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Crowd-based Requirement Engineering

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Received: 01 February 2018; Accepted: 16 April 2018; Published: 08 May 2018

Abstract

Requirement elicitation through crowdsourcing is trending nowadays and due to its major benefits, some of the organizations are implementing this idea. Our research paper discusses the traditional requirement engineering concepts and then compares them with crowd-based requirement engineering to show the benefits of crowdsourcing. Features of Crowd-Based Requirements Engineering are highlighted to give an idea of the basis on which the survey was conducted. Furthermore, we have discussed the online survey and gamification methods to motivate the crowd.

Index Terms: Elicitation, Requirement management, Gamification, Crowd-Based Requirements Engineering, Crowd Sourcing, Diversity, Intrinsic Motivation, Extrinsic Incentive, Feedback, Crowd Centric Requirements Engineering (CCRE).

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1. Introduction

Requirement Management plays an important role in software development but is also challenging due to the ever-complex and changing enterprise environment. There is no such thing as a particular number of requirements. The only purpose they serve is to help the product reach an attainable result and produce client or user satisfaction. A large number of requirements do not determine the higher market success of acceptance rate.

But the question is, how do we attain a sufficient number of requirements? That is done by selecting stakeholders and crowd representatives. But a large number of stakeholders make the traditional steps of requirement gathering, filtration and documentation extremely costly as well as time-consuming. The trend is now shifting towards the automation of this process so that validated user requirement can be gathered from a large group of individuals or "Crowd". The usefulness of the "Crowd" lies in the wide range of expertise and

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talents available in it. Crowdsourcing is now boosted by the internet making communication is easier and faster.

In crowd-centric requirement engineering (CCRE), the crowd of users is involved in the requirement development process continuously, which is why they can evolve, create and verify these requirements. These are no longer centered to elicitation but help in design as well as creation. This level of continuous involvement requires motivation, in order to be guaranteed. One thing that organizations should keep in mind before employing crowdsourcing is that it can create unrealistic expectations. Also getting quality requirements from the crowd can be challenging as there is no assurance for that. They may provide ambiguous requirements for which a requirement analyst is still required.

2. Background

Traditionally, in order to gather requirements for a product or system, a requirement engineer specifies different stakeholders and user representatives and gathers requirements using detailed statements. Although this process seems straightforward and easy to follow, failure of products or system is still blamed upon poor requirement engineering. This usually results due to most of the users not participating in it. The users are seldom involved and this forces us to think about how we should identify our users and whether the number is enough or not. If it is, then why do products fail due to poor requirement engineering and why the users are not motivated to participate [10].

Crowdsourcing is considered the best way to collect requirements and user involvement is also studied in Requirement Engineering. But it is being observed that not many users participate in the elicitation process. Some of the methods that were used to motivate the crowd were partial solutions and are as follows [12]:

- The process of involving the crowd is considered a narrow concept and therefore during the elicitation process priority is given to the stakeholders. These stakeholders are the ones who pay for the product but usually ignore the fact that taking the user requirements into account can in fact make their project a major success.
- In the early phases of RE, users are involved which leads to the discarding of requirements by the developers and the customers. Only selected group of users can participate privately. In this way, the pure concept of crowdsourcing is probably missed.
- No incentives are provided to substitute user involvement which is often unpaid.

These partial solutions and limitations force us to think about newer ways to gather the requirements we need. One way is through creating interest in crowds which help us address these limitations. It is important to note that crowdsourcing cuts the cost of outsourcing and decreases the workload. It cannot be entirely free but costs less [10].

3. Related Works

We often focus on a small number of selected users to give input and feedback on requirements related activities and afterward in user acceptance testing [1]. But now crowdsourcing can help us gather collective user feedback, as mentioned in [2][3] that there is a lot of information that cannot be gathered through automated means and user participation becomes necessary. The result desired for the software is to fulfill its requirements which is more achievable by extensive user opinion feedback. This is compulsory for market acceptance and success.

If a large number of people showing interest in one particular product, discussing its features can influence opinions and help in decision making [4]. Pamela Zave [5] identified in her paper, the first dimension to requirement engineering, these problems or constraints can/are catered through crowdsourcing. These include goals and constraints of the system, Barriers in communication and setting priority for requirements, a solution to which can be gathered by crowd discussion on features, behaviors and desired result of the system [6].

