Sustaining Participant Involvement in Crowdsourcing Contests through Collaboration

Full Paper

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Abstract

With the advances in internet technologies and the emergence of crowdsourcing, organizations are now increasingly looking outside their boundaries for solving problems. Yet, the success of crowdsourcing processes depends on the sustained participation of crowdsourcing individuals. Previous studies have mainly focused on understanding individuals' initial motivation for participation with few focusing on the factors that affect individuals' sustained participation in crowdsourcing contests. None of these studies examined how collaboration affects individuals' participation behavior in crowdsourcing contests. This study attempts to understand how individuals' collaboration (in the form of comments and votes) affects their sustained participation in online problem solving contests. This study uses data from the Kaggle website that holds online data science competitions in which individuals submit their proposed solutions with the best solutions being rewarded. Our results show that individuals who receive more attention from other members tend to come back and maintain their participation in the platform.

Keywords

Crowdsourcing contests, Sustained participation, attention, Kaggle.

Introduction

Web 2.0 and the evolving vision of Web 3.0 have a significant effect on the proliferation and facilitation of knowledge sharing, user-centered design, collaboration on the World Wide Web, and crowd-centered services (Y. C. Zhao & Zhu 2014). This new concept of the Web is the intuition that drives crowdsourcing, crowd servicing, and crowd computing (Y. C. Zhao & Zhu 2014; Zhao & Zhu 2012).

A growing number of organizations are using crowdsourcing to solicit the skills and talents of people around the world for idea generation and to solve business problems. In some of the crowdsourcing processes, companies ask third party crowdsourcing platforms (intermediary mediated crowdsourcing platforms) to crowdsource their problems where the intermediaries manage the whole crowdsourcing process and the companies do not need to worry about the risks, effort, and overhead related to management of the crowdsourcing process and management of the crowd (Zogaj et al. 2014) (e.g. Innocentive, Kaggle, TopCoder, Ninesigma, Mechanical Turk, 99designs, and CrowdSpring) (Ren 2011; Y. Zhao & Zhu 2014; Marjanovic et al. 2012). Another kind of crowdsourcing process is where companies (mostly for ideation purposes) create their own crowdsourcing platform (such as Dell's IdeaStorm and

Threadless) since they need to maintain an ongoing supply of quality ideas from the crowd over time (Bayus 2013). In this paper our focus will be on the former type of crowdsourcing websites.

Companies are increasingly using contests to encourage the generation of new ideas and solving problems (Hutter et al. 2011). The idea of holding competitions to reach people with various backgrounds, skills, talents, and expertise for idea generation and problem solving has a long tradition (Füller et al. 2007; Hutter et al. 2011). With the advances in information and communication technologies, companies increasingly rely on crowdsourcing phenomena especially in the form of contests to receive high quality ideas and solutions from the crowd (Di Gangi and Wasko 2009). However, the viability, success, and sustainment of these crowdsourcing contests depend on the continued participation and content contribution from individual members as well as the quality of the submitted ideas and solutions (Burke et al. 2009; ; Koh et al. 2007; Nov et al. 2009). Therefore, despite the increasing usage of crowdsourcing in companies and their success stories, some crowdsourcing processes failed due to not being able to maintain individuals' active participation in these platforms (Sun et al. 2012; Nov et al. 2009). Thus, it is important to understand the factors that affect individuals' sustained participation in crowdsourcing processes.

We note that there has been much research in the crowdsourcing literature examining individuals' initial motivations to join the crowdsourcing platforms (Forte and Lampe 2013). These motivations range from intrinsic motivations (fun, enjoyment, altruism, self-efficacy) to extrinsic motivations (monetary reward, reciprocity, job improvement) (Zhao and Zhu 2012). However, research shows initial motivations do not always reflect long-term sustained participation of individuals in the platforms or contests (Forte and Lampe 2013; Shah 2006; Sun et al. 2012). Initial motivations of the participants erode over time and might not be sufficient for maintaining long-term sustained participation (Hippel and Krogh 2003; Fang and Neufeld 2009). This has given rise to a new research stream looking at participants' sustained participation; in particular, the factors that affect individuals' sustained participation in crowdsourcing contests (Nov et al. 2009; Sun et al. 2012; Zhao and Zhu 2012).

