Software Crowdsourcing Challenges in the Brazilian IT Industry

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Keywords: Software Crowdsourcing, Software Development, Software Engineering, Brazil, Challenges, IT Industry.

Abstract: Software crowdsourcing has been regarded as a new paradigm for the provision of crowd-labor in software development tasks. Companies around the world adopt this paradigm to identify collective solutions to solve problems, ways to accelerate time-to-market, increase the quality and reduce the software cost. Although this paradigm is a trend in the software engineering area, several challenges are behind software crowdsourcing. In this study, we explore how the software crowdsourcing has been developed in the Brazilian IT industry. We have conducted 20 interviews with Brazilians practitioners in order to identify the main challenges for software crowdsourcing in Brazil. Additionally, we identified and discussed enablers and blockers' factors, practice implications and directions for future research in the area. Our paper aims to provide an overview of the software crowdsourcing in Brazil and motivation for researchers to better understand challenges faced by the Brazilian IT industry.

1 INTRODUCTION

Crowdsourcing (CS) is defined as the act of an organization to make its work available to an undefined, potentially large networked of people – a crowd - using an open call for participation (Howe, 2008). This concept has been adopted to disseminate corporate tasks that were traditionally performed by small groups of people.

CS has been adopted for several purposes such as innovative design (Howe, 2008), information peer production, knowledge and culture dissemination data analysis (Brabham, 2008), and software development (Lakhani et al., 2010; Wu et al., 2013).

CS in software development means to engage a global pool of online workers that can be tapped on-demand to provide software solutions or services (Lakhani et al., 2010; Stol and Fitzgerald, 2014).

Many computational platforms were created to handle the technical aspects of CS tasks, including broadcasting of tasks, task assignment, and submission and analysis of results (e.g. TopCoder, Crowdtest and WeDoLogos).

In Brazil, software CS is in the early stages. We have observed the lack of processes, models, and practices to support the Brazilian community. This is problematic because the adoption of CS in software development activities can help to increase Brazilian companies' competitiveness in the global software development market.

Our paper presents findings from a study conducted in the Brazilian IT industry. This study aimed to understand how software CS has been adopted in the Brazilian IT industry and the main challenges faced during its adoption. Additionally, we identified and discussed enablers and blocking factors for the software CS in Brazil, practice implications and directions for future research in the area.

Our study offers the following main contributions:

- **A Set of Challenges Concerning the Adoption of Software CS by the Brazilian IT Industry:** since Brazil is in the early stages of adoption of software CS, we explore the particular challenges associated with it practice in Brazil.
- **The Theoretical Foundation for Further Research in the Area and Developing of Solutions for the Brazilian Community:** to identify and understand which aspects are related to the adoption, or not, of software CS in the Brazilian IT industry is the first step towards integrating and facilitating the CS model in other organizations.

Machado, L., Kroll, J., Prikladnicki, R., Souza, C. and Carmel, E.
Software Crowdsourcing Challenges in the Brazilian IT Industry.
In *Proceedings of the 18th International Conference on Enterprise Information Systems (ICEIS 2016) - Volume 1*, pages 482-489
ISBN: 978-989-758-187-8

2 SOFTWARE CROWDSOURCING

CS is a hybrid model regarding to intrinsic and extrinsic motivation (Mao et al., 2013). Motivation can be driven by financial rewards, which are extrinsic factors. On the other hand, crowd participants are also interested in reputation that can be earned through knowledge is shared – intrinsic intentions (Olson and Rosacker, 2013).

Despite this outward similarity, characteristics of service providers and suppliers are different in the two models. While with traditional outsourcing an entity subcontracts a handful of professional third-party companies, CS model turns to scale via an undefined, open, and heterogeneous online "crowd" to source in these needs (Saxton et al., 2013).

A significant distinction between software development strategies is the duplication of work. In CS, activities are performed in parallel, distributed in many chunks instead of single projects. The main differences among Innersourcing, Outsourcing, software CS, and Open Source Software (OSS) are presented in Table 1. The payment characteristics of software development strategies also are different. In software CS payments are based on reward per tasks (Âgerfalk et al., 2015). In OSS, knowledge is for sharing, with the focus on the development of better software and little if any attention given to profitability. Software CS is an application of the OSS principles to other industries. However, it receives an open and unidentified group that competes to solve a problem (Olson and Rosacker, 2013).