Our Research is mainly focused on how to motivate and mobilize the crowd to show interest in a particular product to help them communicate and gather requirements. There are some existing techniques such as incentives, but our purpose is to ensure continuous involvement. A technique suggested is to inform the crowd about the result of their requirements and how they are being used in the system. In this way, rather than being a tradition design time activity, perhaps requirements can be gained at runtime by involving actual user or people interested in the product via feedback [7]. To gather feedback, we want to recruit the crowd on an interactive platform.

One method is to gather input from the crowd but to specify requirement independently. In the process of Crowd Centric Requirement Engineering, we can analyze the requirements to see which can be gamified or crowdsourced. Other than elicitation the crowd can help in prioritization as well [8]. For motivation, Gamification can be one of the key factors for reward or by a point system. Members that participate receive points based on the level of involvement, for example: different points for proposing, commenting and voting for requirements. Which means members can propose their own requirements, or vote for other requirements, in return earning points for constructive feedback which will at the same time help them in requirement analysis. Gamification is basically a general term for making the user's participation an enjoyable activity. It includes two types of rewards, monetary and non-monetary rewards. Non-monetary rewards can be (I) *public appreciation*: users will get a recognition in the community due to its everyday participation through rewards like leader boards. (II) *gratification*, which is that decision making is in the hands of the crowd rather than the developers [12]. Monetary rewards can be a kind of incentive or a prize money award. These kinds of rewards will keep the crowd motivated and we will be able to collect an honest feedback.

Some challenges of requirement engineering continue even after crowdsourcing and gamification. Minor group and participants can be overlooked but there is a high possibility of the crowd adopting dishonesty to win points or opt-out completely. One of the most challenging parts, is to recognize the malicious users in the crowd and prevent them from participating. Another challenge can be of feedback analysis. It is challenging because recognizing the anonymous crowd i.e. age group is very difficult. This challenge also leads to no guarantee of the credibility of the information. So, the main challenge we face is not how to distribute a simple task amongst individuals but assigning complex tasks and breaking them into subproblems.

4. Methodology

Crowdsourcing is an evolving paradigm which helps organizations to collect accurate and useful requirements. Anonymous users defined as crowd must have some motivation in terms of rewards or some kind of incentive to provide an honest feedback. Mehmood Hosseini [16] in his research paper mentioned about conducting an expert survey and came up with some authentic results. He asked 34 questions which were open-handed questions and had some comment boxes to add extra comments. Thirty-seven experts took part in the survey out of which only 34 were able to complete the survey.

The experts had a great domain of knowledge and experience in Requirement Engineering. The survey was divided into 9 categories and those categories are as follows: **Largeness**: It is considered as a crowdsourcing feature because it helps in maximizing the information and decision-making is made easier. However, there are some pitfalls for e.g. managing a large crowd can be challenging, **Diversity**: It is considered as a feature of crowdsourcing because a large number of creative information can be gathered, but on the other hand diverse information can lead to highly complex decision making, **Anonymity**: On the one hand anonymity can help us in getting an honest opinion but it can cause risks like participation of malicious users. The users would participate only for incentive hence the credibility of the information cannot be guaranteed, **Competence**: It is also one of the main features of crowdsourcing. Even though, it creates the impression that high capability in the group is constantly positive with no negative results - the truth could be extraordinary. For incentive prerequisites, contrasts in the fitness level could be alluring to fortify new thoughts. Furthermore, the last framework commonly serves both – more and less equipped clients. Moreover, enlisting the able group may mean extra-budgetary expenses, **Collaboration**: There are many benefits of collaboration, including the

capacity to comprehend the method of reasoning for prerequisites and having all-encompassing arrangements. The difficulties are dwarfed by the advantages and for the most part, relate to the association. They ensure that bunching and predominance of specific suppositions, patterns, and gatherings won't develop. Cross-cutting difficulties incorporate how coordinated effort will be actualized with namelessness. Also, how will motivators be offered when the work is done cooperatively, **Intrinsic Motivation:** Characteristically propelled members are really intrigued by the product for which prerequisites are crowdsourced and subsequently give better quality data. Be that as it may, it is difficult to concoct measurements and tests for such a quality property in clients. Likewise, inspiration may prompt predisposition and solid perspectives on what prerequisites the framework ought to satisfy and could, in this manner, influence coordinated effort and achieving accord or assentation, **Volunteering:** These features are believed to be the core of crowdsourcing, which is regularly observed as a free authoritative model in the light of intentional interest. Difficulties in different measurements, for example, secrecy, impetuses, and capability, cover with volunteering and quit challenges. Besides, there are causal connections to investigate among these components, **Extrinsic Incentive:** This implies costs for the crowd sourcer and could likewise mean less reliable prerequisites. Guaranteeing that the members' objective isn't exclusively to get motivation is a test. Measuring what the correct motivators ought to be and how skill, natural inspiration, and obscurity assume a part in that are for the most part still research difficulties to explore, **Feedback:** It is considered to be a positive feature for crowdsourcing but is still under exploration of which kind of feedback to give so that the user does not get offended.