Prior studies in related areas have identified that new users who join an open collaboration platform (e.g. Wikipedia) have a hard time discerning the norms and social structure of collaboration, the requirements of the projects, and how to give and receive feedback on contributions. This leads to user attrition in these projects. In order to reduce the attrition rate of the users over time and improve long-term sustainability, socialization of the new users is important (Forte and Lampe 2013). So in addition to attracting new users, socializing and sustaining them in the platform is of critical importance (Preece and Shneiderman 2009; Forte and Lampe 2013).

While there have been studies which examined the effect of socialization and collaboration on submissions' quality in crowdsourcing contests (Hutter et al. 2011; Majchrzak and Malhotra 2013), and studies which examined the effect of socialization and collaboration on sustained participation in online communities and social networks (Huberman et al. 2009), none of these studies examined the effect of collaboration on sustained participation of individuals in competitive environment like crowdsourcing contests. This study aims to address this research gap by focusing on crowdsourcing contests. In particular, our study uses data collected from Kaggle.com, a Web-based platform, which through the use of online contests, delivers data science solutions and models to its clients. By analyzing the Kaggle data, we seek to show how collaboration in such a competitive environment, actually improves individuals' sustained participation.

Our results indicate that individuals' sustained participation is affected by collaboration in the form of receiving attention from the other members of the platform. Our findings yield interesting managerial implications for crowdsourcing sponsors interested in encouraging individuals' sustained participation and monitoring their behaviors. By including collaborative environment in crowdsourcing platforms, crowdsourcing sponsors are able to encourage stable and active user participation and to enhance the sustainability of the community.

The remainder of the paper is organized as follows. First, we review the prior crowdsourcing literature, paying particular attention to factors associated with individuals' motivations for initial and sustained participation in crowdsourcing contests. Second, we review the literature on how collaboration affects individuals' participation behaviors in crowdsourcing and related activities. Third, we describe our methodology and present our results. Finally, we discuss our findings and offer some thoughts on how

practitioners could use these results to modify their crowdsourcing platforms to improve the likelihood of participants' continued involvement.

Literature review

Because of the importance of the crowd's wisdom and collective intelligence in crowdsourcing, the successful development of crowdsourcing communities largely depends on mass participation (Zhao and Zhu 2012). Not surprisingly, there is a large number of studies identifying individuals' motivations and incentives for participating in crowdsourcing (Brabham 2010; Brabham 2008; Y. C. Zhao and Zhu 2014). There is also a plethora of studies on individuals' motivations for participating in related activities as well such as open source software development and virtual communities (Bagozzi and Dholakia 2006; Chesbrough 2013; Hars and Ou 2001; Ke and Zhang 2009; Shah 2006). A study on crowdsourcing introduced motivation as a spectrum from external motivation to intrinsic by believing that the underlying influencing mechanisms may vary across different types of motivation (Zhao and Zhu 2012). The motivation spectrum includes: *External Motivation* (monetary reward, job improvement, reciprocity) (Archak 2010; Brabham 2010; Brabham 2012; Zhao and Zhu 2012; Bayus 2013), *introjected motivation* (gain peer recognition, perceived usefulness, general trust, subjective norm) (Brabham 2010; Zhong et al. 2011; Brabham 2008), *identified motivation* (glory, social identification, specific trust, task requirements) (Archak 2010), *integrated motivation* (sense of virtual community, past experience, sense of belonging, personal obligation and commitment) (Brabham 2010; Zhong et al. 2011; Bayus 2013), and *intrinsic motivation* (perceived enjoyment and fun, to develop individual skills, curiosity) (Brabham 2010; Brabham 2012; Zhong et al. 2011; Brabham 2008).

Although there is a large body of literature which addresses individuals' initial motivations to join the crowdsourcing platforms (Forte and Lampe 2013), research shows that initial motivations do not always reflect long-term sustained participation of individuals in the platforms or contests (Forte and Lampe 2013; Shah 2006; Sun et al. 2012). Initial motivations of the participants erode over time and might not be sufficient for maintaining long-term sustained participation (Hippel and Krogh 2003; Fang and Neufeld 2009).This led to the emergence of a new research stream focusing on participants' sustained participation; and in particular, the factors that affect individuals' sustained participation in crowdsourcing contests. Research on open source development showed that over half of newcomers did not return after their first contributions (Ducheneaut 2005). Thus, maintaining participants in online communities and platforms has been an important challenge in online communities and open source development (Ren et al. 2012).

