Look! A healthy neighborhood: Means to motivate participants in using an app for monitoring community health

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Abstract

Participatory data collection relies on the commitment
of the participants to report data continuously, which
makes providing incentives to people crucial. In this
case study, we describe how we designed a web app by
using different incentive mechanisms to collect
participatory data for monitoring community health.
The insights we gathered through evaluating the
prototype in focus groups and the lessons we learned
about sustaining motivation and interest are discussed
in the paper. We expect that these lessons would be
useful for other participatory sensing projects that aim
for constant and systematic data contribution from a
large group of people.

Author Keywords

Community health; Participatory sensing; Motivation;
Mobile app; User-centered design; Gamification.

ACM Classification Keywords

H.5.2. [User interfaces]: User-centered design.

Introduction

The physical and social environment we live in has a
deep impact on our health. Safe traffic and public
spaces, clean air, good sound quality, facilities for
social contact are all connected to the prevention of
stress, depression, and cardiovascular diseases [14].

Figure 1: Amsterdam Slotermeer is a low-income neighborhood with a high immigrant population and relatively poor physical and mental health status (Photographs by Doris van Iperen).

The assessment of these conditions, however, is generally in the hands of the related local and government authorities. These parties often gather information about the characteristics of the neighborhoods through nationally available existing registrations (i.e., Geographic Information Systems) or expert visits to the neighborhoods (i.e., auditing). They then analyze health risks and opportunities, create policies and interventions to improve the health in urban environments.

It is questionable, however, whether the observations from this top-down approach reflect what people find important in their neighborhood when it comes to health. There is increasing evidence in public health and urban planning indicating that expert assessments can miss significant contextual information [5]. Citizens have intimate knowledge about patterns and problems in their communities and enabling them to share this knowledge is valuable for community well being. There are only a handful studies that aim to include citizens' input for urban policy making through using geo-located data, e.g., Voluntary Geographic Information [9] and Public Participatory GIS [4], yet these projects are not explicitly designed to elicit what is important for the citizens regarding health and their data analysis tools are not accessible for novice users. Furthermore, the methods are not intended for long term monitoring.

Project background
To address these problems we launched the project "Look! A healthy neighborhood", in which we seek to explore how interactive systems can facilitate continuous input from citizens about geo-referenced records of everyday life, create maps of neighborhood features and community resources, and feed these

back into the physical and social experience in the neighborhood. The project is a collaboration between our university, two governmental health institutions, i.e., National Institute for Public Health and the Environment (RIVM) and the Public Health Service of Amsterdam (GGD Amsterdam), local community development organization Eigenwijks, and the municipality of Amsterdam City-district New-West. The neighborhood Slotermeer was chosen as a pilot area from this district to implement the project due to its repeated low scores on physical and mental health at the nationwide health scans [17] (Figure 1). The project partners conducted two large-scale studies in the neighborhood by actively involving Slotermeer residents in revealing the factors that they found important regarding the health of their neighborhood. The result of these studies set a basis for resident engagement to be reinforced by participatory sensing. In this project we are developing: (1) a Web-based application to systematically monitor these factors over long periods of time and (2) a web portal to visualize the data and offer online community features for developing strategies for practical action.

Actively involving citizens to gather spatiotemporal data through an app has various potentials. First, it promises to make data collection and presentation accessible and available to communities for whom it was once labor-intensive. This situation, we consider, will help define the local character and provide professionals with access to richer data sets for neighborhood modeling. Second, by asking the residents to 'measure' their neighborhood on a regular basis, we aim to increase their awareness about the factors that affect their health and have them feel more connected to the neighborhood. Lastly, the maps produced by the app

and displayed at the web portal can assemble the evidence base for neighborhood plans. As residents discuss the problems they experience in their neighborhoods and view data depicting these concerns, they may become motivated to seek solutions [2]. Therefore, it will serve as an illustrative example of how HCI can engage with grassroots participation in local government and policy making.

