Facilitating Citizen Engagement in Situ: Assessing the Impact of Pro-Active Geofenced Notifications

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ABSTRACT

A key problem in the area of citizen engagement is to make people aware of opportunities to participate and to motivate them to take action. We propose an approach that uses geofences and proactive notifications on mobile devices to raise citizen awareness of engagement opportunities in situ and to trigger the exploration of these opportunities. Notifications are automatically triggered in the near vicinity of engagement opportunities based on space, time, and user preferences. We conducted two user studies to investigate our approach. A field-based study revealed specific usage patterns and motivational aspects of the situated discovery of engagement opportunities. A lab-based comparison study investigated the pragmatic and hedonistic qualities of our application. Results indicate that users prefer to be informed in situ even when they do not necessarily interact with notifications straight away.

ACM Classification Keywords

H.5.2. Information Interfaces and Presentation (e.g. HCI): User Interfaces - Interaction Styles

Author Keywords

Geofencing; Location-based Service; Citizen Engagement; Notification

INTRODUCTION

Facilitating citizen engagement with modern Information and Communications Technologies (ICTs) plays an important role in Open Government initiatives [20, 19] or in Smart City contexts [16, 8], for example. Before citizens can engage in such contexts, they need to be informed about possible engagement opportunities. The information about engagement opportunities usually includes details about the actual topic, why citizens should engage, as well as when and where to contribute. In the commonly encountered communication forms such as newspapers, flyers, posts on social media networks or dedicated

websites, location and time are part of the communication but do not affect to whom the information is provided.

In this paper, we apply the notion of a geofenced Location-based Service (LBS) for informing citizens about potential engagement opportunities. Our approach is motivated by the fact that spatial vicinity helps citizens to connect and identify with the processes that affect their personal lives [24, 27, 7, 30]. The design of the application is informed by existing LBSs that are used for similar purposes in e-commerce [25], tourism [26] or enhancing community awareness for local heritage through situated storytelling [13].

We developed and evaluated a notification app for smartphones that provides information about nearby engagement opportunities. The main function of the app is an automatic notification service that triggers notices on the user's smartphone if an engagement opportunity is in the immediate vicinity. By applying virtual spatial barriers (geofences) around citizen engagement opportunities, we can trigger notifications once users enter or leave the area. Users are directly informed in their current spatial context, e.g., the place of a meeting or an affected area. Also, users can customize the notification service by selecting only certain engagement categories (e.g. children and youth, sustainability, culture) and by specifying a spatial extent to only receive notifications in certain parts of their city.

Our contribution in this paper is threefold. The results are based on a field-based study with 30 participants and a lab-based comparison study with 20 participants: (i) We provide insights into the general applicability and motivational aspects of such a pro-active geofenced notification application for citizens. After using our application, 86% of participants described the notifications as interesting, motivating and practical. (ii) We report on usage patterns of the application that we identified and we report on most valued features. We found that 20% of users consistently interacted with triggered notifications near the engagement opportunities, 53% consistently outside of the immediate vicinity, while 27% of users did not display a clear behavior. (iii) We provide insights on the pragmatic and hedonic qualities of the developed application that we obtained from the lab-based study comparing our application to an official website that informs citizens about engagement opportunities. Participants rated our developed application to be more desirable and attractive than the com-

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MobileHCI '16, September 06-09, 2016, Florence, Italy

ACM 978-1-4503-4408-1/16/09.

DOI: <http://dx.doi.org/10.1145/2935334.2935379>

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pared website, although website and application received high scores for pragmatic quality revealing that both channels are suitable to inform citizens.

Our findings can inform designers of mobile “citizen apps”. They provide evidence that citizens value in situ notification systems that create a spatial relation to the citizen engagement opportunity, although citizens do not necessarily interact straight away “in place” with the notification.

In the following, we discuss related work. We then detail our approach to notifying citizens via a geofenced LBS and continue to provide a short overview of the application as well as its implementation. Next, we present the two user studies we performed to evaluate our application. The outcomes, limitations, and future work are discussed subsequently. Finally, we conclude with a summary.

RELATED WORK

Our research draws mainly from the areas of mobile computing with a focus on LBSs and eParticipation. Conceptually, we categorize our application as public communication in the wider field of citizen participation, based on Rowe and Frewers [23] topology. A categorization based on Arnsteins [2] well-known ladder of citizen participation is similar: As notification service, citizens are just informed as the application does not allow a direct exchange with the information provider. However, she notes that “informing citizen of their rights, responsibilities, and options can be the most important step toward legitimate citizen participation”.