For each CS area three main elements are adopted as shown in Figure 1. The first component is the CS platform, which acts as the intermediates between the two other components and consolidates the tasks outcomes. The second component is the Crowd, which is globally dispersed. The third component is the Requesters. They are the companies or the individuals whom demands the work (tasks) (Prikladnicki et al., 2014).

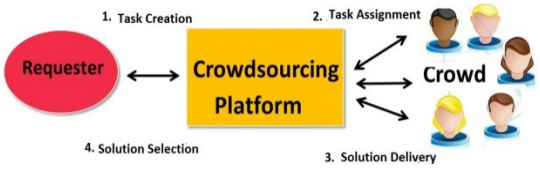

Figure 1: Basic crowdsourcing model.

Many authors argue that CS promotes creativity and problem solving (Kittur et al., 2013). However, software CS has many issues and unique features. Some of them still need for support (Wu et al, 2013): complex and heterogeneous tasks, interdependent tasks, several types of expertise, and activities of collective control.

These issues in software CS include quality, cost, diversity of solutions, delivery speed and, competitive scenarios. Furthermore, studies discuss many challenges and opportunities for better understand, evaluate and support the CS influence the software industry (Huhns et al., 2013).

2.1 The Brazilian IT Industry

Brazil is one of the largest economies in the world. Brazil has unique characteristics. Population of 200 million people; large and expanding domestic market; single language; sophisticated financial market; industry and business knowledge; qualified human resources; infrastructure; governmental support; favorable economic, political, and legal environment (Prikladnicki and Carmel, 2014). Thus, Brazil plays an important role in the global economy.

We decide to investigate software CS in the Brazilian IT industry because Brazil has the biggest and most diversified science, technology and innovation system of Latin America. According to Forbes magazine (2014), Brazil's economy outweighs that of all other South American countries, and Brazil is expanding its presence in world markets. We expect having emerging and large economies like Brazil taking place in the software CS market with more platforms, requesters

Table 1: Software Development Strategies.

	Innersourcing	**Outsourcing**	**CS**	**OSS**
Concept	Traditional business model	Traditional global business model	Web business model	Online Community
Nature of workforce	Specific group	Specific group	Open and undefined group	Open group
Incentives	Extrinsic	Extrinsic	Extrinsic/Intrinsic	Intrinsic
Intellectual Propriety	Enterprise	Enterprise	Winning solutions CS enterprise	Members' license
Payment	On payroll	Contract	Pay per tasks	Often unpaid

and large crowds.

The Brazilian IT industry does not take a risk before something (technology, model or process) is been widely known in other international markets. The Brazilian market has a more pre-cultural attitude in order to preserve conditions, principles, and existing processes. This market keeps a traditional way to carry out business. Few companies engage in innovative projects and pilot projects with a degree of uncertainty (Prikladnicki et al., 2014).

3 RELATED WORK

Whereas CS has been discussed in a wide variable domain, still have a small number of studies discussing software CS initiatives in different countries.

The adoption of CS platforms in South Africa is discussed by Chuene and Mtsweni (2015). This study was performed in order to understand how it is used and by whom. The authors report the embracing of CS initiatives has been slow, especially amongst public organizations, due to various reasons, such as lack of awareness. Some local CS platforms such as "Txteagle" launched in Kenya and Rwanda enables citizens to earn few dollars by completing micro-tasks on their mobile phones. A South African platform presented is focused on crowd-funding, social, and government crowdsourcing aspects. This study reveals a lack of information pertaining to the status and number of users benefiting from the adopted and/or deployed platforms.

In a recent study performed by To and Lai (2015), the authors discuss the latest developments in crowdsourcing in China. They describe CS scenarios in terms of concerns and opportunities. China offers CS advantages, it because includes the online population's size people's and their willingness to participate of the CS activities. Other opportunity was the Zhubajie's CS Chinese platform, where it services aren't closed off to English speakers. Chinese freelancers also participate in other markets. CS barriers reported in this study are the language between client and CS partners. Another concern was the censorship and government control, and intellectual property rights.

