

Toward Crowdsourcing for Requirements Elicitation: Results from Expert Survey

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Abstract. Crowdsourcing is an emerging paradigm, which utilizes the power of the crowd in contributing information and solving problems. Crowdsourcing can support requirements elicitation, especially for systems used by a wide range of users and working in a dynamic context where requirements evolve regularly. For such systems, the application of traditional elicitation methods is typically costly and limited in catering for the high diversity, scale and volatility of requirements. In this survey, we confirm and enhance our findings from two focus groups with an expert opinion study involving 34 participants. Our results support the move from developer-led to human-centred requirements engineering through enabling the users' crowd to voice their needs and opinions.

1 Online Expert Survey

The main purpose of the online expert survey was to compare and contrast the views of experts in requirements engineering with those who participated in our focus groups as ordinary users and software developers, which was conducted prior to this survey and yielded interesting findings. We also wanted to confirm or otherwise reject the findings of the focus groups.

1.1 Expert Survey Session

The online expert survey was initially and formally introduced in the opening ceremony of REFSQ'14, the 20th International Working Conference on Requirements Engineering: Foundation for Software Quality. The conference was held in Essen, Germany, from April 7th to April 10th, 2014. The online expert survey was designed in a way that the volunteering participants could use any electronic devices (mobile phones, tablets, laptops, etc.) to access it. A prize draw for three £30 Amazon vouchers was proposed to encourage participation in the online expert survey. The questions were all open-ended, allowing for participants to add their comments and opinions about the enquired questions. To make sure that every participant understands the meaning of crowdsourcing, two different links to the definition of crowdsourcing was provided, a shorter definition from Merriam Webster Online Dictionary and a longer definition from Wikipedia. For more enthusiastic participants, another link to a 4-minute video describing crowdsourcing and its applications was provided, with the video being on YouTube.

1.2 Expert Survey Participants

A total of 37 experts took part in our online expert survey. Providing personal information was optional, and was limited to participants' names and email addresses. The names and email addresses were requested when the participant wished to participate in our prize draw, and/or if they wanted to be sent the results of the survey. Also this information would be needed if they decided to withdraw their data at any later stage. The participants were mainly from the REFSQ community, although some had not participated in the main event.

Out of the 37 experts who started the survey, only 34 experts completed it. As a result, we will report on this last group of experts who have completed their online survey. The experts' type of expertise in requirements engineering, their years of experience in statistics, and their major expertise are summarized in Table 1.

Table 1: Summary of Experts' Information

Types of Expertise in RE		Years of Experience in RE		Major Expertise in RE
Academic	18	Min	2	Modeling, Management, Specification, Traceability, Goal Oriented RE, Problem-Frames, Privacy and Security Requirements, RE for Systems of Systems, RE teaching, Automation for RE, User-Centered RE, Social RE, Collaborative RE
		Max	33	
Industrial	7	Average	9.44	
		Median	8	
Mixed	9	Mode	10	

The level of familiarity of the experts with crowdsourcing, and instances where crowdsourcing has been put to practice in Requirements Engineering is summarized in Table 2.

Table 2: Summary of Experts' Familiarity with Crowdsourcing and Its Application

Familiarity with Crowdsourcing		Study or Product Which Utilizes Crowdsourcing for Requirements Engineering
No Familiarity	8.82%	StakeSource
Low Familiarity	47.07%	RE4RE
Good Familiarity	35.29%	RequirementsBazaar
High Familiarity	8.82%	WinBook
		StakeNet

1.3 Expert Survey Procedure

The online expert survey took about 8 minutes to complete, although it took more time if participants provided their comments and opinions. The participants were assured that their personal information, if provided, would remain confidential, and would not appear in any published work.

1.4 Expert Survey Analysis

Overall, the online expert survey remained open to the participants for 21 days, allowing for more participation from experts in their leisure time. After closing the online expert survey, all the provided data, including the comments the experts had provided, was aggregated and analyzed using both quantitative and qualitative methods.

2 Results from the Expert Survey

The expert survey consisted of 34 questions in 9 different categories. In this section, we will analyze the results of the expert survey in each category.

2.1 Largeness

In this category, the experts were asked how the largeness of the crowd engaged in requirement elicitation would affect the quality of elicited requirements. There were 4 questions in this category. Table 3 summarizes the results obtained from the experts.