The idea to use location-based or context-aware services to inform citizens is not new: In 2002, Munson and Gupta [21] proposed LBSs as general notification services and applications like UbiPOL [17] or BlueTo [4] aimed to increase citizen motivation in public policy making by providing individualized information. Location- or context-aware computing often includes LBSs as information about the user’s location is highly relevant for the evolving processes [18]. Recent developments in the field of LBSs have focused on the “proactive” provision of information by monitoring spatial objects and temporal relations between the user and the surroundings [12]. This proactive provision is enabled by a technique known as geofencing. Geofences are virtual barriers that usually generate events if a tracked object crosses the virtual barrier. These virtual barriers can have different shapes, ranging from simple circular ones that represent a particular point or area to complex shapes that represent artificial or natural phenomena like roads, buildings or rivers.

The evolution of reactive systems (that required user actions) to proactive systems that react to changes is seen as an important step for the use of LBSs in the field of eParticipation. Particularly the shift of focus towards application-oriented approaches rather than content-centric applications may help in their adoption [29]. LBS are seen as a suitable tool in the context of mobile participation for socializing and changing the organization of public life [1]. Although their use is not widespread, people usually accept and demand technologies in the context of eParticipation, that are relevant to their everyday life and which are easy to use [6].

Our approach to inform citizens about engagement opportunities with a geofenced LBS that acts as notification service is informed by past research in e-commerce [25] but also by recent HCI research: Mobile applications for tourism [26] or applications for situated voting [30, 28] motivate our approach. Han et al. [13] developed a mobile application called Lost Stage College to raise community awareness for local landmarks, leveraging the potential of user generated content and situated digital storytelling. Their study revealed a relationship between local residents and the spatial features of their community, similar to the way Taylor et al. [27] described how “data, people and things intermingle to continuously enact place”. Another example that uses digital content and associations to place to raise civic engagement was presented by Crivellaro et al. [7]. They used digitally supported urban walks and counterfactual maps to prompt discovery of issues and to reveal (dis-)associations to places and practices in the city. Our developed application works in a similar fashion as notifications are triggered if somebody is in the near vicinity of an engagement opportunity.

Situated voting applications such as PosterVote [30] and Viewpoint [28] further demonstrate the role of place in local civic activism. PosterVote combines conventional posters, and low-tech and cost hardware to allow the collection of opinions. The result is a physical artifact, a digitally enabled poster, that offers passing by citizens the option to vote. Posters are attached to highly visible and public positions like lampposts in the area in question, e.g., the road that is to be restructured. Viewpoint [28] allows similar interactions, although it displays the current status of the poll immediately. Additionally, it offers the option to vote via SMS to avoid being seen using the physical interface and the system is suited for longer deployment times in comparison to posters. PosterVote and Viewpoint were both found to be effective tools for local activist groups. Such situated opinion polling approaches could be easily combined with our developed notification application. Citizens can be made aware of such voting opportunities via the notifications if they do not see such systems while they commute or recognize that they can interact with them.

GEOFENCING ENGAGEMENT OPPORTUNITIES

Our approach and application are described in the following paragraphs. We introduce our approach to informing citizens about engagement opportunities based on spatial and temporal conditions that take their preferences into account. First, we provide a generalized description of interaction and continue to illustrate it with an example. Second, we provide a detailed overview of the developed notification application and some details on the implementation.

Approach: Triggering Notifications Implicitly

As spatially enabled notification service, our application uses the following interaction idea: *The act of moving through the city is used as an implicit interaction with the notification application leading to an explicit interaction with the application.* An action of the application, a notification, is triggered *implicitly* if certain spatial, temporal and individual user conditions are met. After perceiving the notification, users *explicitly* interact by investigating the notification obtaining

(a) Two notifications (one expanded, one collapsed) and the status indicator that the notification application is active are shown.

(b) Card view: image, textual description and contact information are shown. Users can like the engagement opportunity, dismiss it, go to its website or show the location on a map.

(c) Content customization: Users can subscribe to only receive notification about certain topics

(d) Spatial customization: Users can specify to only receive notifications for a certain area of their city.

