Configuring Crowdsourcing for Requirements Elicitation

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Outline

- **Crowdsourcing for requirements engineering**
- Research question
- Taxonomy of crowdsourcing
- Methodology
- Challenges
- Conclusion

Crowdsourcing

- Crowdsourcing is outsourcing a task that is usually done in-house, to a potentially large and diverse group of people in form of an open call
- People bring their knowledge, expertise, innovation, resources, or money and usually get rewarded financially, get social recognition for their activity or get entertained
- There are many crowdsourcing platforms such as Amazon Mechanical Turk, Threadless, and Kickstarter.

Crowdsourcing for Requirements Engineering

- crowdsourcing has the potential to aid requirements elicitation[1,2]
- crowdsourcing facilitates the discovery and involvement of a wider range of stakeholders[3] and users[4,5]

1 A. Adepetu, A. Khaja, Y. A. Abd, A. A. Zaabi, and D. Svetinovic, "Crowdrequire: A requirements engineering crowdsourcing platform," in Proceedings of the 2012 AAAI Spring Symposium: Wisdom of the Crowd, 2012.
2 M. Hosseini, K. Phalp, J. Taylor, and R. Ali, "Towards crowdsourcing for requirements engineering," in Proceedings of the 20th International working conference on Requirements engineering: foundation for software quality(REFSQ)-Empirical Track, 2014.
3 S. L. Lim, D. Quercia, and A. Finkelstein, "Stakenet: Using social networks to analyse the stakeholders of large-scale software projects," in Proceedings of the 32nd ACM/IEEE International Conference on Software Engineering (ICSE)-Volume 1. ACM, 2010, pp. 295–304.
4 R. Ali, C. Solis, I. Omoronyia, M. Salehie, and B. Nuseibeh, "Social adaptation: when software gives users a voice," in Proceedings of the 7th International Conference on Evaluation of Novel Approaches to Software Engineering (ENASE), June 2012.
5 D. Pagano and B. Br¨ugge, "User involvement in software evolution practice: A case study," in Proceedings of the 2013 international conference on Software engineering (ICSE). Piscataway, NJ, USA: IEEE Press, 2013, pp. 953–962.

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Research Question

- What are the relations between human-related crowdsourcing features and the quality of elicited requirements in crowd-centric requirements engineering?

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Taxonomy of Crowdsourcing

- Our Taxonomy of Crowdsourcing[1], consisting of the following four pillars:
  - The Crowd
  - The Crowdsourcer
  - The Crowdsourced Task
  - The Crowdsourcing Platform
- Each pillar has a set of features (or in the case of the crowdsourcing platform, facilities or services)
- Two of these pillars, the crowd and the crowdsourcer, relate to the human aspects of crowdsourcing

1 M. Hosseini, K. Phalp, J. Taylor, and R. Ali, "The four pillars of crowdsourcing: A reference model," in Proceedings of the 2014 IEEE Eighth International Conference on Research Challenges in Information Science (RCIS), May 2014, pp. 1–12.

Mapping of Human Aspects of Crowdsourcing

- The crowd in a crowdsourcing activity can be mapped to users and other stakeholders who provide information to requirements engineers, whereas the crowdsourcers in a crowdsourcing activity can be mapped to requirements engineers[1]
- Selection of some of the features of the crowd and the crowdsourcer can potentially influence the quality of the information[2] they provide during requirements elicitation

1 M. Hosseini, K. Phalp, J. Taylor, and R. Ali, "Towards crowdsourcing for requirements engineering," in Proceedings of the 20th International working conference on Requirements engineering: foundation for software quality(REFSQ)-Empirical Track, 2014.
2 Beverly K. Kahn, Diane M. Strong, and Richard Y. Wang. 2002. Information quality benchmarks: product and service performance. *Commun. ACM* 45, 4 (April 2002), 184-192. DOI=10.1145/505248.506007 http://doi.acm.org/10.1145/505248.506007

List of Crowd and Crowdsourcer Features[1]

TABLE I. THE LIST OF CROWD AND CROWDSOURCER FEATURES

The Crowd		The Crowdsourcer
1. Diversity	4. Undefined-ness	1. Incentives Provision
1.1. Spatial Diversity	5. Suitability	1.1. Financial Incentives
1.2. Gender Diversity	5.1. Competence	1.2. Social Incentives
1.3. Age Diversity	5.2. Collaboration	1.3. Entertainment Incentives
1.4. Expertise Diversity	5.3. Volunteering	2. Open Call
2. Unknown-ness	5.4. Motivation	3. Ethicality Provision
2.1. Not Known to Crowdsourcer	5.4.1. Mental Satisfaction	3.1. Opt-out Provision
2.2. Not Known to Each Other	5.4.2. Self-Esteem	3.2. Feedback to Crowd
3. Largeness	5.4.3. Personal Skills Development	3.3. No Harm to Crowd
3.1. Number Fulfils the Task	5.4.4. Knowledge Sharing	4. Privacy Provision
3.2. Number Not Abundant	5.4.5. Love of Community	

1 M. Hosseini, K. Phalp, J. Taylor, and R. Ali, "The four pillars of crowdsourcing: A reference model," in Proceedings of the 2014 IEEE Eighth International Conference on Research Challenges in Information Science (RCIS), May 2014, pp. 1–12.