Researchers have recently started to investigate various factors that could influence participants' sustained participation in crowdsourcing contests. For example, Sun et al. (2011) in their study found a negative interaction effect between extrinsic motivation and task complexity, and a positive interaction effect between intrinsic motivation and self-efficacy on individuals' sustained participation (Sun et al. 2012). Another study on educational online communities found that displaying adaptive rewards to the user at the beginning of each session, encourages stable and active user participation and enhances the sustainability of the community (Cheng and Vassileva 2006). Our study is part of this emerging research stream by considering individuals' collaboration as social motivation for individuals to maintain participation in online crowdsourcing contests. In the following section we will provide a brief history about the concept of collaboration and its effect on individuals' behaviors in various communities.

Collaboration

Moving toward a global, knowledge-based economy necessitates developing the ability to effectively collaborate (Holton 2001). Collaboration in communities indicates the participants' willingness to share their information and knowledge with other members (Hippel and Krogh 2003). There have been studies on the effect of collaboration on various communities from classrooms to firms. Research on collaborative learning in the classroom shows that peer interaction and collaboration facilitates individual cognitive growth, knowledge acquisition, and problem solving (Ku et al. 2013). Some research has examined the collaborative behavior of firms in competitive environment which is called *co-opetition* (Brandenburger and Nalebuff, 1996) and defined as a 'situation where competitors simultaneously co-operate and compete with each other' (Bengtsson and Kock 2015). Co-opetition results in greater knowledge

development, technology progress and acquisition of new skills (Hamel 1991). The advances in information and communication technology facilitated cooperative activities especially *open collaboration* (Forte and Lampe 2013). Open collaboration refers to the collective production of an artifact through a technically mediated platform with low barriers to entry and exit which supports the emergence of persistent but malleable social structures (Forte and Lampe 2013). One of the well-known examples of open collaboration is open-source software development. In these communities, expert programmers collaboratively work together in order to create and improve software programs (Hippel and Krogh 2003).

Research on open collaboration projects (e.g. Wikipedia) shows that new users who join an open collaboration platform have a hard time discerning the norms and social structure of the environment, and the requirements of the project. This all leads to the high probability of user attrition in these projects. In order to reduce the attrition rate of the users over time and improve long-term sustainability, socialization of the new users is thought to be a key challenge (Forte and Lampe 2013). In sum, in addition to attracting new users, socializing and sustaining them in the platform is of critical importance (Preece and Shneiderman 2009; Forte and Lampe 2013).

Collaboration allows individuals to communicate, interact, discuss, and share their ideas with each other and build a sense of community (Forte and Lampe 2013). Studies on online innovation communities show that network effects, reputational gains, the revealing of related innovations by other, and receiving feedback from a knowledgeable audience, are all important motives for individuals to participate in joint innovation activities (Füller et al. 2007).

There is also some research which examined the collaborative behavior of individuals in community-based contests (Hutter et al. 2011; Majchrzak and Malhotra 2013). In these community-based contests, individuals collaborate while simultaneously competing with each other to submit the best idea or design and win the contest (Hutter et al. 2011; Marjanovic et al. 2012). Research in crowdsourcing and community-based contests shows that the simultaneous collaboration and competition increases submissions' quality (Hutter et al. 2011). Hutter el al. introduced the concept of 'communititon' for the simultaneous existence of competition and collaboration in crowdsourcing contests (Hutter et al. 2011). Research shows that individuals are incentivized not only by competitive outcomes, but also by cooperative behaviors (Ebner et al. 2009; Lakhani et al. 2012). Research on the psychological aspects of software crowdsourcing, indicates that crowdsourcing must be competitive while at the same time friendly, sociable, educational, and personally fulfilling for participants, requesters, and administrators (Wu et al. 2013). However, none of these studies examined how collaboration affects individuals' sustained participation in crowdsourcing contests.