Problem Statement
One of the main challenges we have in the project is to maintain *interest* and *motivation* of a critical mass of volunteers to report data in a continuous manner. There are existing apps in the Dutch app market, which aid citizens in reporting the immediate problems in their physical environment, such as trash in the streets, broken street furniture, and so on.[1]. Local authorities react on these reports by collecting the trash or sending a maintenance team. But imagine groups of people fetching their cell phones to map things like scenic views, social hubs, and exercise spots, which requires a different kind of motivation than the promise of short term problem solution. Leveraging this citizen engagement effectively, therefore, requires not only tools for data collection but also means that enable community members to engage in collaborative and sustained neighborhood measuring.

The aim of this paper is to present a case study of how we tackled this issue. We designed a prototype app by means of examining the incentive strategies used in the relevant domains of citizen science and participatory sensing, and discussed the app with two different

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1 For example, http://www.verbeterdebuurt.nl/, http://www.buitenbeter.nl/

groups of target users. Below our process and what we learned from this process will be described in detail.

Motivational Strategies
Collecting data across an array of locations over spans of years is key in environmental sciences. One way to gather such data is through citizen science, i.e., a research approach that appoints non-scientists in scientific investigation [3]. A quick search in Wikipedia shows a list of more than 130 ongoing citizen science projects from bird watching to asteroid categorizing, which involve thousands of people making a contribution. In urban environments, citizen science has evolved into another research area: participatory sensing, namely the research that exploits the capabilities of mobile phones to collect data about everyday life, including activities and behavior (e.g., exercising, eating) and environmental parameters (e.g., air quality, noise pollution) [14].

The success of citizen science and participatory sensing projects relies on a lasting commitment of volunteers to data collection. Therefore, providing incentives is crucial for preventing people to lose their interest and quit their participation. The most obvious incentive is an intrinsic one—people want to *contribute to a worthy cause*. These people typically love the outdoors, are concerned about environment, and take pride in protecting the nature [6]. Holohan and Garg [10] conducted a large-scale survey in the distributed computing online community to identify the reasons why people participate. The top reason was "contributing to scientific research" as another case of worthy cause like protecting the nature, which was followed by "contributing to friendly competition". Ranking high in a leaderboard and earning respect from
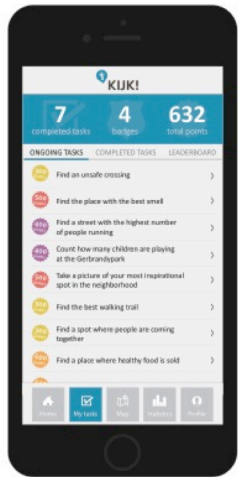
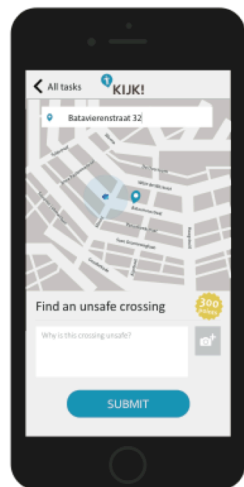**Figure 2**: Scavenger hunt concept with the tasks. ©Nazli Cila

Figure 3: Data entry. ©Nazli Cila

their peers also motivated the participants. This drive for *acquiring social reputation* was aptly utilized in the Ikarus project, in which paraglider pilots helped collecting sensor data about thermal effects in the atmosphere while the sensors also recorded the pilots' altitude and route [11]. This data was then used for ranking the pilots according to the shape of their route.

Related to the idea of friendly competition, there are some citizen science projects that gracefully manage to motivate participation through *gamification*, i.e., the use of game elements to improve user experience in non-game applications typically by giving reward points, achievement badges, and reputation system [8]. For instance, Foldit [7] is a multiplayer online game where players compete to create accurate protein structure models and Peekaboom [1] is a two-player game in which people help construct a database for training computer vision algorithms.

In addition to these general strategies, there are a couple of studies that give guidelines about how to design citizen science projects, e.g., by giving opportunities to people to discuss the data, giving rapid feedback, creating minimally invasive tutorials, and granting privileged roles to top contributors [15], or participatory sensing projects, e.g., by showing personally relevant data, presenting data gradually, and using a simple language [16]. Getting inspiration from these incentive strategies, we created a product concept to be presented in the following section.

