Configuring Crowdsourcing for Requirements Elicitation

Mahmood Hosseini, Alimohammad Shahri, Keith Phalp, Jacqui Taylor, Raian Ali
Faculty of Science and Technology
Bournemouth University, UK

Fabiano Dalpiaz
Utrecht University
The Netherlands
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\(^4,5\)


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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

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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

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http://doi.acm.org/10.1145/505248.506007
List of Crowd and Crowdsourcer Features

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

### Information Quality Benchmark

<table>
<thead>
<tr>
<th>Product Quality</th>
<th>Conforms to Specifications</th>
<th>Meets or Exceeds Consumer Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound Information</td>
<td>Free-of-Error</td>
<td>Useful Information</td>
</tr>
<tr>
<td></td>
<td>Concise Representation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Consistent Representation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Service Quality</th>
<th>Dependable Information</th>
<th>Usable Information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Timeliness</td>
<td>Believability</td>
</tr>
<tr>
<td></td>
<td>Security</td>
<td>Accessibility</td>
</tr>
</tbody>
</table>

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Methodology

- An empirical study following a mixed method sequential exploratory approach

**Phase 1: Qualitative**
- Two focus groups
- Users and developers
- Purpose: to find an initial set of relations between crowdsourcing features and quality attributes for elicited requirements

**Phase 2: Quantitative**
- Expert study
- Experts in RE / REFSQ’14 Community
- Purpose: to confirm, enhance and explain, via open-ended text, the results we obtained in the first phase
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>
<thead>
<tr>
<th>Session</th>
<th>Participants</th>
<th>Expertise</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Four users and three developers</td>
<td>All four users are students&lt;br&gt;Developers are software developers with three years of experience on average.</td>
</tr>
<tr>
<td>2</td>
<td>Three users and four developers</td>
<td>All three users are students&lt;br&gt;Developers are software developers with four years of experience on average.</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Types of Expertise in RE</th>
<th>Years of Expertise in RE</th>
<th>Major Expertise in RE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max 33</td>
<td></td>
</tr>
<tr>
<td>Industrial</td>
<td>Mean 9.44</td>
<td></td>
</tr>
<tr>
<td>Both</td>
<td>Median 8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mode 10</td>
<td></td>
</tr>
</tbody>
</table>
List of 34 Questions (1)
Resulted from the Focus Groups and Confirmed/Refined via the Expert Study

<table>
<thead>
<tr>
<th>Crowdsourcing Feature</th>
<th>List of Items Asked from Experts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Largeness</strong></td>
<td>A large crowd supports getting more accurate requirements.</td>
</tr>
<tr>
<td></td>
<td>A large crowd supports having objective and non-biased requirements.</td>
</tr>
<tr>
<td></td>
<td>A large crowd supports reaching a saturation in the elicited requirements.</td>
</tr>
<tr>
<td></td>
<td>A large crowd is difficult to organise and coordinate for eliciting the right requirements.</td>
</tr>
<tr>
<td><strong>Diversity</strong></td>
<td>Diversity makes it hard to reach a consensus/agreement on requirements.</td>
</tr>
<tr>
<td></td>
<td>Diversity increases the relevance and meaningfulness of requirements.</td>
</tr>
<tr>
<td></td>
<td>Diversity supports creativity in requirements.</td>
</tr>
<tr>
<td></td>
<td>Diversity causes inconsistency problems in elicited requirements.</td>
</tr>
<tr>
<td><strong>Anonymity</strong></td>
<td>The crowd will give their honest opinion when they are anonymous.</td>
</tr>
<tr>
<td></td>
<td>The credibility of the elicited information cannot be guaranteed.</td>
</tr>
<tr>
<td><strong>Competence</strong></td>
<td>The crowd competence supports getting the right requirements.</td>
</tr>
<tr>
<td></td>
<td>The crowd competence supports getting creative requirements.</td>
</tr>
<tr>
<td></td>
<td>The crowd competence supports getting more relevant requirements.</td>
</tr>
<tr>
<td></td>
<td>A competent crowd is more willing to see positive changes and, hence, willing to provide their requirements.</td>
</tr>
<tr>
<td><strong>Collaboration</strong></td>
<td>The crowd collaboration means an extra overhead from the management perspective.</td>
</tr>
<tr>
<td></td>
<td>The crowd collaboration leads to clusters of users with different and sometimes conflicted views.</td>
</tr>
<tr>
<td></td>
<td>The crowd collaboration leads to dominance of certain opinions and missing that of less powerful users.</td>
</tr>
<tr>
<td></td>
<td>The crowd collaboration helps requirements engineers to understand the rationale of elicited requirements.</td>
</tr>
</tbody>
</table>
### List of 34 Questions (2)

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

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
</table>
| **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

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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)

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1 L. Erickson, I. Petrick, and E. Trauth, “Hanging with the right crowd: Matching crowdsourcing need to crowd characteristics.” AIS Electronic Library (AiSeL), 2012.
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
  • Collaboration may hinder other crowdsourcing features such as anonymity

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\(^2\)

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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\(^1\)

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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

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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
Acknowledgement

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