The survey concluded that adopting crowdsourcing technique for requirement elicitation has become more challenging.

5. Results of the Questionnaire

The survey that we have conducted includes students and professionals, both. This survey also covers the crowd-sourcing features and consists of 15 questions. It includes some general questions which are somewhat like the questions asked in the research paper [16]. The difference is that the survey was conducted in the United Kingdom and our survey was conducted in Pakistan and it had 37 questions whereas our survey has 15 questions. We got 31 responses which included students as well as professionals (not specifically requirement engineers). The results that we have collected from the survey are as follows:

As shown in Fig.1 approximately 22.6% disagreed that the large crowd provide accurate requirements, 16.1% were neutral about the statement whereas 61.3% agreed that the requirements gathered by large crowd are accurate.

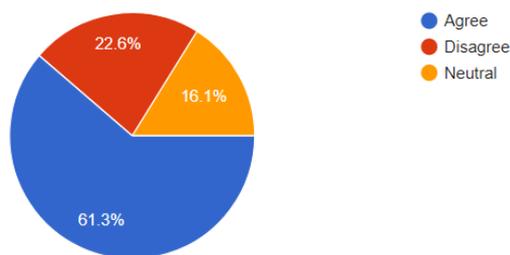


Fig.1. Requirements when Gathered by a Large Crowd are More Accurate.

As shown in Fig. 2, 38.7% disagreed with the statement, 22.6% were neutral about it while 38.7% agreed to the statement.

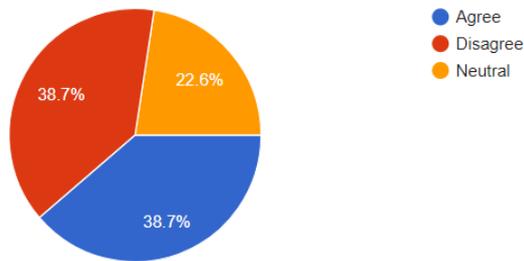


Fig.2. A large Crowd Supports Reaching Satiety in the Elicited Requirements

In Fig.3, approximately 71% of the respondents said that requirements gathering becomes difficult with high diversity ratio. 16.1% disagreed with this point whereas 12.9% were neutral about it.

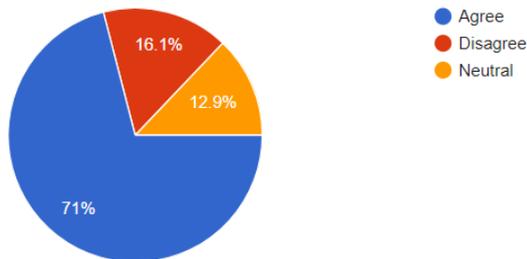


Fig.3. Requirements Gathering Becomes Difficult When the Diversity Ratio Is High

In Fig.4, Almost 54.8% agreed that creative requirements can be gathered by the large crowd. 35.5% respondents disagreed with this statement.

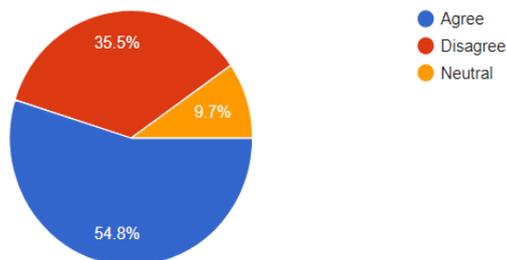


Fig.4. More Creative Requirements Are Gathered When the Diversity Ratio Is High

As shown in Fig.5, approximately 64.5% respondents agreed to the statement that honest feedback can be gathered by the anonymous crowd. 16.1% disagreed whereas 19.4% were neutral.