China and India are successful in attracting global outsourcing industry (Perera and Perera, 2014). China has a large educated workforce, high quality infrastructure, government keenness, etc. While India has lower labor cost, familiarity with western business practices, positive time zone difference, Indian owned global delivery centers and strong private-public partnership. In China, crowdsourcing platforms such as Zhubajie (zhubajie.com), TaskCN (taskcn.com) and K68 (k68.com) have attracted a lot of innovative talent and solution seekers, which greatly enhance business operations (Shao et al., 2012).

4 RESEARCH METHODOLOGY

An initial ad hoc literature review was carried out with the purpose of sharing the basic CS concepts with the research team and identifying the challenges to be addressed. Semi-structured interviews were conducted iteratively with Brazilians practitioners from different Brazilian companies. Our goal here is better understand how the software crowdsourcing has been adopted in the Brazilian IT industry. The interviews focused on both industry and academic perspective. Each interview lasted between 30 and 60 minutes.

We created an interview protocol with open-ended questions focusing on the discussions of both perspectives: *industry* - organizational motivations for leveraging the crowd, specific tasks to be completed and perceived impacts on the organization; and *academic* – sharing characteristics with related research areas like software testing, collaborative software engineering, distributed software development and distributed collaborative programming.

4.1 Participants

We conducted a total of 20 interviews, in which the majority of interviewees were males (18) and the others females (2). Thirteen participants were from the first group (industry) and 7 participants were from the second group (academic). These participants are mainly from the south of Brazil. Participants have 3 years of working experience in average.

The industry participants are classified under three different CS perspectives: buyer, platform, and crowd. We interviewed participants from two pioneer Brazilian CS platforms – Crowdtest and WeDoLogos. These companies are the two largest crowd testers and crowd designers in Latin America.

We interviewed academic participants during The Brazilian Conference on Software: Theory and Practice (CBSoft 2014). The CBSoft is one of the largest events held by the Brazilian Computer Society, with the goal of promoting and encouraging

Table 2: Participants' information.

Participant #	Job Title	Type of experience (Academic or Industry or Both)	Element
P1..P6	Tester	Industry and Academic	Crowd
P7, P8	Developer	Industry and Both	Crowd
P9..P11	Assistant Professor (System analyst)	Academic	Crowd
P12	Developer	Both	Requester
P13	Manager (IT Consultant)	Industry	Requester
P14	IT Manager (Host Service Company)	Industry	Requester
P15	IT Manager (E-Commerce Company)	Industry	Requester
P16	Manager (IT Company)	Industry	Requester
P17	Manager (Media Company)	Industry	Requester
P18	CEO (Innovation Consultant)	Industry	Requester
P19	CEO (WeDoLogos)	Industry	Platform
P20	CEO (Crowdtest.me)	Industry	Platform

the exchange of experiences between the scientific, academic and professional communities in Software Engineering (SE). The participants' details are presented in Table 2. The last column called Element presents the three basic elements of the CS model, in which each participant was classified (see Figure 1).

4.2 Procedure

We conducted the interviews face-to-face, by voice or video conference call, and by email. Some conversations were not audio recorded because of companies' confidentiality issues. The interviewees were asked to report their experiences in software CS under six aspects: (1) CS initiative, (2) CS platforms, (3) CS tasks and projects, (4) CS payment, (5) business impact, and (6) the future. We present the interview questionnaire in Table 3.

Table 3: Interview Questionnaire.

Aspects	Questions
CS Initiatives	Do you know CS? Tell us about your CS experience?
	Are you doing micro-tasking specifically? Or are you doing macro task projects?
CS Platforms	Which Platforms (middlemen) have been used?
	What is the number of workers in the crowd?
CS Tasks and Projects	What have you done to achieve and inspect for quality? What has worked best?
	How do you manage day-to-day tasks?
CS Payment	Is the enterprise encouraging / discouraging the use of paid CS?
Business impact	By what measure was it successful? What has made this challenge a success?
	How did you measure success?
Future	What are your plans for CS?
	What is the Brazilian CS scenario for the next three years?

4.3 Data Analysis

Our data analysis was guided by techniques associated with less procedural versions of the grounded theory (GT). Specifically, we applied the techniques of coding and constant comparison as recommended by Corbin and Strauss (2008). These techniques helped us to elicit emergent themes in the Brazilian IT industry, to identify concepts in the collected data and to link these concepts to higher-level categories.