Table 3: Experts opinion on the effects of largeness on the quality of the elicited requirements

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total Answers
Typically, a large crowd supports getting more accurate requirements	5.88% (2)	47.06% (16)	32.35% (11)	14.71% (5)	0% (0)	(34)
Typically, a large crowd supports having objective and non-biased requirements	14.71% (5)	35.29% (12)	23.53% (8)	23.53% (8)	2.94% (1)	(34)
Typically, a large crowd supports reaching a saturation	14.71% (5)	41.18% (14)	29.41% (10)	14.71% (5)	0% (0)	(34)
Typically, it is difficult to organize and coordinate a large crowd for eliciting requirements	29.41% (10)	41.18% (14)	17.65% (6)	8.82% (3)	2.94% (1)	(34)

2.2 Diversity

In this category, the experts were asked how the diversity of the crowd (in expertise, age, gender, locality, etc.) engaged in requirement elicitation would affect the quality of elicited requirements. There were 4 questions in this category. Table 4 summarizes the results obtained from the experts.

Table 4: Experts opinion on the effects of diversity on the quality of the elicited requirements

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total Answers
Typically, diversity makes it hard to reach a consensus/agreement on requirements	20.59% (7)	38.24% (13)	23.53% (8)	14.71% (5)	2.94% (1)	34
Typically, diversity increases the relevance and meaningfulness of requirements	35.29% (12)	50.00% (17)	14.71% (5)	0% (0)	0% (0)	34
Typically, diversity supports creativity in requirements	45.45% (15)	36.36% (12)	15.15% (5)	0% (0)	3.03% (1)	33
Typically, diversity causes inconsistency problems in elicited requirements	23.53% (8)	26.47% (9)	26.47% (9)	14.71% (5)	8.82% (3)	34

2.3 Anonymity

In this category, the experts were asked how the anonymity of the crowd (either to other people in the crowd or to the requirements team of engineers) engaged in requirement elicitation would affect the quality of elicited requirements. There were 3 questions in this category. Table 5 summarizes the results obtained from the experts.

Table 5: Experts opinion on the effects of anonymity on the quality of the elicited requirements

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total Answers
Typically, the crowd will give their honest opinion when they are anonymous	18.18% (6)	36.36% (12)	30.30% (10)	9.09% (3)	6.06% (2)	(33)
Typically, the credibility of the elicited information cannot be guaranteed	18.18% (6)	30.30% (10)	30.30% (10)	21.21% (7)	0% (0)	(33)

2.4 Competence

In this category, the experts were asked how the competence of the crowd engaged in requirement elicitation would affect the quality of elicited requirements. There were 4 questions in this category. Table 6 summarizes the results obtained from the experts.

Table 6: Experts opinion on the effects of competence on the quality of the elicited requirements

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total Answers
Typically, the crowd competence supports getting the right requirements	27.27% (9)	57.58% (19)	12.12% (4)	3.03% (1)	0% (0)	(33)
Typically, the crowd competence supports getting creative requirements	9.09% (3)	36.36% (12)	36.36% (12)	15.15% (5)	3.03% (1)	(33)
Typically, the crowd competence supports getting more relevant requirements	30.30% (10)	45.45% (15)	21.21% (7)	3.03% (1)	0% (0)	(33)

Typically, a competent crowd is more willing to see positive changes and, hence, willing to provide their requirements	18.75% (6)	21.88% (7)	59.38% (19)	0% (0)	0% (0)	(32)
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2.5 Collaboration

In this category, the experts were asked how the collaboration of the crowd engaged in requirement elicitation would affect the quality of elicited requirements. There were 4 questions in this category. Table 7 summarizes the results obtained from the experts.

Table 7: Experts opinion on the effects of collaboration on the quality of the elicited requirements

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total Answers
Typically, the crowd collaboration means an extra overhead from the management perspective	15.63% (5)	46.88% (15)	21.88% (7)	12.50% (4)	3.13% (1)	32
Typically, collaboration leads to clusters of users with different and sometimes conflicted views	12.50% (4)	68.75% (22)	18.75% (6)	0% (0)	0% (0)	32
Typically, collaboration leads to dominance of certain opinions and missing that of less powerful users	22.58% (7)	41.94% (13)	25.81% (8)	9.68% (3)	0% (0)	31
Typically, collaboration helps requirements engineers to understand the rationale of elicited requirements	28.13% (9)	31.25% (10)	31.25% (10)	9.38% (3)	0% (0)	32

2.6 Intrinsic Motivations

In this category, the experts were asked how the intrinsic motivations (such as self-esteem, personal skills development, and love of community) in the crowd engaged in requirement elicitation would affect the quality of elicited requirements. There were 3 questions in this category. Table 8 summarizes the results obtained from the experts.