Figure 1: Overview about triggered notifications, obtainable information from the app, and customization options.

additional information or by dismissing or ignoring the notification, choosing to disregard it. We base our use-case on the premise that citizens might be additionally motivated and engaged if they find spatial connections and relations between their daily lives and engagement opportunities. The entire approach and resulting interactions are best described with an actual engagement opportunity example from our field study.

An urban planning project in the city of Münster aims to restructure a large vacant space in the city—the “Oxford Barracks” that are not used anymore. The organizers desire a high involvement of the population in the planning process as multiple repurposing options are available, e.g., living quarters and/or a recreational space are to be discussed. A series of participation workshops is planned, and the organizers reach out to the population. They provide information via newspaper, a broadcast by the radio station and flyers. Additionally, the same information is entered into the managing component of the notification application. The only difference is that the places and times of the participatory workshops are entered spatially via a map interface as simple points while the vacant area is represented by its actual bounds. Spatial representations are extended (buffered) automatically to cover the immediate vicinity to cover sidewalks or the other side of the road. Temporal information, such as the estimated duration of the entire project and workshop dates, are used by the notification service to only trigger notifications about engagement opportunities that have not already taken place.

Citizens that installed the notification app on their smartphone will receive an automatic notification if they are near one of the workshops locations or the Oxford Barracks. This is an *implicit interaction* with the notification application, no user input is required. Citizens are informed as they move through

the city during their regular activities like commuting to work, casual walks or sportive activities. Space, time, and individual user preferences that were specified beforehand affect if a notification is triggered. Spatial and temporal information about the engagement opportunities are set in the managing component of the notification service. They are provided by the organizers of the engagement opportunity alongside additional information as textual descriptions, the category of the engagement case, and an image illustrating the case. Refer to sub-figure 1b for the representation of the information for the given example—the Oxford Barracks. Users of the notification app can customize the notification application to only trigger notifications that are likely to be more relevant for them: They can apply a spatial filter to limit notifications to a certain part of the city and subscribe to certain engagement categories, e.g., children and youth, infrastructure or culture. Notifications are then only triggered for the subscribed categories and spatial extent, see sub-figure 1c and 1d for these spatial and content customization options.

Notification Application and Implementation

Our developed application follows four of the seven principles of persuasive technology that were recommended by B.J. Fogg [11]. It *reduces* the complex act of finding engagement opportunities based the simple premise that they “pop up” as one moves through the city caring about the daily business. A citizen can *tailor* the received notifications by using spatial and content customization options. Citizens are also guided or *tunneled* through a series of simple steps if they want to obtain more information about an engagement opportunity. They can click on a notification, read a short description and are guided to the website of an engagement opportunity if they want to know more. The application provides *suggestions* to citizens

which they can read at an opportune time of their choosing, either right now at the moment that it is provided in situ or later on if they have finished their current activity that takes precedence, e.g., rushing to work. We leave the principles of self-monitoring, surveillance, and conditioning for future work as our application aims only to inform citizens instead of nudging them towards a particular behavior.

Figure 1 depicts the concrete realization of the core functions that we described earlier. Sub-figure 1a shows two triggered notifications in the notification center of an Android smartphone. The top entry is expanded (this can be achieved by swiping down) while the second entry is collapsed. The entry below both notifications indicates that the notification application’s movement tracking function is active. Sub-figure 1b displays an engagement opportunity “card” that is opened if the user clicks on a notification: it offers textual descriptions about the engagement opportunity, a small picture, and contact information. Furthermore, users can open up the website of the engagement opportunity or display the geofenced area/location of the engagement opportunity on a map alongside their position via two buttons. We included the option to like/star engagement opportunities as a simple expression of interest from citizens and reminder as another function of the app allows citizens to display all liked engagement opportunities. Citizens also have the option to suppress notifications about this particular engagement opportunity in the future.

Aside from these core functions, the notification application offers a set of other explicit interaction options. As notifications are only generated by entering a geofenced area, some citizens may never receive them if they do not move through the city or only through parts that do not offer any engagement options. Citizens might also be interested in getting a quick overview of all available engagement opportunities. Therefore, we included two exploration views, see Figure 2. Citizens can show all cases via simple spatial and textual overviews in the application. A map displays all engagement opportunities with their corresponding geofenced areas, and we list all engagement opportunity “cards” linearly in a scrollable textual overview. The spatial and textual overviews are linked, meaning users can switch between them and explore the engagement opportunities using both ways. Additionally, category, textual, and temporal filters and can be applied in both views to reduce and specify the shown engagement opportunities. The last filter that can be applied shows only previously “liked” engagement opportunities, essentially allowing user to manage favorites.