Information Quality Benchmark[1]

	Conforms to Specifications	Meets or Exceeds Consumer Expectations
Product Quality	Sound Information • Free-of-Error • Concise Representation • Completeness • Consistent Representation	Useful Information • Appropriate Amount • Relevancy • Understandability • *Interpretability* • *Objectivity*
Service Quality	Dependable Information • Timeliness • Security	Usable Information • Believability • Accessibility • Ease of Manipulation • Reputation • Value-Added

1 Beverly K. Kahn, Diane M. Strong, and Richard Y. Wang. 2002. Information quality benchmarks: product and service performance. *Commun. ACM* 45, 4 (April 2002), 184-192. DOI=10.1145/505248.506007 http://doi.acm.org/10.1145/505248.506007

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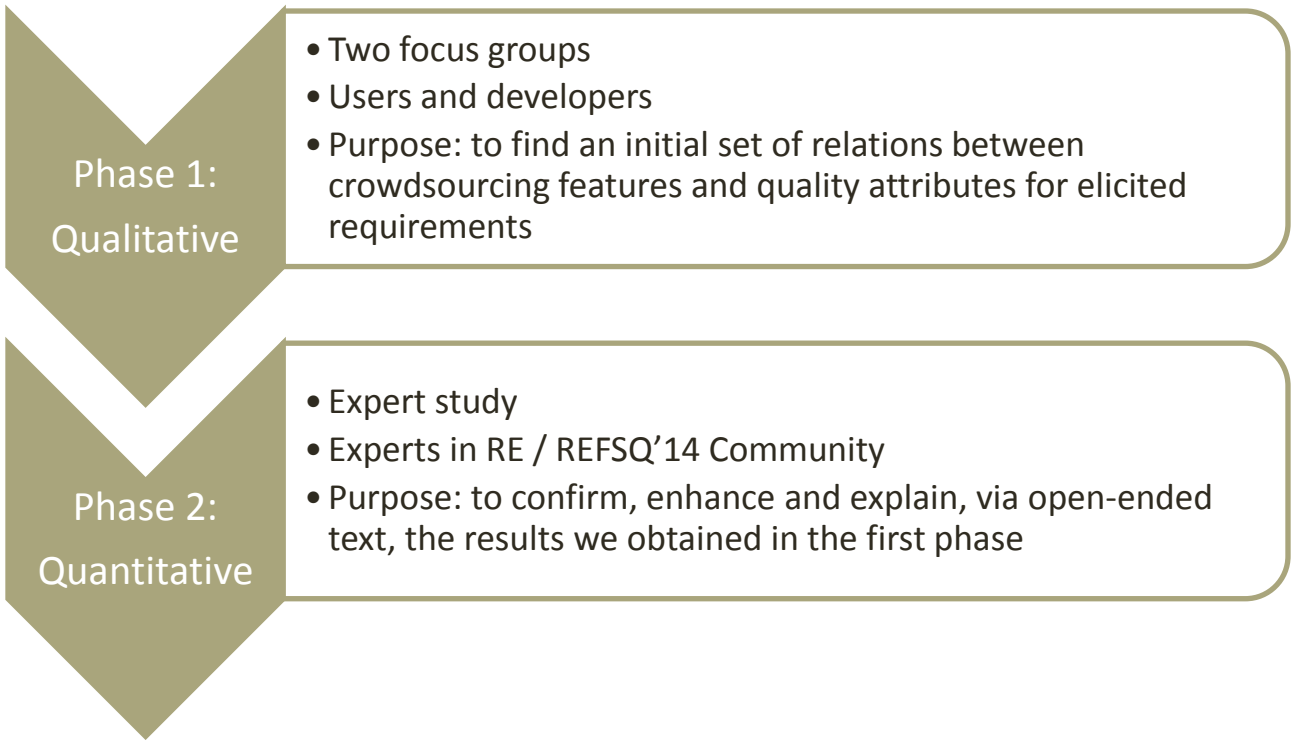
Methodology

- An empirical study following a mixed method sequential exploratory approach



Phase 1: Focus Groups

- two focus groups in two different sessions at Bournemouth University, UK
- same set of questions was used in each session
- 14 volunteers invited to participate
- participants from ten different countries with mixed backgrounds, different ages and various genders
- same moderator recruited for both sessions to avoid different attitude towards participants and questions
- a questionnaire designed and handed over to the participants
- content analysis performed by two experienced researchers, and in case of a conflict, a third researcher consulted to investigate and settle the debate

Phase 1: Focus Groups

TABLE II. FOCUS GROUP SESSION SETTINGS

Session	Participants	Expertise
1	Four users and three developers	All four users are students Developers are software developers with three years of experience on average.
2	Three users and four developers	All three users are students Developers are software developers with four years of experience on average.