Table 8: Experts opinion on the effects of motivation on the quality of the elicited requirements

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total Answers
Typically, the crowd motivation supports getting the right requirements	18.75% (6)	43.75% (14)	28.13% (9)	9.38% (3)	0% (0)	(32)
Typically, the crowd motivation supports getting more relevant requirements	18.75% (6)	31.25% (10)	31.25% (10)	18.75% (6)	0% (0)	(32)
Typically, the crowd motivation means that the crowd will give a more complete and detailed answer	25.00% (8)	25.00% (8)	37.50% (12)	12.50% (4)	0% (0)	(32)

2.7 Volunteering

In this category, the experts were asked how recruiting the crowd voluntarily through an open call would affect the quality of elicited requirements. There were 2 questions in this category. Table 9 summarizes the results obtained from the experts.

Table 9: Experts opinion on the effects of volunteering through an open call on the quality of the elicited requirements

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total Answers
Typically, a volunteering crowd is more likely to state their true and genuine requirements	21.88% (7)	46.88% (15)	15.62% (5)	15.62% (5)	0% (0)	(32)
Typically, open calls provide a chance for malicious users to enter the elicitation process and affect the overall quality of elicited requirements.	12.50% (4)	50.00% (16)	28.13% (9)	9.38% (3)	0% (0)	(32)

2.8 Extrinsic Incentives

In this category, the experts were asked how providing extrinsic incentives (e.g. financial or entertainment incentives) would affect the quality of elicited requirements. There were 3 questions in this category. Table 10 summarizes the results obtained from the experts.

Table 10: Experts opinion on the effects of incentives on the quality of the elicited requirements

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total Answers
Typically, incentives motivate the crowd to be more active during requirement elicitation	3.13% (1)	50.00% (16)	31.25% (10)	12.50% (4)	3.13% (1)	(32)
Typically, incentives increase the number of participants	18.74% (6)	71.88% (23)	9.38% (3)	0% (0)	0% (0)	(32)
Typically, incentives mislead the crowd from acting truly on requirement elicitation	6.24% (2)	46.88% (15)	34.38% (11)	12.50% (4)	0% (0)	(32)

2.9 Opt-out Opportunity

In this category, the experts were asked how providing an opt-out opportunity (either with or without any consequences such as being banned or reputation damage) would affect the quality of elicited requirements. There were 3 questions in this category. Table 11 summarizes the results obtained from the experts.

Table 11: Experts opinion on the effects of providing an opt-out opportunity on the quality of the elicited requirements

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total Answers
Typically, providing such an opt-out opportunity motivates the participants for active involvement	3.13% (1)	43.74% (14)	37.50% (12)	15.63% (5)	0% (0)	(32)
Typically, providing such an opt-out opportunity attracts more participants	6.25% (2)	37.50% (12)	46.88% (15)	9.38% (3)	0% (0)	(32)
Typically, providing such an opt-out opportunity allows only motivated participants to carry on to the end, which means an improved quality of the elicited requirements	9.68% (3)	41.94% (13)	29.03% (9)	19.35% (6)	0% (0)	(31)

2.10 Feedback

In this final category, the experts were asked how providing feedback (on the intermediate or final results of what has been collected from the crowd) would affect the quality of elicited requirements. There were 5 questions in this category. Table 12 summarizes the results obtained from the experts.

Table 12: Experts opinion on the effects of providing feedback on the quality of the elicited requirements

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total Answers
Typically, feedback motivates the participants to engage	34.38% (11)	46.88% (15)	12.50% (4)	6.25% (2)	0% (0)	(32)
Typically, feedback disturbs participants' comfort	0% (0)	15.63% (5)	37.50% (12)	43.75% (14)	3.13% (1)	(32)
Typically, feedback could influence their opinion for the next stages	15.63% (5)	71.88% (23)	12.50% (4)	0% (0)	0% (0)	(32)
Typically, feedback gives participants the feeling that their ideas (are important	18.75% (6)	56.25% (18)	18.75% (6)	6.25% (2)	0% (0)	(32)
Typically, feedback increases the willingness of participants to participate in future studies	18.75% (6)	43.75% (14)	31.25% (10)	6.25% (2)	0% (0)	(32)

3 Discussion

In this section, we report and reflect on some preliminary challenges and issues that our study shows vital in order to successfully develop and apply crowdsourcing for requirements elicitation. These challenges and issues are informed by the experts' comments who participated in our study.