5 FINDINGS

Our findings show that both academic and industry participants have different experiences using CS for micro and complex tasks. They have adopted CS for software and other domains. They have performed tasks such as, testing service and image recognition.

We also identified collaborative tools adopted by Brazilians to improve software development. These tools are based on crowd knowledge such as GitHub and Stackoverflow.

Table 4: CS research in Brazil.

Research Area	Crowdsourcing Topics
Experimental SE Software Engineering	Barriers to contribute to the open sourcing process
Software testing	Crowd testing model of the enterprise
Collaborative Software Engineering	Collaborative tools – CS Platform Crowd knowledge
Software Ecosystems Platform	Distributed software development and open participation (crowd)
Distributed collaborative programming	Motivation, coordination and sharing knowledge

Researchers are investigating Crowd testing in two contexts – distributed and traditional testing software. We observed from these findings research opportunities in other software ecosystems that share the same characteristics with other research areas. Table 4 presents the research areas and topics in software CS.

5.1 CS Elements Perspective

Our findings show that Brazil has a few CS buyer's initiatives and platforms. On the other hand, Brazilian active members' are emerging both on national and international CS platforms.

We describe our findings based on three perspectives: Crowd, Requesters, and Platform. These results can be categorized in enablers and blockers' factors. Table 5 shows these factors.

Table 5: Enablers and Blockers' factors in Software CS.

Elements	Enablers	Blockers
Crowd	Extra money	Poor feedback
	Shared knowledge	Few collaboration
	Curiosity	Scarce context project information
	Free time	Unavailability of documentation
Requesters	Scalability	Specific business knowledge
	Save money and time	Low quality of services
	Creativity	Maturity of suppliers (crowd)
	New ways to do the same	Identifying a specific process
Platform	Fast delivery	Data confidentiality
	Reduced cost	Very specific business rules
	Diverse types of testing	Laws and taxes involved

An enabler factor means a characteristic that promotes or motivates the CS practice. On the other hand, a blocker factor means a characteristic that inhibits or limits the CS practice.

As enablers, there is the collective intelligence of the software engineering industry with more diversity, creativity and knowledge sharing. Scalability, cost reduction and time-to-market are also important enablers for platforms and requesters. As blockers, the requesters pointed out the low quality of services, the difficulty in identifying a specific process to distribute tasks to the crowd and the maturity and adoption of CS in Brazil.

5.2 Challenges

We identified challenges related to three areas: Tasks, Processes and People. Each area can describe one or more challenges.

- **Tasks – Lack of Quality**

Challenges related to tasks area includes the lack the quality of platforms and micro-tasks. The platform should provide clear information and support documentation to the crowd, appropriate structure for the submission of solutions, and feedback to submitted tasks.

Micro-tasks refer to the personal demand created by requesters. The configuration of the micro-task request is performed through CS parameters such as specific subject, constraints, quality issues, monetary reward, and target worker. Participants reported the unavailability of documentation on tasks requirements, specific business rules and scarce context about the tasks. In some projects, participants report the need for more information to complete and deliver distributed tasks. They also need to achieve the requesters' expectations. Stol and Fitzgerald (2014) also describe the task quality assurance challenge under the requester perspective.

Testers describe the lack of information on reported bugs. A tester participant, who has worked on the Crowdtest Brazilian platform, describes how errors are reported.

"Everyone reports errors in the same place and the tool does not return with the reason why the reported error was not considered as an error to the platform (client), and we were no guarantee" (Participant 5).

On the other hand, the requester describes the quality of crowd deliveries. In his opinion, the lack of qualified works is the main problem.

"Sometimes there is a lack of professionalism in this environment. Most of the time filters are not performed by the platforms to allocate the profile of qualified members" (Participant 14).

A buyer, who has bought services on WeDoLogos platform since 2010, says that in this field there are few professionals with specific skills. For him, the majority of workers are not skilled. Although the quality of the service is considered good for him, he receives few proposals to perform the work (approximately 10 proposals per project). On the other hand, another participant describe a project in which he received more than 200 proposals. However, the quality of the delivery by the crowd was very low. Only 10% of solutions received from the crowd could be take. For some projects, he has considered to return to the

traditional model of hiring service to meet his needs.

