in Section C for the feedback tool and monitoring solution.

A. The Feedback Tool

SEnerCon implemented a built-in feedback tool in addition to the current feedback communication channels. A paper prototype was delivered by the SUPERSEDE project after a detailed analysis of feedback tools available [14]. Based on the problems identified in the as-is analysis, SEnerCon and the academic authors discussed and decided on a first configuration of the feedback tool such as supported formats [15].

After end-user's login in the energy saving account, a big green feedback button is shown below the end-user's account area in the iESA website. Clicking on the *feedback button* opens the feedback tool that guides the end-user through four steps. First, the end-user communicates her feedback by providing a textual description in the *text field* and attaching a *screenshot*. The screenshot is per default automatically taken and can be annotated by highlighting or blackening screen areas. The idea of such visualization is to support the end-user, but also the feedback receiver in communicating respectively understanding the feedback issue (e.g., [16]).

Second, the end-user can specify her feedback by choosing *categories* (which were defined by the helpdesk based on previous end-user requests), and (ii) by *rating* her satisfaction about this part of the energy saving account on a five-star scale (as used in app stores). Third, the end-user checks a preview of the feedback, and fourth decides whether her feedback is *visible to the energy saving account team only or for other end-users* (i.e., the crowd). If latter is selected, her feedback will be published in the iESA forum. Except for the satisfaction rating and the selection of a feedback receiver, end-users' inputs for the feedback documentation are optional. The user id is stored in the SEnerCon database alongside the feedback submitted.

B. The Monitoring Solution

The monitoring solution of SUPERSEDE is composed of a set of monitoring types. Each monitoring type includes a set of monitors, and in turn, these monitors are implemented by one or more Monitoring tool. Figure 1 depicts a metamodel of the composition of the monitoring solution.

Fig. 1. Metamodel of the monitoring solution.

For the evaluation study, SEnerCon stated that they were interested in the monitoring type of *user events*. This monitoring type refers to the monitors of events generated by (a crowd of) end-users. An example of a monitor of this type is the monitor of the clickstream in a web platform and the monitoring tool is an implementation of such monitor. The architecture is further described in [17], and enables to manage and add new monitors and monitoring tools dynamically at runtime.

The monitoring tool used in this evaluation is a custom-made HTML-based event-monitoring tool. Such a monitoring tool was implemented by the academic authors, and can monitor the clickstream of a user, including data such as, timestamps, type of click (e.g., right-, left-, or double-click), the id of the clicked element, the text included in that element. The monitored data of this tool can be correlated with the feedback gathering data, since it identifies the users using the same mechanism as in the feedback tool.

C. Evaluation

1) Feedback Tool

In this section, we describe SEnerCon's experience in a short evaluation phase of their newly introduced feedback tool. The key goal of the evaluation was to explore to what extent the problems, which we identified in SEnerCon's initial solution, could be solved with the feedback tool implemented. Thus, we were interested in: (i) the crowd involvement level including the amount of feedback data gathered and the acceptance of the feedback tool by the end-users, (ii) the percentage of public feedback entries sent with the feedback tool, and (iii) the crowd's usage of media to enrich the feedback entries and the quality of the feedback entries perceived by SEnerCon.

After implementing the feedback tool in the iESA, SEnerCon sent an email out to all the end-users of the energy saving account promoting the feedback tool. Crowd-members who

sent feedback by using the feedback tool in a time-period of two weeks received another email with a link to a short follow-up online questionnaire designed by the researchers.

The evaluation data were analyzed by the academic authors and are presented as following.

(i) Amount of feedback data gathered and acceptance of the feedback tool. SEnerCon received 81 feedback entries from 82 end-users in two weeks (seven feedback entries were excluded for further analysis due to invalid information, such as "test"). The feedback was mainly about (multiple-answers possible) ideas for improvements (37), computation error (17), others (17) and technical problems (13). "General error" was chosen in seven cases and "expert question" in four cases.

Regarding the follow-up online questionnaire, only 32 end-users participated. First, we asked how the end-user would give SEnerCon in the future feedback about the energy saving account (multiple answers). Approximately three quarters of the survey participants could imagine giving feedback again by using the feedback tool (i.e., "feedback-function") (23 of 32), whereas 13 of these 23 end-users choose the feedback tool as an exclusive channel to provide feedback. However, some end-users plan to give feedback using SEnerCon's other feedback communication channels: Forum (3 times selected), email (6), contact form (6), and hotline (1).

Second, end-users evaluated the *usability and usefulness* of the feedback tool by answering two meCUE question modules [18]. In average, the 32 end-users agreed that the feedback tool is usable (M = 6.1, SD = 1.0) and useful (M = 5.3, SD = 1.1).