It is interesting to note, that in the above-mentioned studies, the notion of 'collaboration' is based on the Hippel and Krogh definition which sees collaboration as the condition where participants share their information and knowledge with other members. Another concept/construct that might be useful in this context is the notion of 'paying attention'. It is where individuals 'pay attention' to other members in the community, by offering comments, suggestions, voting, and the like. This could be seen as a specific form of collaboration. According to (Franck 1999):

> *"When paying attention to the work done by others, those demanding scientific information are effectively collaborating with those supplying it….[But] being highly competitive, the exchange of information for attention is effective in self-organizing control, as well as in measuring the pragmatic value of scientific information."*

In fact in online communities and crowdsourcing platforms individuals compete for attention to get more recognition in the community (Majchrzak and Malhotra 2013). In competing for attention individuals not only pursue their own interest, but also are concerned with what is useful for other members and what satisfies them. Therefore, the other members' comments and votes will help the individuals to supply the information that is interesting and useful for others. Therefore, suppliers of information are collaborating with those who read, comment, and vote on them and vice versa (Franck 1999).
Thus, 'paying attention' could be a valuable notion in understanding sustainability in participation. To this end, we note that the Huberman et al. (2008) research on Twitter found that users who receive more attention from others will post more often than people who receive little attention. Their finding showed that total number of posts increases with both number of followers and friends (Huberman et al. 2008).

By using data from YouTube they also found that users' content generation rate increases directly proportional to the number of downloads. So their productivity depends on the attention they have received for previous contributions (Huberman et al. 2009). In the scientific community, researchers also found that paying attention is the primary motive for becoming a scientist and practicing science (Franck 1999). Suppliers of scientific information compete for the attention of others who pursue both their own interests as well as others' (Franck 1999). Studies on online review systems also found that reviewers contribute to online review systems to receive social benefits such as attention, peer recognition, and/or reputation (Shen et al. 2015). Therefore, gaining social benefits such as attention is an important factor for individuals' contributions to online communities. The "attention economy" theory proposed by Goldhaber (1997) explains the above statements about the effect of attention on individuals' motivation to contribute in online communities. He states:

> *"Obtaining attention is obtaining a kind of enduring wealth, a form of wealth that puts you in a preferred position to get anything this new economy offers".*

With the advances in Web 2.0 and Web 3.0 technologies, there is an increase in the amount of web content generated by online users, which suggests they are more likely to compete for attention when contributing voluntarily to online communities (Shen et al. 2015). Attention is one of the most valuable and scarce resource on the internet. The research on two different online review systems shows that when reviewers are able to quantify the social benefits, they are more motivated to contribute to the community (Shen et al. 2015). Literature on online communities also shows that when individuals do not have monetary incentives, social incentives such as peer recognition and online reputation motivates them to contribute voluntarily (Lerner and Tirole 2002). In crowdsourcing contests with a large-scaled group of solvers, each member will have relatively small chance of winning (Walter and Back 2011), therefore social incentives such as peer recognition could motivate them to participate in the platform (Brabham 2010). Drawing upon the findings in the literature, we argue that receiving attention would be viewed as important social reward to the contributors in online crowdsourcing contests. The more attention the individuals receive for their submissions, the more they are motivated to come back to the platform and contribute to it. Therefore we hypothesize:

Hypothesis: Individuals' sustained participation is positively associated with the amount of attention they receive from other members in the crowdsourcing platform.

This study builds on the founding of the previous studies by considering how collaboration in the form of "paying attention" affect individuals sustained participation in crowdsourcing contests.

Research Methodology

Empirical Context: Contests at Kaggle.com

The relationship between collaboration (in the form of receiving attention) and individuals' sustained participation is tested by using data from Kaggle, a web-based platform that delivers data science models for its clients through the use of online competitions involving a members' base of over 536,000 registered users, or Kagglers, from 194 countries with a variety of backgrounds from computer science to biology. Established in 2010, Kaggle allows companies and researchers to post their data science/ machine learning problems such that data scientists from all over the world compete to produce the best solutions to the problems. Kaggle competitions are open to all data scientists registered on the site. In April 2015, Kaggle implemented the first version of their Kernels product in their platform. Kernels allow users to write, run, and publically share their code on Kaggle. This product helps individuals to initiate new ideas and improve their models. Therefore, Kaggle provides collaboration opportunity for the individuals in the competitive environment.