We include an step-by-step interactive tutorial in the application that helps citizens to set up the notification application. Users are guided through all of the available functions via interactive overlays that highlight functions and explain their use. Starting the application for the first time initiates the tutorial. Individual steps can be skipped, returned to or the entire tutorial can be canceled at any time. The tutorial remains accessible via the app’s main menu, which also provides access to the necessary disclaimers for our research and basic settings for the application.

Our application informs users at start-up that it tracks their movements and how their location data is anonymized and

(a) Linear, textual overview of the engagement opportunity cards with expanded filter options.

(b) Spatial overview displaying geofences of all engagement opportunities on an interactive map.

Figure 2: Overview about the spatial and textual exploration overviews that citizen can use independently from the notification function.

processed. The movement tracking function needs to be explicitly started in the main menu with a large button. Stopping movement tracking is possible at any point with the same button. An indicator that the movement tracking function is active is displayed in the notification center at all times (refer to sub-figure 1a). If users disable the movement tracking function, textual and spatial exploration overviews remained functional, albeit no notifications can be provided. The settings menu offers the option to play a special audio cue if a notification was triggered to be independent of the general notification settings that apply per default as recommended by Chang and Tang [5]. Further settings allow an automatic start of the application including the movement tracking after a reboot of the smartphone.

The entire client of the notification application is based on Cordova and Ionic¹ as they allow cross-platform development. Although we realized the notification application only for Android 4.4 devices we wanted to retain the ability to include additional platforms in the future. Cordova was used to access hardware-related functions to locate the smartphone’s position. All user interface elements were realized with Ionic as it provides several interface elements that follow the Android Design Guidelines. Additionally, we are comfortable with the used technology stack that is based on HTML5, AngularJS, and SASS. The server side component containing the necessary logic for triggering notifications is based on ESRI’s ArcGIS Server² and the Geo-Event Extension. Custom implemented server side processes regulate the geofencing mecha-

¹See <https://cordova.apache.org/> and <http://www.ionicframework.com/>, accessed February 6, 2016.

²See <https://www.esri.com/software/arcgis/arcgisserver>, accessed February 6, 2016.

nisms for the spatial and temporal dimension, including user preferences. For example, we ensure that notifications are only triggered once a citizen enters a geofence, rapid leaving or re-entering do not repeat the notification. We account for such effects as they can occur due to the shape of geofences (they do not have to be convex polygons) or as the tracked movements accuracy can vary widely resulting in “jumps”. All processing intensive operations are performed on the server side to save battery life on citizen’s smartphones. ESRI’s ArcGIS Server offers several of the necessary processing options out of the box and was therefore chosen. We implemented the notification application in an agile approach resulting in the rapid deployment of prototypes. We tested the different iterations of the notification application with a small group of users that provided feedback.

EVALUATION

We performed two user studies to test our approach and the developed notification application. Overall, our goal was to test how participants used spatially triggered notifications and if they value a smartphone application with such functions. The first study is field-based focusing on usage patterns and motivational aspects of the in situ discovery of engagement opportunities. Our second study compares the application with an official website of the city in a lab-based setting. We were interested in the pragmatic and hedonistic qualities of our application and whether participants would find it more attractive compared to the more common form of representing citizen engagement opportunities via a website.

Field Study

To assess the usefulness of our application for citizens in their daily lives we conducted a field-based study “in the wild”. It took place in Münster, Germany during a ten day period in October 2015. Before we conducted our field-based study, we tested the application and all individual elements of the apparatus in a pre-study with seven participants. Pre-study participants were not included in the final field study, and we omit the results as it was only conducted to ensure all technical components were working. We made no technical changes to the application, but we updated the available engagement opportunities by adding additional ones.

Participants

We recruited 37 participants (14 female and 23 male) by word of mouth, e-mail lists, a blog-post, and university campus from diverse backgrounds. Participants’ age ranged from 18 to 51 years, with an average age of 25.6 years. All participants owned an Android smartphone. We allowed participants to invite other participants themselves to gain a wider reach. All necessary consent forms and disclaimers were available digitally in the smartphone application and had to be filled out before the application could be used.