(ii) Public feedback entries. In more than half of the cases (62%), end-users chose the SEnerCon team as feedback receiver only and therefore decided against a publication of their feedback. Latter option was chosen in 30 cases.

(iii) *Media used and perceived quality.* Surprisingly, the screenshot function was only used thirteen times, and in only three cases end-users annotated the screenshot. The academic authors asked three SEnerCon team members, who received and analyzed the feedback, how *clear and relevant* they judge the feedback entries. The three team members had heterogeneous opinions on the clearness: one selected "moderate clear", one "quite clear", and one "very clear". However, all three team members stated that the feedback was "quite relevant". Linked to the statements about the clearness, the team suggested that end-users should be more engaged to use *the screenshot (and annotation) function*, especially when an end-user wants to provide feedback about a specific part in the iESA. Moreover, end-users should be requested to *write shorter text*; in the evaluation study, the text written by the end-users had an average length of 315 characters (MIN = 47, MAX = 998 characters). In addition, SEnerCon would like to receive *more structured feedback*, for example, by asking end-users about previous actions in the iESA. As stated by SEnerCon, all these aspects would not only help SEnerCon as feedback receiver to understand the feedback, but also the feedback sender to communicate her feedback efficiently. Beyond that, we assume that a short and structured feedback entry enriched with media would also help the crowd to easily interpret that feedback entry and to react on it (e.g., by providing an agreement rating).

2) Monitoring Solution

In this section, we describe the evaluation of the monitoring solution. We conducted the evaluation in two parts and aimed to explore: (i) SenerCon's acceptance of the monitoring tool, and (ii) the amount and usefulness of monitored data that can be gathered.

In the first part, the academic authors prepared a document with the specifications of the monitor (i.e., its functional description), a mock-up of the monitor and a questionnaire to evaluate the potential benefits of the monitor. Four internal evaluators from the SEnerCon development team with different backgrounds (see Table I) assessed the proposed monitoring solution from different points of view. In this scenario, the evaluators read and analyzed the specifications of the monitor, test the prototype and finally, filled in the questionnaire.

The main results are reported in Table I, which presents the perceived benefits obtained by using the monitor. In the questionnaire, the evaluators indicated their level of agreement on each of the proposed statements (1 = strongly disagree, 7 = strongly agree).

The last statement (see Table I) shows that SEnerCon was willing to adopt the monitoring system. Therefore, SEnerCon installed the monitoring system in the productive environment of the iESA platform and the academic authors conducted the second evaluation part. We monitored the end-users clickstream and their navigation through the web page. For 80 days, we collected an amount of 260,637 user events from 2,930 end-users. Afterwards, the academic authors with the help of SEnerCon team members conducted a manual analysis on a small subset of such data to evaluate its usefulness.

In this regard, we could identify several ways in which the automatic combination of monitored data and feedback data can be exploited. For example, we could identify what the users did before they complained that a functionality was too complex to use. In this regard, we could gather how the end-users interacted with the system and identify if that problem was only for a small subset of the end-users or affected the whole crowd. We were also able to identify how some end-users searched for a not existing functionality before they provided the feedback asking for the implementation of such functionality. This may help the developers to identify where and how the requested functionalities should be presented to the end-user.

TABLE I. PERCEIVED BENEFITS OF THE MONITORING SOLUTION

Statement	Evaluator answers			
	PM	*SA*	*DV1*	*DV2*
Using the monitoring system would improve our *Quality of Service*.	4	6	6	5
Using the monitoring system would improve our *end-user satisfaction*.	4	6	6	7
Using the monitoring system would give our company a *financial benefit*.	4	5	n.a.	5
Having the monitoring system would be *more useful* than the current approach.	3	4	6	7
Using the monitoring system would enable me to analyze the software *more effectively*.	5	5	4	6
I would like to *adopt* the monitoring system. (overall assessment)	3	7	6	6

PM = Project Manager, SA = Software Architect, DV1/2 = Developer 1/2

Finally, we were also able to identify the most used functionalities by the crowd and the average time it took them to complete their activities.

After the analysis, the usefulness of the monitored data was discussed with SEnerCon, who considered all these capabilities that the monitor offers very relevant. As one team member stated, "understanding what the users look for, what they do, what are the most used functionalities, how do they use them, etc. is a very interesting and very valuable information for us to improve the usability of the system".

IV. Discussion and Next Steps

With implementing a dedicated multimodal feedback tool, SEnerCon intended to increase the crowd activity and to receive more public feedback that is easy to understand as it is enriched with further media and data.

