

Incentives Mechanisms for Participatory Sensing within Research Context

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Abstract. In the last years, a great participation of citizens and their integration into the tasks and activities of professional organizations became possible through Web 2.0-based concepts of crowdsourcing. One of the most important aspects of all those concepts is the chosen incentive mechanism, which serves for getting in contact with the crowd and its individuals. Participatory Sensing, as one subset of crowdsourcing, asked individuals to gather, analyze and share data using the integrated sensor capabilities of their mobile devices. Based on the results of an empirical study on the motivation towards participating within participatory sensing studies in the context of research, this paper outlines incentive mechanisms for research studies from a participant's perspective.

Introduction

In the recent years, open innovation concepts – emerging from Web 2.0 – have been geared to citizen involvement as well as different types of community engagement. Those concepts mainly comprise support for a greater participation and integration of citizens into the tasks and activities of professional organizations (Brabham, 2013). Crowdsourcing is a “type of participative online activity in which an individual, an institution, a non-profit organization, or company proposes to a group of individuals via a flexible open call, the voluntary undertaking of a task” (Estelles-Arolas & Gonzalez-Ladron-de-Guevara, 2012).

Howe (2006) introduced the term ‘crowdsourcing’ for the first time within his article „The rise of Crowdsourcing“ and defined it as “the act of a company or

institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call. This can take the form of peer-production (when the job is performed collaboratively), but is also often undertaken by sole individuals. The crucial prerequisite is the use of the open call format and the large network of potential laborers”. Nowadays crowdsourcing can be found in a lot of different fields, for instance, it is applied for the targeted search of employees or for communication tasks during emergencies (Ludwig et al., 2015).

One key aspect of all crowdsourcing concepts is the chosen incentive mechanism, which serves concepts for getting in contact with the crowd and its individuals as well as long-term participation. If the incentive mechanism does not mediate the task appropriately or does not address the right target group, the results of crowdsourcing campaigns will not be successful. It is therefore important to address the different situations and target groups and chose the right incentive mechanisms in a right way. A lot of incentive mechanisms already exist such as rewards, punishments, or playful or competitive approaches.

One subset of crowdsourcing, which emerged with the ubiquity of smart mobile devices is *participatory sensing* (Burke et al., 2006) in which individuals are asked to gather, analyze and share data and information using the integrated sensor capabilities of their mobile devices. Application areas for participatory sensing include, for example, GPS or speed data from cyclists to infer route and traffic noisiness (Reddy et al., 2010), audio data from microphones to discover biodiversity (Moran et al., 2014) or to measure the air quality (Kuznetsov et al., 2014). The presence of such multimodal sensors is enabling a broad range of possibilities through the automatic collection of sensor data.

Within this paper, I want to examine incentive mechanisms with regard to the concept of participatory sensing in the context of research studies. I will therefore present the results of our empirical study regarding the motivation towards participatory sensing studies. The overall goal of this empirical study was exploring people’s attitudes towards, and behavior when using, mobile devices and their attitudes and behavior concerning the capturing and study of this behavior. It also included issues of privacy and transparency as well as people’s motivation and concerns about participating in real life and long-term studies.

Empirical Study

Participatory Sensing studies are usually large-scale and long-term studies including the capturing of smartphone data. Previous studies have shown that technical systems for sensing mobile device data should reflect not only ethical and privacy concerns, but also factors relating to long-term user motivation (Gouveia & Karapanos, 2013; Kärkkäinen et al., 2010; Kujala & Miron-Shatz, 2013). The focus of our empirical study was to discover what challenges of

people's motivation have to be met when designing participatory sensing applications that support the capturing of individual in situ contextual behavior in large-scale studies over a long period of time. One of our main questions was therefore what influences the users' motivation to participate in large-scale and long-term studies?