Phase 2: Online Expert Study

- The results of the focus group were turned into 34 questions
- 34 questions were classified into 10 categories
- The online expert survey was introduced in the opening ceremony of REFSQ 2014
- The questions were accompanied by comment boxes, allowing experts to add their opinions
- There were also general questions about participants' expertise and affiliation in RE, its duration, and their familiarity with crowdsourcing

Phase 2: Online Expert Study

TABLE IV. SUMMARY OF EXPERTS' INFORMATION

Types of Expertise in RE		Years of Expertise in RE		Major Expertise in RE
Academic	18	Min	2	User-Centred RE, Collaborative RE,
		Max	33	Modelling, Management, Specification,
Industrial	7	Mean	9.44	Traceability, Goal Oriented RE,
		Median	8	Privacy and Security Requirements,
Both	9	Mode	10	Social RE, Automation for RE

List of 34 Questions (1)

Resulted from the Focus Groups and Confirmed/Refined via the Expert Study

TABLE III. LIST OF ONLINE EXPERT SURVEY QUESTIONS AND THEIR CATEGORIES

Crowdsourcing Feature	List of Items Asked from Experts
Largeness	A large crowd supports getting more accurate requirements.
	A large crowd supports having objective and non-biased requirements.
	A large crowd supports reaching a saturation in the elicited requirements.
	A large crowd is difficult to organise and coordinate for eliciting the right requirements.
Diversity	Diversity makes it hard to reach a consensus/agreement on requirements.
	Diversity increases the relevance and meaningfulness of requirements.
	Diversity supports creativity in requirements.
	Diversity causes inconsistency problems in elicited requirements.
Anonymity	The crowd will give their honest opinion when they are anonymous.
	The credibility of the elicited information cannot be guaranteed.
Competence	The crowd competence supports getting the right requirements.
	The crowd competence supports getting creative requirements.
	The crowd competence supports getting more relevant requirements.
	A competent crowd is more willing to see positive changes and, hence, willing to provide their requirements.
Collaboration	The crowd collaboration means an extra overhead from the management perspective.
	The crowd collaboration leads to clusters of users with different and sometimes conflicted views.
	The crowd collaboration leads to dominance of certain opinions and missing that of less powerful users.
	The crowd collaboration helps requirements engineers to understand the rationale of elicited requirements.

List of 34 Questions (2)

Resulted from the Focus Groups and Confirmed/Refined via the Expert Study

Intrinsic Motivations	The crowd motivation supports getting the right requirements.
	The crowd motivation supports getting more relevant requirements.
	The crowd motivation means that the crowd will give a more complete and detailed answer.
Volunteering	A volunteering crowd is more likely to state their true and genuine requirements.
	Open calls provide a chance for malicious users to enter the elicitation process and affect the overall quality of elicited requirements.
Extrinsic Incentives	Incentives motivate the crowd to be more active during requirements elicitation.
	Incentives increase the number of participants.
	Incentives mislead the crowd from acting truly on requirements elicitation.
Opt-out Opportunity	Providing an opt-out opportunity motivates the participants for active involvement.
	Providing an opt-out opportunity attracts more participants.
	Providing an opt-out opportunity allows only motivated participants to carry on to the end, which means an improved quality of the elicited requirements.
Feedback	Feedback motivates the participants to engage.
	Feedback disturbs participants' comfort.
	Feedback could influence their opinion for the next stages.
	Feedback gives participants the feeling that their ideas are important.
	Feedback increases the willingness of participants to participate in future studies.

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Largeness

- Benefits:
  - Recruiting a large crowd can affect accuracy, relevance and saturation positively, and can help a more complete elicitation of requirements
- Challenges:
  - Management and coordination can be problematic
  - Software-based solutions are needed for crowd coordination
    - minimum intervention from developers
    - cost-efficient

Diversity

- Benefits:
  - Recruiting a diverse crowd leads to more relevant requirements
- Challenges:
  - Reaching an agreement can prove difficult
  - Aggregation of knowledge obtained from the crowd is another challenge

Anonymity

- Benefits:
  - Anonymity can increase honesty in opinion sharing[1]
  - Anonymity can improve quality and quantity of comments[2]
  - Anonymity enhances users' privacy[3]
- Challenges:
  - Malicious users may also participate and try to mislead with disinformation
  - Social recognition incentives cannot be applied
  - Deindividualisation may happen, which is a state of loss of self-awareness, decreased social disinhibitions, and increased impulsivity