The fact that only 82 of approximately 100,000 end-users used the advertised feedback tool in a pilot phase of two weeks should be interpreted with caution. In 2015, end-users gave about 300 times feedback; related to this sum, nearly 80 feedback entries in two weeks could be interpreted as increased crowd activity. However, long-term evaluation data are needed to indicate whether this was an irregular peak of crowd activity caused by the advertisement of the feedback tool. In this long-term evaluation, also the distribution of feedback among the other feedback communication channels should to be tracked and used for interpretation. In our feedback tool evaluation, we did not consider how many feedback issues were reported via other communication channels. Thus, we don't know whether end-users used the feedback tools instead of other communication channels or in addition. Moreover, we need to identify how we can motivate end-users to provide feedback continuously. The academic authors and SEnerCon assume that based on a higher number of feedback entries received, SEnerCon could make better software evolution decisions as a high number of feedback would allow for validation and prioritization of feedback entries done by SEnerCon team members. In addition, SEnerCon appreciates receiving public feedback, because public feedback would allow other end-users to comment and even prioritize and validate feedback [9]. However, derived from the evaluation results, it seems that it is still an issue for SEnerCon to engage their end-users to make their feedback public. Again, a long-term evaluation would help us to clarify if the SEnerCon end-users simply need more time (cf. two-weeks evaluation) to get used to the feedback tool and to appreciate public exchanges. In case it is not a matter of habituation, but end-users are worried about their privacy, one solution could be that SEnerCon still collects feedback in a non-public bilateral communication, but asks the feedback sender to agree on forwarding her modified (e.g., anonymized, shortened) feedback to the crowd. In case of a lack of motivation to provide (public) feedback, a promising approach to engage end-users is gamification (e.g., [19]). However, in the case of SEnerCon, we first need to investigate which gamification elements are candidates to engage the SEnerCon end-users.

In our case study, we showed that the feedback received via the dedicated feedback tool was relevant and understandable. However, we did not compare feedback entries received from the feedback tool with those communicated via other channels. Moreover, as only few end-users used the screenshot (and annotation) function, we cannot state to what extent further media helps to understand a feedback. Thus, as a next step, we will investigate why end-users did not use the screenshot function, although the feedback tool was rated as usable.

Regarding the monitoring solution, the monitored data has enabled SEnerCon to enrich the feedback data with details on how the end-users interacted with the iESA platform. Such combination provided support to developers to better understand the feedback. However, SEnerCon also identified some improvements that should be addressed in subsequent versions. First and foremost, collecting the user events related only to clicks is not sufficient in some circumstances (e.g., to gather how the end-user fills a web form). To address this issue, we will enhance this monitor to collect more types of user events (e.g., content changes in a text-box).

Secondly, combining the monitored data with feedback data is a significant and complex challenge. Currently, the academic authors have been able to do so manually (i.e., inspecting what the users did before and after providing feedback). Such manual intervention has been useful to demonstrate the feasibility and usefulness of combining monitored data with feedback data. Nevertheless, in a crowd environment, automatic means to analyze this data is needed. To address this challenge, we need to provide valuable automatic (or semiautomatic) means that would help developers on analyzing the feedback with monitored data autonomously.

Finally, we need to identify and exploit the full potential of such a combination. For instance, it could be used to automatically define or tailor the *priority* of a feedback issue (e.g., when one single end-user reports an issue, the monitoring data could help to identify the dimension of this problem). Another example is that it provides data than can be used to identify how the software should be improved from a usability point of view.

V. Conclusion

Although CrowdRE seems promising for gathering requirements for software development and evolution, there is a lack of knowledge on how software companies set up crowd involvement activities in practice. We observed a German software SME during their first steps in crowd-based feedback and monitoring data collection, and reported on their experiences during an initial implementation and evaluation phase.

We found that the end-users of the energy saving account communicate feedback very seldom and prefer a bilateral and non-public feedback communication with the software company. This could make it cumbersome for the software company to involve the crowd for feedback gathering and validation activities. Regarding crowd-based monitoring, we identified that the company requires a monitoring system that is not only aimed at maintaining the QoS and other operational functions of the system, but that it can be combined with feedback data.

In this regard, we want to investigate in a follow-up long-term evaluation, how combined monitoring and feedback data can increase the data analysis quality in the use case. We as-

sume, for example, that correlations of monitoring and feedback data are useful to make decisions in software evolution or to derive requirements based on data from the crowd.

Concluding, our initial findings are not surprising and need to be validated in a long-term evaluation study. However, our case study shows that a CrowdRE process is not an overnight, but complex task for a software company and requires major efforts of the company that go beyond ad-hoc feedback communication channels and collecting monitoring data. With the software company analyzed, we plan to investigate how solutions provided by research could prove themselves in practice and help software companies to involve the crowd for requirements engineering.

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