Procedure & Apparatus

Our notification application was distributed through Google’s PlayStore and available for Android devices that use version 4.4 or above. The application featured 55 actual engagement opportunities that were distributed evenly throughout Münster with a focus on the city center. We obtained the engagement

opportunities from the city’s official website, called “Gutes Morgen Münster”³, categorized the engagement opportunities into 16 categories, and included all opportunities that would happen in the future. During the recruitment phase of the user study participants were asked to fill out the first of two questionnaires to establish baseline parameters like age and gender. Also, we asked participants if they had experience with citizen engagement opportunities. The first questionnaire featured additional preformulated statements that participants could agree or disagree with using a five point Likert Scale ranging from strongly disagree (1) to strongly agree (5). These statements asked participants about their preferred channels to inform themselves about engagement opportunities (e.g. newspapers, flyers, e-mails, citizen apps), general aspects of the information provision (e.g. actuality), and which features they value in the digital provision such as chatting with other users or playfulness.

We logged participants’ interactions with the notification application during the ten-day deployment with a custom event-driven framework. Every user interaction such as accessing a notification or accessing a certain view generated an event with a unique identifier that described the interaction and included a participant’s location. Events were sent to a remote server for later processing. The custom logging allowed us to describe the app use in general, to identify the most used features and where interactions took place in the city.

After the ten-day evaluation period, users were prompted to fill out the second questionnaire via e-mail. The second questionnaire consisted of the System Usability Scale (SUS) [3], five additional pre-defined statements, and a free text field for general responses. We asked users to rate whether they felt engaged while using the application, which features they found most useful, and if they had concerns regarding their privacy. We only considered 30 of the 37 participants for the analysis of the results, as seven participants did not fill out the second questionnaire or did not use the application at all by generating a notification.

Results

Based on the results from the questionnaires and logged data, we conclude that individualization options and suggestions were useful for our participants. Participants were valuing spatial notifications and the resulting suggestions, but the interaction with the triggered notifications do not necessarily occur in situ. The following paragraphs described how we came to these conclusions.

Our participants’ responses to the first questionnaire indicate that they primarily would use a “citizen app”, social media networks such as Facebook, local media like radio shows or newspapers for information provision about citizen engagement opportunities. 72% agreed or strongly agreed to use a mobile application (mean=4.0, SD=1.3) while 66% also agreed or strongly agreed to use social media networks such as Facebook (mean=3.7, SD=1.3). However, there is also a strong desire for information about engagement options in

³See <http://www.gutes-morgen.ms/>, accessed February 10, 2016.

Table 1: Logged interactions with the notification application during field-based study. The results are clustered according to notification, notification trigger customization and general data.

Notifications	
<i>Average per user</i>	11.5 (SD=8.3, max=29, min=2)
<i>Triggered</i>	345 notifications were triggered for 43 out of 55 engagement opportunities
<i>Interactions</i>	230 notifications (67%) were accessed, 115 dismissed (33%)
<i>Referrals to websites</i>	166 referrals (61%) to show engagement opportunities websites occurred due to a notification (273 total)
<i>Show location on map</i>	220 clicks (73%) to show an engagement opportunity location on the map occurred due to a notification (311 total)
<i>Deactivations</i>	78 times, 11% of the participants deactivated notifications for specific opportunities after they were received
Trigger customization	
<i>Topic customization</i>	27 participants (90%) subscribed to topics of interest, only receiving notifications for these (total of 45 times)
<i>Spatial extent customization</i>	22 participants (73%) applied a spatial filter, only receiving notifications for this part of the city (total of 26 times)
General	
<i>Likes/Stars</i>	161 likes on engagement opportunities were logged; 93% of participants used this function
<i>Filter functions</i>	21 participants (70%) used the filter functions in the exploration and spatial overview in a total of 89 times
<i>Navigation Distribution</i>	HomeView with textual descriptions: 325 times (47%); MapView with spatial overview: 221 times (35%); Settings: 98 times (15%); Help: 34 times (3%)

traditional channels. Local media such as newspapers or radio shows were most valued by our participants. All of them agreed or strongly agreed to use them and no one disagreed (mean=4.4, SD=0.8). With an average of less than 2.3, participants disagreed on using flyers (SD=1.4) or e-mail newsletters (mean=2.2, SD=1.1). Cities' websites were similarly disfavored with a mean of 1.9 and SD of 1.1. Most important for all participants was "up-to-date" information provision (mean=4.8, SD=0.4). Ten of our participants (33%) had previous experiences with public polls, discussions, online-based surveys or demonstrations.