System Overview

The system, entitled as "Kijk!" (Look! in Dutch), consists of two major components: a web app to collect data and a web portal for data visualization and discussion.

The app design
As mentioned in the introduction, the factors to be monitored through the app were investigated by our project partners. Following the social reputation and gamification strategies identified earlier for citizen engagement, we came up with a *scavenger hunt concept* for tracking these factors. This means that the participants are required to "find the places" in the neighborhood that display the related factors. Therefore, if the factor is about monitoring "unsafe crossings", we ask participants to find an unsafe crossing in the neighborhood and submit data (Figure 2). We created a pool of 46 such tasks, and every week 10 random tasks are given to the participants to accomplish. The location of the measurement is attached by using the GPS location of the smartphone, dragging a marker on a map, or typing the exact address (Figure 3).

Users are required to create a user account with a pseudonymous user name. Each task is assigned a point from 100 to 500 depending on its difficulty, and the aim of the participants is to gather points. These points are used for ranking them on a leaderboard showing the top contributors all time, last month, and last week. Real-time recognition will be given as users earn points, enter the leaderboard, or rank up/down in the leaderboard. There is also a score summary providing users with performance feedback to facilitate progress assessment (the blue bar in Figure 2).

The app also displays the data collected from all users and these data points can be tapped to gain more
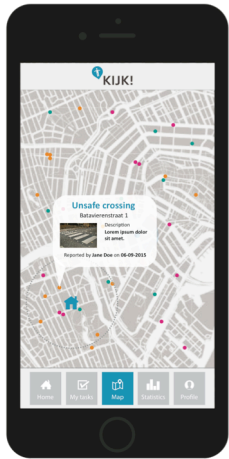
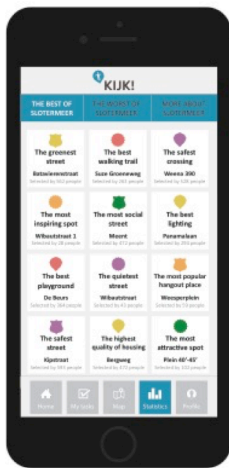**Figure 4**: Map overview with collected data points. ©Nazli Cila

Figure 5: Neighborhood badges. ©Nazli Cila

information (Figure 4). On the basis of the reports, we also give the neighborhood prestige badges: If a substantial number of people reports that a particular street is green, this street will be announced as the greenest street of Slotermeer (Figure 5).

In addition to these core functionalities, we also included some secondary functionalities that have the potential to reinforce the engagement of the participants. These are: a timed-response for accomplishing the tasks (e.g., the player is required to find the best walking trail in two days), a redeeming system for the points, badges related to the player's number or most reported type of data (e.g., if many of the data points are reported about sports and exercise, a badge called "sportive" is given), option to share own accomplishments on Facebook and Twitter, option to react on other's data points by sharing them on Facebook or Twitter, and lastly option to enter home address to get notifications every time a data point is reported from vicinities of one's home (e.g., your street has been voted as the quietest street of Slotermeer).

The application is being developed as a hybrid web application built with the Ionic platform. Ionic uses both AngularJS and Cordova to enable the development of cross-platform applications with basic native functionality, such as GPS and access to a phone's camera, without using native coding. This allows for quick development on multiple platforms.

Web portal
The data points plus GPS data are stored in a NoSQL database. In the near future we expect to launch a public website which will visualize the collected data. The data will be published as open data so it will be possible to download and analyze it, or combine it with other data sets. The web portal will also provide online community features to support discussion and bring together local authorities and citizens.

Study
To investigate which of the incentive strategies we used are perceived as meaningful and effective, we conducted two focus groups with the prototype. The core functionalities listed above were all working at the smartphones we handed out to the participants; the secondary functionalities were shown as static pages.

The first focus group was conducted with five Slotermeer residents (4 females aged between 42-53, and a male aged 19). Our local project partner Stichting Eigenwijks recruited the participants from the people who were actively involved in the community. Two of the participants volunteered at the school to help with children, one gave free computer lessons at the local library, one gave free Dutch lessons, and one of them volunteered as a health ambassador. The second focus group was conducted with five ICT students from Amsterdam University of Applied Sciences (all male, aged between 18-27). The students applied to a call by us for testing our app. The reason for choosing these two target groups was due to their different type of experience (e.g., volunteering, neighborhood involvement, technical literacy) and demographics (e.g., age group, education, residence).