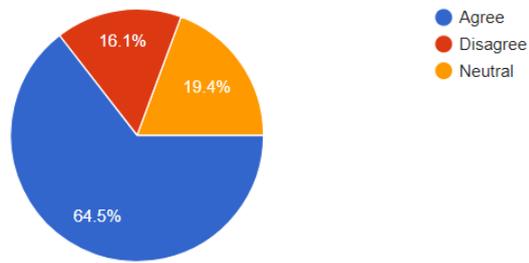


Fig.5. Anonymity Helps in Gathering Honest Opinion by the Crowd

As shown in Fig.6, About 41.9% respondents agreed with the statement that credibility cannot be guaranteed when collecting requirements from the crowd, whereas 25.8% respondents disagreed to this point.

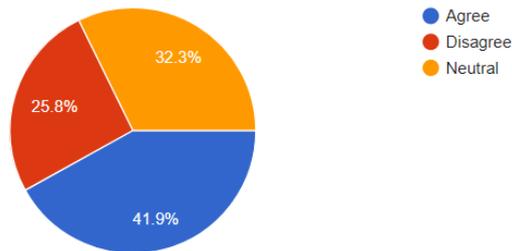


Fig.6. The Requirements Gathered by the Crowd Doesn't Guarantee Credibility

As shown in Fig.7, Almost 54.8% respondents agreed that motivation is the key to gather right information from the crowd.16.1% disagreed to this point.

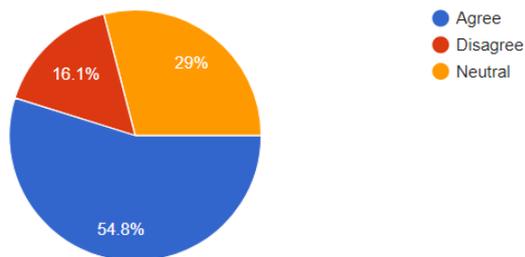


Fig.7. Motivation Helps Gathering the Right Requirements from the Crowd

As shown in Fig.8, 48.4% respondents agreed to the point whereas 29% disagreed to the point.

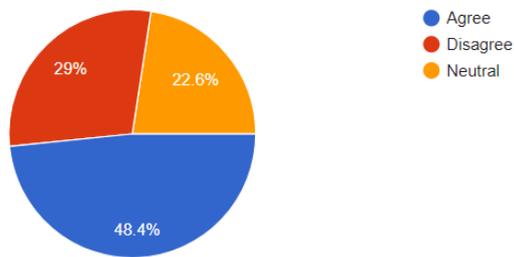


Fig.8. Crowd-based Requirements Gathering May Lead to Malicious Users Interrupting the Whole Eliciting Process

As shown in Fig.9, 29% respondents agreed to the question that feedback can be a negative feature whereas 54.8% disagreed with this statement and 16.1% had a neutral response.

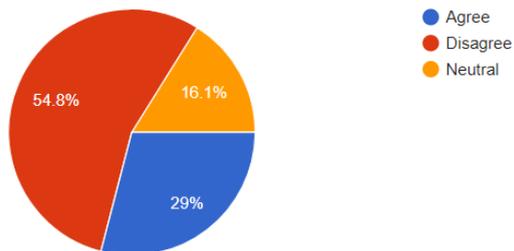


Fig.9. Providing an Honest Feedback to the Requirements May Cause Discomfort to the Participant

In Fig.10, it shows that 41.9% respondents agree that feedback is a positive feature whereas 25.8% disagree with this and 32.23% had a neutral response.

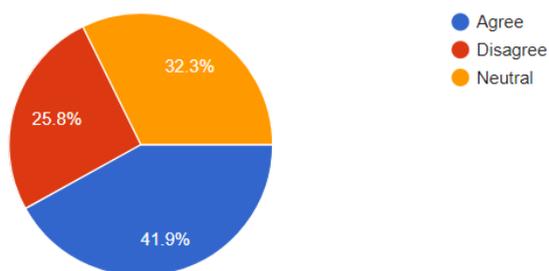


Fig.10. Providing an Honest Feedback Can Motivate the Crowd/Participant

In Fig.11, it shows that 74.2% agree to the statement whereas 12.9% disagree to the statement and 12.9% had a neutral response.

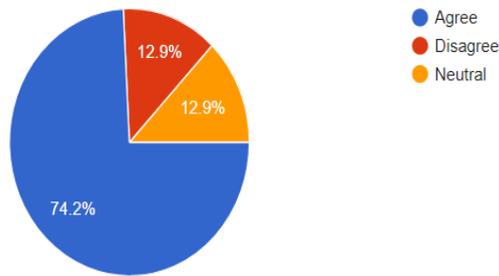


Fig.11. During Requirement Elicitation Providing Incentive Motivates the Crowd to Take Part Actively

As shown in Fig.12, 41.9% agree to the point that for management crowdsourcing is just increasing an overhead.22.6% disagreed with this statement. 35.5% had a neutral response.