1 J. Ghorpade, "Managing five paradoxes of 360-degree feedback," The Academy of Management Executive, vol. 14, no. 1, pp. 140–150, 2000.
2 P. G. Kilner and C. M. Hoadley, "Anonymity options and professional participation in an online community of practice," in Proceedings of th 2005 conference on Computer support for collaborative learning: learning 2005: the next 10 years! International Society of the Learning Sciences, 2005, pp. 272–280.
3 A. Beach, M. Gartrell, and R. Han, "Solutions to security and privacy issues in mobile social networking," in Proceedings of the 2009 International Conference on Computational Science and Engineering (CSE), vol. 4. IEEE, 2009, pp. 1036–1042.

Competence

- Benefits:
  - Competence is generally considered to be of desirable effects within a crowd[1]

- Challenges:
  - Competence is not always needed, as tasks can be broken down into micro-tasks
  - Different competence levels can stimulate new ideas[2]
  - The system-to-be will be used by both competent and less competent stakeholders
  - Seeking competence may mean more financial resources, leading to fewer participants (i.e., it affects crowd largeness)

1 L. Erickson, I. Petrick, and E. Trauth, "Hanging with the right crowd: Matching crowdsourcing need to crowd characteristics." AIS Electronic Library (AISeL), 2012.
2 L. Yu and J. V. Nickerson, "Cooks or cobblers?: crowd creativity through combination," in Proceedings of the 2011 SIGCHI conference on human factors in computing systems. ACM, 2011, pp. 1393–1402.

Collaboration

- Benefits:
  - Collaboration facilitates holistic solutions
- Challenges:
  - Collaboration needs organisation
  - User dominance can become a problem
  - User clustering may occur
  - Engineering solutions for collaboration are needed[1]
  - Collaboration may hinder other crowdsourcing features such as anonymity

1 R. Klinc, Z. Turk, and M. Dolenc, “Engineering collaboration 2.0: requirements and expectations,” 2009.

Intrinsic Motivations

- Benefits:
  - An intrinsically motivated crowd can provide more genuine, better quality requirements
- Challenges:
  - There are no metrics and test for intrinsic motivation
  - Such motivations may introduce bias and strong views on what requirements the system should fulfil

Volunteering

- Benefits:
  - Volunteers are usually intrinsically motivated
- Challenges:
  - Reward schemes should be carefully designed not to shift intrinsic motivations toward extrinsic incentives
  - Volunteering does not guarantee competence

Extrinsic Incentives

- Benefits:
  - Extrinsic incentives come in forms of financial rewards, social recognition, or entertainment

- Challenges:
  - They can introduce costs for the crowdsourcers
  - Providing incentives does not necessarily increase quality[1]
  - Providing incentives may harm intrinsic motivation[2]

1 M. Varela, T. Maki, L. Skorin-Kapov, and T. Hoßfeld, "Increasing payments in crowdsourcing: dont look a gift horse in the mouth," in Proceedings of the 4th international workshop on perceptual quality of systems (PQS 2013), Vienna, Austria, 2013.
2 E. L. Deci, R. Koestner, and R. M. Ryan, "A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation." Psychological bulletin, vol. 125, no. 6, p. 627, 1999.

Opt-out Opportunity

- Benefits:
  - Opting out seems to be in the core of crowdsourcing
- Challenges:
  - Several issues, such as tasks with higher complexities, inadequate incentives or loss of motivation can result in participants opting out[1]

1 B. Shao, L. Shi, B. Xu, and L. Liu, "Factors affecting participation of solvers in crowdsourcing: an empirical study from china," Electronic Markets, vol. 22, no. 2, pp. 73–82, 2012.

Feedback

- Benefits:
  - Participants usually embrace the feedback they get after their involvement
- Challenges:
  - Feedback must be timely
  - It must not affect participants' opinion for the next steps (i.e., it must not create bias)
  - Feedback must not cause information overload
  - It must not lead to convergence of opinions and elimination of diversity of opinions[1]

1 J. Lorenz, H. Rauhut, F. Schweitzer, and D. Helbing, "How social influence can undermine the wisdom of crowd effect," Proceedings of the National Academy of Sciences, vol. 108, no. 22, pp. 9020–9025, 2011.

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Conclusions

- there is a huge potential of crowdsourcing for requirements elicitation
- such use of crowdsourcing introduces new research problems and a wide range of trade-offs
- adopting crowdsourcing and configuring it in the correct way for the purpose of requirements elicitation is challenging

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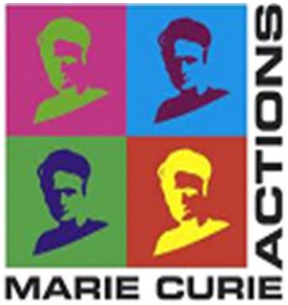

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