- **Largeness:** on the one side, the large size of crowd is acknowledged to maximize accuracy, relevance and saturation in elicited requirements. On the other side, it also has its pitfalls related to management and coordination. Developing software-based mechanisms to coordinate the crowd with minimum intervention from developers, and to stay cost-efficient, is a challenge. On the same time, the strictness of such platforms should not violate the principles of crowdsourcing which basically advocate the voluntary nature of the participation and the freedom of speech.
- **Diversity:** experts highly agreed on the benefits of diversity in leading to more relevant and creative requirements. Again, and similar to largeness, it is not cost-free. Diversity might introduce problems in reaching consensus or at least an agreement especially when the software is meant to serve different sets of users and roles. Aggregation of knowledge from a wide set of users and coming up with potential decisions is a challenge as well. Current widely accepted visions, like Wisdom of Crowds and Swarm Intelligence, still do not have concrete and algorithmic solutions to such an aggregation and coordination.
- **Anonymity:** Anonymity typically makes users more honest in explaining their opinions. However, it can also be risky as it would allow malicious users or users intending for incentives only to join in. Anonymity is not necessarily allowed in some business being crowdsourced and also due to the data protection rules and intellectual properties in certain environments. Finally, anonymity might still discourage certain users who care more about social recognition and would like to see their voices heard and get recognition for that. Managing anonymity in a way which puts together these points is a challenge.
- **Competence:** Although it appears that high competence in the crowd is always positive with no negative consequences, the reality could be different. For creative requirements, differences in the competence level could be desirable to stimulate new ideas and also because the final system typically serves both competent and less competent users. Furthermore, recruiting the competent crowd might mean additional financial costs, thus restricting largeness. The competent crowd might also include participants' inflated egos which would then reduce the level of collaboration and lead to conflicts and inconsistency. Choosing the degree and variety of competence level and managing those trade-offs are main challenges.
- **Collaboration:** Collaboration benefits are many, including the ability to understand the rationale for requirements and having holistic solutions. The challenges are outnumbered by the benefits and mainly relate to the organization and making sure that clustering and dominance of certain opinions, trends, and groups

will not emerge. Cross-cutting challenges include how collaboration will be implemented with anonymity and how incentives will be offered when the work is done collaboratively.

- **Intrinsic Motivation:** Intrinsically motivated participants are genuinely interested in the software for which requirements are crowdsourced and thus give better quality information. However, it is hard to come up with metrics and tests for such a quality attribute in users. Also, motivation may lead to bias and strong views on what requirements the system should fulfil and could, thus, affect collaboration and reaching consensus or agreement.
- **Extrinsic Incentives:** This means costs for the crowdsourcer and could also mean less trustworthy requirements. Ensuring that the participants' goal is not solely to get incentives is a challenge. Measuring what the right incentives should be and how competence, intrinsic motivation and anonymity play a role in that are all still research challenges to investigate.
- **Volunteering and Opt-out:** These facets are seen to be in the core of crowdsourcing, which is typically seen as a loose contractual model based on voluntary participation. Challenges in other dimensions, such as anonymity, incentives and competence, overlap with volunteering and opt-out challenges. Furthermore, there are causal relationships to explore among these factors and volunteering and the possibility and desire of the crowd to opt-out.
- **Feedback:** Feedback is often seen in a positive way. However, we still need to investigate how to decide what feedback to give and when to do that in a way that it does not affect participants' opinion for the next steps and, also, does not overload them with unnecessary information.

4 Conclusion

In this survey, we advocated the potentials of crowdsourcing for requirements elicitation. Considering the lack of knowledge on how crowdsourcing should be configured to maximize the quality of elicited requirements, we conducted this expert survey. The study allowed us to deduce and confirm a set of relationships among crowdsourcing features and requirements quality. The preliminary results addressed and reported here are only a part of a more comprehensive study we have conducted. We, together with a vast majority of experts surveyed, advocated that there is a high potential of crowdsourcing for requirements elicitation and observed that there is not a significant number of literature investigating it. We also observed that such use of crowdsourcing introduces new research problems and a wide range of trade-off, which makes the decision on adopting it and configuring it in the right way challenging. Our survey is meant to provide insights for the researchers and practitioners where the crowd is given a voice in the engineering process.

5 References

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