"I believe that for small businesses the crowdsourcing model can work. The quality of service is low and any delivery is part of the crowd" (Participant 12).

- **Processes – Lack of CS Processes**

Since the crowd and requesters from Brazil have little experience in software CS, we observed challenges related to the immature adoption of CS processes. Users are not familiar themselves with the CS processes.

Participants from the buyer's group report the importance of having a process to support the adoption of CS initiatives. Participants emphasize limitations to adopt CS models in business. These limitations are related to CS management processes in terms of collectively coordination, communication and collaboration.

"Brazil is a very conservative country and it needs to prepare people to work with crowdsourcing. It is necessary to have a strong process behind the platform and people to support business" (Participant 13).

"Crowdsourcing is difficult in our company because it is necessary to have a visibility of tasks (progress activities, for instance "to do", "doing" and "done"). We have a strong work process orientated on quality and productivity. Crowdsourcing could be a new direction to the future but it requires a maturity level and another mindset" (Participant 16).

A participant reports the use of CS model for open innovation domain in Brazil. This project started in 2006. Recently, this project has a partnership with a CS innovation platform called *Innocentive*. The requester describes how the CS processes work in this project.

"I believe in the crowdsourcing model for my business and my clients. The process created by them has been used with good results for the clients. The success in crowdsourcing projects depends on some factors, such as number of projects, participant engagement, ideas proposed by participants, deployment of solutions, number of participants, and concept of phases to crowdsourcing projects (dependent on the complexity and investment by client)" (Participant 18).

The participant also describes tools to support the process. These tools are only adopted as an interface between customers and network (crowd). For him. It is more important to focus on how the project design is planned and executed by the workers.

- **People – Cultural Barriers**

Brazil has particular laws and legislation. The country is very concern on labor law and bureaucratic issues.

Brazil is a conservative country in terms of distributed software development. Usually, Brazil receives a lot of outsourcing demands but it is not used to outsource. The most of the time, Brazil is much more a supplier than a consumer.

The country is a special case in terms of software development. Brazilians companies and labor participate in global CS marketplaces, but it also "plays in their own sandbox". It may happen because of language issues. Portuguese is the official language in Brazil and the majority of the population do not speaks another language.

Another fact is that Brazilians prefer to have a permanent job besides to be to have freelancer job. In addition, participants report do not trust in having a virtual contract of work. They are very conservative people.

One of our findings shows a contradiction between the collaborative culture of Brazil and the competitive environment in the economy. Brazil still trying to introduce a new model of work.

"Companies control logic and create an antagonism in relation to digital networks. Companies have difficulty in changing their business to work in a complex world. Companies want the control of their idea" (Participant 8).

Brazilians companies do not understand the distributed workforce within a collaborative system. They have concerns about intellectual property and business rules. According to the participant 18, CS is much more talked about than consumed in Brazil.

6 DISCUSSION

CS is an emerging topic in software industry. It provides a new approach for companies involve their workers with innovation activities. However, despite the positive effects, many challenges are identified for CS practice. The Brazilian IT industry has specific challenges that make this country different from others.

We found that the main challenges faced by Brazilians practitioners are concentrate in three areas Tasks, Processes, and People. We also found eleven enablers and blockers factors for the CS practice in Brazil.

Tasks are difficult to manage in CS environments. Requesters expect to receive a task with certain level of quality. However, in some cases

the delivery do not attend the expectations of the requester. According to (Li et al., 2013), one of the most problems in CS is quality control to ensure the quality of results. The factors of quality for CS tasks are the number of participants, tasks assignment to workers according to their individual expertise, and the reward amount. The inappropriate worker-task matching may harm the quality of the software deliverables (Mao et al., 2015).

On the other hand, workers report the lack of information that can result in a task delivered with low quality. When workers understand what information is need for the task specification, it will be possible to provide solutions to problems that meet customers' needs. However, to Wu et al. (2013) the vendor selection has a direct correlation with the quality of an outcome. Workers are attracted by an open call format rather than being selected. It encourage the non-skilled workers to participate. The list of countries with higher level of active members shows Brazil on 14º ranking position between 50 countries. Country rankings are based on an aggregation of the TopCoder members within a particular country that have competed within the last 180 days (https://community.topcoder.com/).