If information about engagement opportunities is provided digitally, participants rated the option to inform themselves based on individual interests as most important. 47% of all persons strongly agreed and 40% agreed to use individualization options (mean=4.3, SD=0.7). This factor seems to be particularly important for smartphones as all participants strongly agreed or agreed on individualization options for smartphones (mean=4.6, SD=0.5). Suggestions about potential engagement opportunities seem to be useful for digital channels as well. With a mean of 4.1 (SD=1.0), participants agreed to suggestions in general for digital media. Location-based suggestions for smartphones were also agreed on with a mean of 4.1 (SD=0.9). Other functions such as an integrated chat for communication with other citizens were deemed as rather unimportant (mean=2.6, SD=1.3), and concepts for playful entertainment like badges or banners even more unimportant (mean=1.9, SD=1.1).

The logged data, see table 1, of our field study underpin the participants' responses regarding individualization options and use-fullness of (spatial) suggestions. Almost every participant customized the notification triggers (27, 90%) by subscribing to certain topics and 22 (73%) set a spatial extend for notifications. A total amount of 345 notifications were triggered during the field study. 230 notification were accessed (67%) and 115 were dismissed (33%). This equals a two to one ratio, indicating that suggestions were not perceived as an unnecessary distraction. Another indicator for the usefulness of the suggestions is that out of the 230 accessed notifications 166 (72%) lead to a direct referral to the websites of an engagement

opportunity. Almost three out of four accessed notifications started a direct subsequent information retrieval outside of the application at the homepage of the provider.

However, participants did not necessarily interact with the triggered notifications in situ. In fact, of the 345 triggered notification 215 (62%) were dismissed or accessed outside the immediate vicinity of the engagement opportunity and 130 interactions (38%) took place in situ. Additionally, we find no change in accessed or dismissed notifications based on the location of their interaction. Interactions in situ and outside of the immediate vicinity have almost the same access to dismiss ratio: 89 (26%) of all triggered notifications were accessed and 41 (12%) were dismissed in situ, almost a two to one access to dismiss ratio. Outside the immediate vicinity, 141 notifications (41% of all notifications) were accessed, while 74 (21%) were dismissed. Again, almost a two to one access to dismiss ratio.

We analyzed individual participant's interactions to establish if there were specific user types or patterns. We found that only six participants (20%) interacted with 80% of their triggered notification in situ. 16 participants (53%) interacted with 80% of their notification outside of an engagement opportunity's geofence. The remaining eight interacted in situ and outside of engagement opportunities falling into neither category. Figure 3 provides a complete overview as a bar chart of the per participant spatial interaction distribution. The plot uses absolute values to show the total number of triggered notifications per user. The six participants that consistently interacted in situ (labeled "Group Inside") have almost the same average number of notifications (11.8, SD=6.08) as all 30 participants overall (mean=11.5, SD=8.3).

There are also no strong differences regarding accessed to dismissed notifications between the three user groups. The first group that acted primarily in situ accessed 81% and dismissed 19% of notifications while being in situ. Outside the immediate vicinity, they accessed and dismissed notifications evenly. The second group (primarily interacting outside of the geofence) accessed 72% and dismissed 28% of the notifications while they were in situ. Similarly, they accessed 73%

Figure 3: This bar chart depicts absolute values for accessed/dismissed notifications based on the location of interaction for each participant. Bars to the right show the amount of notifications interacted with inside the geofence (in situ). Bars to the left display the amount of notifications that were interacted with outside of the geofence. Participants are ordered according to the three identified groups: participants that primarily interacted with notifications inside of a geofence, both inside and outside of a geofence, and primarily outside of a geofence.

outside of the context and dismissed 27% of the notifications. The last and third group without a clear preference accessed 64% of notifications in situ and dismissed 36%. This group accessed 61% of the notification while they were further away, dismissing 39%. Therefore, we find no clear behavior regarding accessed or dismissed notifications concerning the spatial location. In general, the majority of our participants interacted outside of a citizen engagement's geofence with the triggered notifications and not in situ.