The focus groups were semi-structured and lasted approximately 1.5 hours. We divided our discussions to three parts: understanding their general attitude about volunteering and neighborhood improvement, soliciting feedback on prototype, and comparison with

competitors. We recorded and transcribed all the discussions, and performed an affinity clustering on the textual corpus to identify emergent themes.

Insights and Lessons learned

We organized the insights we gained from the focus groups around four themes corresponding to Target Group, Usability, Motivational Strategies, and Concerns. We elicited design directions from these insights to inform the development of our system, which will be presented as bullet points after each theme.

Target group

One of the main discussion points was related to identifying who our audience was. Since Slotermeer is a culturally mixed area with a low socio-economic ranking, the participants had some concerns about the app's accessibility. One of the participants, who is from a Moroccan heritage, commented that older Moroccan people would not be able to use the app because of *language barriers*. The same was also mentioned for the Turkish community. Second, the issue of *technical literacy* was raised a couple of times; and everyone agreed that the app appeals to the tech-savvy people. They suggested limiting the target group of the app with children or younger adults (age between 18-40), and try to access older members of the community through more standard research methods like interviews. Lastly, the participants had questions about the *smartphone ownership and cellular data plans*. Among the first focus group participants, one did not own a smartphone and expressed her wish to be able to submit data through the website as well. From a total of 10 participants, 6 participants did not have a cellular data plan. Although they acknowledged that

there were free Wi-Fi spots in their neighborhood, they considered this as a problem.

- Using the language of the cultural communities in the neighborhood is crucial for this app.
- When developing participatory sensing projects, there is no catch-all solution.
- Other means than smartphones should also be included for data collection for our target group.
- It is crucial to offer different data transfer policies to people with limited or no cellular data plans.

Usability

All of the participants were able to understand the app and give data input without much confusion. Only one participant had trouble with reading the map and locating herself, but she overcame it with some help from another participant. A participant suggested using icons for different data types, e.g., representing trash with a trash can icon, to be able to differentiate them on the map with a quick glance.

- Map literacy is an issue when dealing with geo-tagged data collection.
- Additional ways to visualize the data needs to be considered.

Motivational Strategies

GAMIFICATION

The participants found the scavenger hunt concept positive in general. As a matter of fact, it triggered a *competitive impulse* more than we expected. Participants seemed to be eager to compare their achievements against those of other participants and

therefore considered the leaderboard as a good indicator of their performance.

Still, they suggested us to highlight badges more than the leaderboard as an incentive mechanism. They identified two different roles for badges. Personal badges to be given according to the number or type of data submitted would motivate them to participate when they are new at the app community. When they see a list of all the badges they could win, they would be motivated to collect them all and therefore submit data. But the thing more meaningful for them was the badges to be given to the neighborhood because gaining those requires *cooperation between the residents.* As one participant stated, "It doesn't matter if you have all the badges. It is more important if you have the cleanest street"; and another said, "I think it is better for the neighborhood to receive badges because there you're working as a team, not on your own to provide the best place". They considered that this situation would lead to a competition between the neighborhood areas or different neighborhoods, which would eventually provide a physical improvement in all. Since badges are like status symbols in this case, one can lose them. This adds to the motivation to react on the data and improve the neighborhood.

- People would be motivated to compete on their own with others, but competing as a team with another team would motivate them even further.

SOCIAL REPUTATION
Either performing alone or in a group, it was very important for the participants to *gain reputation*. They would want other people to see their badges when they check their profile in the app. All the participants

recognized the strength of leveraging social media outlets such as Facebook to show their contribution, yet there were mixed opinions about whether they would share there. At the end the common consensus was to share the big achievements only. They suggested having an option to decide whether or not to share after each achievement.

It was also another idea of the participants to grant special roles or privileges to people. For instance, special types of badges or rewards could be given to people who actually solve the problems that were reported or high-reputation users of the app could be assigned the role of a moderator to help filter data and check reliability.