The lack of processes definition is another challenge faced by the Brazilian IT industry. To take advantage the power of software CS, it is important to define the proprieties, elements, responsibilities and interaction flows of software CS as a new software development process (Kittur et al., 2013). While other countries like United States adopt and invest in crowdsourced development processes, Brazil adopts a timid posture regards to it. Brazil has only two CS platforms to support software activities. We believe that online markets for software CS tasks such as software project development activities, still have not received attention from companies and workers. Currently, Brazilian platforms do not meet the requesters' expectations. According to our findings, Brazilian platforms support only few types of activities.

Portuguese is the official language in Brazil. English is the global language of business. The majority of Brazilians speak only Portuguese. Thus, the Brazilian community face difficulties to use international CS platforms due to the language.

The intellectual propriety in software CS is a world polemic question. In Brazil, this question is amplified because the Brazilian laws and legislation have characteristics of trade protectionism.

In literature, few authors explore region-specific practices in CS software project. Europe and United States are well populated with CS participants, but that still does not say much about potential differences in acceptance of CS across the globe.

In our study, some cultural aspects in CS are presented. Brazilians are highly creative in their own way, but the country is still underdeveloped in terms of software CS. Cross-cultural differences in the adoption of CS and open approaches to business are still under-explored.

CS is a business concept that focus on the use of intelligence, collectivity and volunteer knowledge to solve problems, improve or develop new products, technologies and services (Brabham, 2008). Nevertheless, CS still not clearly understood by many companies that can take advantage of this concept. Brazilians are highly creative in their own way, but the country is still underdeveloped in terms of software CS. Cross-cultural differences in the adoption of CS and open approaches to business are still under-explored.

Under the Brazilian perspective, there are many issues regards to CS elements' (requester, platform and crowd). To Carmel and Eisenberg (2006), Brazilian national software builds pride inside the Brazilian software community to develop software under conditions of hardship. For these authors, Brazilian software companies do not believe in its capacity to create and offer job for other workers and other markets.

Every country is unique and has its own specific challenges when it comes to change the way of work, like implementing software CS. This study gives a starting point on region-specific practices in crowdsourced software development.

6.1 Limitations of this Study

We are aware of the limitations of this study, since our study does not seek to establish any causal relationships, we do not discuss threats to internal validity.

The qualitative analysis of the interviews was performed by the authors together, which limited the effects of possible researcher bias in the analysis. We also adopted grounded theory to analyze collected data using descriptive statistics and techniques (Corbin and Strauss, 2008).

We interviewed Brazilians practitioners with different experience levels. The imbalance experience could have influenced positively or negatively in our findings. Unfortunately, the identified findings are not exhaustive. They only represent those that have been experienced and observed by our participants. We have carefully

selected the participants in this study.

7 CONCLUSIONS AND FUTURE WORK

In this study, we investigate how the software CS has been developed in the Brazilian IT industry. We found that Brazil is very conservative and moderate in terms of adoption of software CS in IT scenario. Brazil has a few requesters' demand, both in national and international CS platforms. Also, we found few CS platforms to support the Brazilian market.

Although Brazil is an important software market and one of the most important emerging economies, we are not surprised with our findings. Brazil has a weak participation in software CS initiatives.

Our results show that the main challenges in software CS in Brazil are related to Tasks, Processes, and People. We believe that for the software CS to work effectively, it is important to better understand the issues related to the three CS elements (Crowd, Requesters, Platform). Given this perspective, the research we present here is of value to both to academic and industrial communities. We also believe that these findings are particularly important from the Brazilian perspective; however, they also help add to the body of evidence in the field of software engineering.

In spite of the challenges, we believe that CS will get new labor markets in future. Markets that are disrupted, like the Brazilian software market, shall see changes in the types of tasks that are currently being performed. Also, software development though CS may it will help to alleviate the Brazilian cultural limitations mentioned in this study.

More empirical research is needed on how to develop software CS in Brazil. We plan to follow our case organizations to see how they minimize the identified challenges, collecting more detailed data about their software practices, as well as by additional interviews.

ACKNOWLEDGMENTS

This work is partially funded by CNPq (312127/2015-4).

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