Data collection and analysis

Data from Kaggle was extracted by going through individuals' kernel submissions for a number of Kaggle competitions from April 2010 through January 2017. The number of all posted competitions during this time period is 234, but only 66 of these competitions have kernels. Since in this study we examine the effect of individuals' collaboration in the form of attention on their sustained participation, we scraped posted comments, votes, and views on the submitted kernels. In total, we extracted 42439 data records

related to 21687 kernels for 66 competitions. After calculating the dependent and independent variables (which will be explained in the next section), we omitted the records with null values for those variables and finally 7028 records remained in the data set for data analysis.

Variable measurement

To test whether there is any relationship between receiving attention from peers and the individuals' sustained participation, we need to measure "attention" as the independent variable and "between participation days" as the dependent variable. We now describe the measurement method that is used for each variable:

"Between-participation-days": is the dependent variable of our model. This dependent variable is measured by the number of days that have passed from the last participation of a user in the platform until the current participation. For example if a user has submitted three kernels at time t1, t2, and t3, the dependent variable's value for time t2 is t2-t1 and the dependent variable's value for time t3 is t3-t2. The smaller this number, means that the user came back to the platform in a shorter period of time and maintained his/her participation in the platform.

"Attention": is the independent variable of our model. This independent variable is measured by the number of the comments that a user received for his/her previous submission. For example if a user has submitted three kernels at times t1, t2, and t3 and received c1 comments at time t1, c2 comments at time t2, and c3 comments at time t3 then the independent variable's value for time t2 is c1 and its value at time t3 is c2 (illustrated in Table 1).

User	Submission date	Number of comments	Between-participation-days	Attention
A	t1	c1		
A	t2	c2	t2-t1	C1
A	t3	c3	t3-t2	C2

Table 1. A Very Nice Table

Further in the study, we also examine how the results may differ if we measure attention by the number of views or the number of votes a user has received from his/her previous participation.

Research model and results

The dependent variable is count data and it follows a Poisson distribution, so the Poisson model is used to determine if there is any relationship between "attention" and participants' "between-participation-days" in the platform. Poisson model has been widely used in marketing and information systems literature to account for the discrete and non-negative nature of the count data (Schmittlein et al. 1987; Dillon and Gupta 1996; Shen et al. 2015). We controlled for "competition's prize" since based on the literature, monetary reward is one of the important motives of individuals to participate in crowdsourcing contests (Brabham 2008; Brabham 2010). We also controlled for "the number of teams competing for the contest" since the literature shows competitors on average react negatively to an increase in the total number of competitors (Boudreau et al. 2012). The between-participation-days can be captured by a Poisson process. Therefore, the probability that user i comes back to the platform at time t with between-participation-days rate λ_{it} can be presented as:

$$P_{it}(y_{it}|\lambda_{it}) = \frac{e^{-\lambda_{it}}\lambda_{it}^{y}}{y!} \quad y=1, 2, 3,...$$

Where y_{it} is the between-participation-days of user i at time t (e.g. the between-participation-days at time t2 equals t2-t1). To consider the attention effect, we model the between-participation-days rate following Dillon and Gupta (Dillon and Gupta 1996):

$$\lambda_{it} = \exp(\alpha' Z_{it} + \varepsilon_{it})$$

Where Z_{it} is the vector for explanatory variables and α is the vector of parameters and ε_{it} is an error term.

We ran the Poisson model of "between-participation-days" (measured by number of days between participations) on the "attention" (measured by the number of comments on previous participation) controlling for the "competition prize in $10,000 scale" and "the number of teams competing for the contest in $100 scale" (Since "Between-participation-days" is negatively correlated with the sustained participation of a user, we expect the coefficient for attention to be negative.) The results show a significant negative relationship between the "between-participation-days" and "attention" which means that an increase in the number of comments results in a user's desire to come back and participate in the platform after a shorter time period. Therefore, receiving attention increases individuals' sustained participation. We repeated the same analysis with the number of views and the number of votes an individual received in the previous participation as the independent variable. We found a significant negative relationship between the number of votes from the previous participation with between-participation-days controlling for "competition's prize" and "the number of teams competing for the contest". We found a significant positive relationship between the number of views from previous participation with between-participation-days controlling for "competition's prize" and "the number of teams competing for the contest". The results are summarized in Table 2.