- Gaining reputation is very important, but the control of the means to share the achievements should be given to people.
- Granting roles with experience will motivate contributors to effectively assume moderator role.

RECIPROCITY
The participants of the second focus group responded well to the gamification as a motivation, but the major incentive for the participants of the first focus group was *reciprocity*. This may be due to the difference between age and technical literacy between the two groups. All the participants in the first group stated they would participate to this app if they could benefit from the data. For instance, one participant said the motivation for her is to see good and bad things in her neighborhood. She would like to learn where she could do activities with her children, which are the safest playgrounds, and so on. To do so, she would like to be able to search things on the app. Another participant

also mentioned it is important for her to see the ratings of other people, so that she would be getting reliable information about the facilities at the neighborhood. In this case, the importance of the web portal intensifies.

Furthermore, a participant mentioned that he would like to get *personally relevant data* from the app, such as seeing what is happening at his street. Yet all the participants stated that if this information were given to them through notifications, they would like to turn this option off. In other words, they would like to explore the data themselves instead of the app prompting them to do so.

- The app should not be a tool for data collection only, but it should also provide useful information back to users.
- Giving personally relevant data is appreciated but without obtrusive notifications.

OWNERSHIP

What we realized in the focus groups is that the participants were willing to use the app only for the places they felt they belonged to. *Ownership* of the neighborhood seems to be a necessary condition to feel a sense of responsibility. Being active members of the community, the participants of the first focus group stated they would use this app for their own neighborhood, whereas none of the participants of the second group stated they would use it for their current neighborhoods (but two participants mentioned they would use it for their home town). The reasons were about those neighborhoods being safe and respectable and there was no need for any improvements. It was clear from these comments that the participants considered the app as a neighborhood improvement

tool than a monitoring tool, which is an issue we need to consider in the further versions of the app.

- Ownership of the place is a barrier for us. We should find means to involve the people who do not feel invested to the neighborhood they live in.

REDEEMING POINTS

When we asked about the things we could give the users as a reward for the collected points, it was surprising that none of the participants considered money as a good incentive. They preferred having us giving vouchers from local and healthy businesses. The examples were free juices, vegetables/fruits, discount at the sport school or gym, swimming pool card, and so on. Money as an incentive was considered to promote false data, i.e., people may make up incorrect data just to get money, which will be explained in the next section.

- People will be motivated to win health-related promotions.

Concerns

The two major problems of participatory sensing were also considered an issue in our system—*reliability* and *privacy* [12, 13]. Depending on the participation incentives, we can expect some erroneous or malicious data to beat the high score of the game or deliberately pollute data for own benefit. Therefore it was imperative for the participants that the system provides a method to verify the trustworthiness of the data. The participants of the second focus group came up with three possible solutions: using a moderator who is granted this role provided by his/her high reputation at the game, ranking up (or down) each other's data

points if you think they are correct or not, and tracking people with GPS to make sure that they are actually reporting from the related places.

The last solution was surprising for us because it did not cause any concerns of privacy for the participants. It may be the case that the participants share location and activity within a group in which they have an existing trust relationship based on a common shared interest, they do not mind sharing sensitive information. They only asked the app to get their permission before recording their location. With regard to revealing their identity, they stated that they would not like using their real names because it may cause some troubles when reporting data about unsafe things and places. But this does not mean they wanted to report anonymously. They would like to choose a username so that they can show up at the leaderboard. Furthermore, they considered that anonymity might bring less reliable data. They suggested offering "make an anonymous contribution" as an option, if the participants feel uncomfortable to report certain type of data.

- It is crucial for us to design some ways to assure data reliability.
- People may not mind sharing their location and activities as long as they have a trust relationship with the group members and control over the data they share.
- An option for anonymous data submission is necessary.

Conclusion

In this paper, we have presented design considerations to motivate people in monitoring community health through an app. We discussed our app with users in two focus groups and learned some lessons. Although the app was used in artificial environments for limited amounts of time, we consider that we obtained good insights to develop the app further. Future work will be testing the app in the field with in a longer time periods, and measure its impact on participant motivation, health awareness, and neighborhood ownership, and investigate how it can be involved directly in grassroots policy making.

Acknowledgements

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