The research strategy of our empirical study consisted of a methodological triangulation involving a combination of 13 qualitative interviews (I01-I13) to get insights into current mobile practices *at a micro-level* as well as a quantitative online questionnaire with 190 participants, published via our home university's Facebook group, to evaluate the qualitative findings *at a macro-level*. All qualitative interviews were audio recorded and later transcribed for data analysis. To analyze our data, we used a qualitative content analysis approach (Hsieh & Shannon, 2005). *Conventional content analysis* is appropriate when prior theory exists (from literature study), but stays open to unexpected topics and only at a later stage relates findings to existing theory (Karapanos et al., 2009). Based on the results of our interviews, we established a quantitative online questionnaire with the aim of evaluating the qualitative findings *at a macro-level*. It contained 27 hypotheses separated into the three different areas: (1) user's general data, (2) transparency and application usage patterns, and (3) motivation and requirements for participating in long-term studies.

Results

For users, it is important to have constant control over which mobile data is transmitted from an application (I05). 76% of the users interviewed in the questionnaire highlighted the importance of the traceability of data handling. Those findings are not, we acknowledge, particularly novel and have to some degree already been addressed in previous literature. However, our results suggest that users have in common a negative attitude towards a random collection of data and participation as well as giving feedback in commercial apps (I04). In contrast to their unwillingness to provide feedback within commercial apps, the interviewees were willing to participate in studies within the context of non-industrial research; especially studies which represent shared interest and common good in some way: "If it had a positive, non-profit benefit with a common public interest, I would definitely participate" (I02) "it being relevant for the public is a good reason to me" (I01). 80% of online users share this attitude. Two thirds would not mind participating in research studies or studies of interest to the public by providing their mobile data (70%). The majority is open-minded, especially towards research: "In a research context, I know data will be anonymous and won't be communicated to third parties" (I04).

Even before using an app, users already specified which information is interesting and crucial for a possible participatory sensing study designed to

capture user information and usage data: “If this is a study where the initiator is clearly visible and s/he triggers a request for a specific study that includes a description of what it is about, I would participate” (I02). 82% share the opinion that such a description and additional background information on studies and research projects is important and provides a good overview. Based on this information, “I could pick out those studies that I am interested in and where I am willing to transmit my data to” (I09), because “I do not want to put all my data onto a platform, but I am willing to make my data accessible to a specific research project or to a specific group” (I04). Almost 70% see such individual selection of interesting studies as a decisive factor.

Following the participants’ agreement regarding the access of data, the subsequent handling of data during the usage as well as afterwards must be transparent and guaranteed: I want to know what data of mine is being stored and how it is being analyzed at all times” (I08). 94% consider transparency as one of the key conditions. This transparency is not only useful for following the processing of data, but also for users’ understanding of their own mobile usage with regard to the context (I02): “A smartphone is used so often, I sometimes think I am not even aware of how often I use it, how often the display is active or how much time it takes up every day” (I04). A lot of systems already offer such “quantified self” approaches, but as literature has already revealed, access to and overview of user’s device data alone is not sufficient for an intrinsically-motivated long-term participation: “I would probably use such apps just for a week to see how my usage patterns are and then I would uninstall it” (I06).

It is therefore important to create long-term and individual motivation factors (I01). The main motivation factor for participating in ‘quantified self’ studies mentioned by the participants is an interest in documenting their own behavior in comparison to that of other participants. This does of course vary greatly from individual to individual (I01, I04). There is, for instance, an overall interest in apps that are frequently used by other participants (I01, I03, I04), as well as an interest in shared common topics (I01, I02, I09, I10) and a significant degree of interest in maintaining contact with other study participants or researchers (I01, I02, I03, I09, I10). However, to establish communication between participants, a few challenges have to be addressed. Firstly, they must be continuously and actively integrated both in the entire gathering as well as in the analyzing process of captured data: “I’m not a researched object! It should be a kind of ‘community thing’, in a way you understand everything” (I04).

Conclusion

One of the main motivation factors in participatory sensing studies in the context of research and therefore incentive mechanisms is the concept of the ‘community thing’ (I04) that considers users rather to be active participants than just passive

data providers. To move users to participate, they need to have an opportunity to select by content only those research studies in which they want to participate by intrinsic factors or common goods. To present the user with results and the progress of a study as well as to foster discussions, a communication channel between users among themselves, but also between users and researchers, must be established thus promoting stronger integration into the overall research process and the community which may form around it.

As a new step we are trying to implement incentive mechanisms into a participatory sensing application to test its impact on participation and long-term motivation.

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