	Variables	*Coefficient*	*significance level*
Model1	Recent Comments	-0.00054	**
	Competition's prize	0.00808	***
	Competitors	-0.00129	***
Model2	Recent Views	0.000013	***
	Competition's prize	0.005291	***
	Competitors	-0.001170	***
Model3	Recent votes	-0.00005	***
	Competition's prize	0.00808	***
	Competitors	-0.00129	***
	Note: Dependent variable: between-participation-days		
	* Level of significance: p < 0.1.		
	**Level of significance: p < 0.05.		
	***Level of significance: p < 0.001		

Table 2. Results of analysis

Discussions and implication

This study attempts to examine the effect of collaboration (in the form of receiving attention) from other members on the individuals' sustained participation in the crowdsourcing platform where competition exists in the environment. The results from our data analysis using data from Kaggle, show that individuals who have received more comments for a submission tend to come back to the platform in a shorter period of time and participate. We repeated the same analysis on the effect of the number of votes an individual received in the previous participation on sustained participation and found that individuals who have received more votes for a submission tend to come back to the platform in a shorter period of time and participate. Therefore, receiving attention (in the form of comments and votes) motivates

individuals to maintain their participation in the platform. We also repeated the same analysis on the effect of the number of views an individual received in the previous participation on sustained participation and found that individuals who have received more votes for a submission tend to come back to the platform in a longer period of time and participate. A possible explanation for the positive significant effect of number of views from previous participation on between-participation-days is that when individuals receive a large number of views but on the other hand small number of votes or comments, they get disappointed from participating in the platform. Since, the members who have viewed their submission but have not voted for them probably did not like their submission/work. Therefore, in future research we would like to include number of views, comments, and votes in the same model (controlling for the collinearity problem) to examine the interaction effect of number votes and number of views and interaction effect of number of comments and number of views on sustained participation of the individuals.

This paper yields an interesting and valuable managerial implication. Prior research has already acknowledged how difficult it is to get individuals to become participants of a crowdsourcing platform. Once they become participants, the key is keeping them. That is where our research results can help. Our findings indicate that individuals are more likely to sustain their participation if they receive enough attention from other members of the crowdsourcing platform. We suggest that Crowdsourcing platform sponsors pay attention to the factors that motivate individuals to maintain their participation in the platform since sustained participation of individuals is more likely to lead to an active and successful platform. The results of this study indicates the fact that crowdsourcing platforms should be designed in a way that facilitates individuals to vote and comment on each other's submissions so that they will get motivated to sustain their participation in the platform.

Limitation and Future Research

This paper contains some limitations that influence the potential generalizability of our findings. First, we conducted this research entirely within the Kaggle environment; additional research on other crowdsourcing platforms is necessary before the results can be generalized. For example, we would like to know how the individuals' participation differs in Innocentive which does not have any environment for collaboration and Topcoder which only allows at most 20 competitors in each competition room to compete and post feedback to each other's submissions.

Second, we only focused on collaboration in the form of attention by considering: number of comments, number of votes, and number of views. Future research should explore if the content of the comments (e.g. emotive, prescriptive, content free, etc.) affects individuals' sustained participation. We also recommend the exploration of individuals' activities in discussion forums of crowdsourcing platforms.

Conclusion

Despite these limitations, this paper makes an important contribution for academics and practitioners. It provides empirical evidence that receiving attention from other members of the crowdsourcing platform has a positive effect on individuals' sustained participation. Moreover, it highlights the fact that attention in the form of comments and votes motivate individuals to maintain their participation in the platform and submit solutions after relatively small time gaps. We conclude that crowdsourcing sponsors can encourage stable and active user participation and can enhance the sustainability of the community by including collaborative environment in crowdsourcing platforms.

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