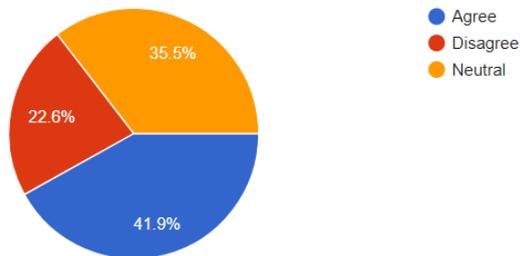


Fig.12. According To Management Perspective Crowd-based Requirements Gathering is Just Increasing an Overhead

As shown in Fig. 13, 54.8% agreed to the question whereas 29% disagreed with this statement. 35.5% had a neutral response.

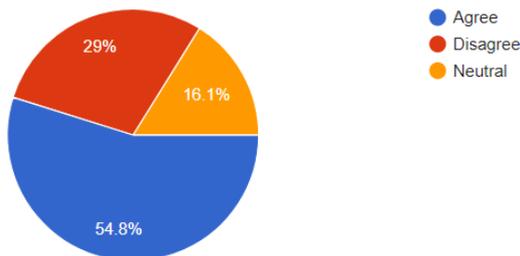


Fig.13. The Crowd Competence Supports Gathering More Relevant Requirements

As shown in Fig.14, 58.1% agreed to the statement that feedback is important for the crowd whereas 29% disagreed with the statement and 12.9% had a neutral response.

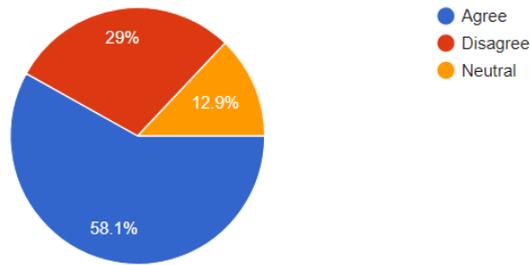


Fig.14. Feedback Gives the Crowd a Feeling That Their Ideas Are Important

As shown in Fig.15, 61.3% agreed that elicited requirements can be easily understood by the requirement engineers with the help of collaboration of crowd. 16.1% disagreed with this statement and 22.6% had a neutral response.

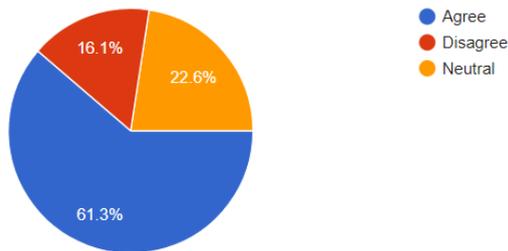


Fig.15. The Collaboration of the Crowd Helps Requirement Engineers to Understand the Foundation of Elicited Requirements

In our research survey, we observed that people in Pakistan do have an idea of how important accuracy, anonymity, motivation, feedback and collaboration of the crowd is, to gather proficient requirements. We also observed that the use of this technique brings in new challenges like avoiding malicious users and motivating the crowd. Furthermore, this survey highlights the most important feature of crowd based requirement engineering that is, Feedback. Fig 14, shows most of the respondents agreed that positive feedback not only gives motivation to the crowd but also helps in bringing out quality ideas. However, one still needs to investigate the type of feedback provided to keep the crowd motivated. This survey gives us an idea that in future organizations might adopt this idea and result in an early return on investment but issues might exist that would affect little bit of its successful implementation.

6. Conclusion

By way of conclusion, it can be said that if Crowd based Requirement Engineering has some benefits it can have some pitfalls too. The only source to motivate the crowd to participate in the requirement elicitation is through gamification and the survey that we conducted explains that applying the crowdsourcing technique would bring up some challenges that should be resolved in the future in order to gather creative, accurate and error-free requirements. Quality of requirements gathered through the crowd is still doubtful but it will help engineers to understand trends in the crowd.

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Authors' Profiles



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How to cite this paper: Ume-Sauda Ghanyani, Maham Murad, Waqas Mahmood,"Crowd-based Requirement Engineering", International Journal of Education and Management Engineering(IJEME), Vol.8, No.3, pp.43-53, 2018.DOI: 10.5815/ijeme.2018.03.05