Still, the results of the second questionnaire that participants completed after the deployment shows that spatially triggered notifications were well received: 26 participants (86%) liked the feature (16 strong agreements, 10 agreements) and four participants disliked it (3 participants disliked it, one participant strongly). Participants that disliked the spatial notifications did so due to privacy concerns, as they want to avoid providing a third party with location sensitive information. Additionally, they could not see any benefit of spatial notifications (mean=1.3, SD=0.5) and they found notifications to be disturbing (mean=1.3, SD=0.5). The 26 participants that liked or strongly liked the spatial notifications described them as interesting (mean=4.2, SD=0.7), motivating for an

actual participation (mean=3.7, SD=1.1), supporting the information provision about engagement opportunities (mean=4.5, SD=0.8), and practical (mean=4.3, SD=0.7).

We categorized and coded the open responses from the free text field. 26 participants mentioned the overall design and layout with phrases such as “easy usage”, “understandable, modern and pretty” or “clear and well structured”. These free text statements are backed up by the overall SUS score of 85.5 (minimum=55, maximum=97.5, SD=10.4) that suggests a good usability. The spatial notification function was mentioned explicitly by 20 participants with positives phrases liking the “continuously and automatic character” based on the “individual interests and own needs”. Six users mentioned improvements to the user interface. They would have liked a less “plain or flat” interface and 15 participants would have liked to see technical improvements regarding performance and stability of our application.

Comparison Study

We recruited 20 participants for a comparison study in our lab directly after the field study ended. The study compared the official website of the city that informs citizens about engage-

ment opportunities with our notification application. We were interested in the perceived pragmatic and hedonistic qualities of our application compared to a regular website that offers similar functions. Both qualities are important as the medium that citizens use to inform themselves about engagement opportunities needs to be appealing and useful to facilitate a prolonged use. These aspects need to be considered carefully in citizen engagement scenarios as engagement often originates from intrinsic motivations linked to citizens' convictions, values, and needs.

Participants & Apparatus

For the comparison study, we recruited 20 participants (twelve male and eight female) from the pool of users who had participated in the previous field study. Ages of the recruited participants ranged between 22 and 32 (mean=26, SD=3). We recruited participants from the previous study to ensure that they had experienced the notification application for a prolonged time. While the use of a website can be assessed without moving, the notification application and its approach are very dependent on actually moving through the city during one's daily business—something that is hard to simulate in a lab-based setting.

The official website of the city, Gutes Morgen Münster, features the same engagement opportunities that we used for our field study plus a large number of additional initiatives. All engagement opportunities that are featured on the website were collected via a crowd-sourcing process during a contest to raise awareness about existing initiatives in the city. The website was created for the contest and offered functions and design follow modern standards. Citizens can obtain information about all projects via a simple spatial overview that locates all projects on an interactive map. Alternatively, all projects are displayed in a gridded mosaic-view that shows a picture, a short title, and a description. Both functions have counterparts in our application that features a spatial and textual overview as well (see figure 2).

We compared the website and our notification application using the "AttrakDiff2" questionnaire [15] that was specifically developed to compare the pragmatic and hedonic qualities of two systems or products. Hedonic aspects refer to the human need for stimulation and the human desire for a positive attitude towards artifacts they interact with. In contrast, the pragmatic quality measures usability and effectiveness. The questionnaire consists of 28 word pairs that each represent the opposite end of a continuum [14, 15]. Participants are asked to indicate on a seven point scale for each word pair, where the used system is located with respect to the two words. The 28 word pairs belong to four dimensions with seven word pairs each and the four dimensions describe the pragmatic quality (PQ), hedonistic stimulus (HQS), hedonistic identity (HQI), and attractiveness (ATT). By explicitly targeting the subjective view of participants, the questionnaire compares the satisfaction of participants between two systems or products [15]. As our participants were native German speakers we used the German version of the AttrakDiff⁴ to exclude errors due to language. However, we provide the results in English using

⁴See <http://www.attrakdiff.de>, accessed February 10, 2016.

Figure 4: Average values for both systems in the dimensions of pragmatic quality (PQ), hedonistic stimulus (HQS), hedonistic identity (HQI) and attractiveness (ATT).

the official translation of the AttrakDiff to make them more accessible to a wider audience.

Task & Procedure

Before we started, we first explained topic, procedure and task for five minutes for each participant. Participants received necessary consent forms and signed them before we started with the study. The instructions explained that the participants should explore and use the official website of the city to obtain information about engagement opportunities. Identical instructions were given for the notification application; additionally, we asked participants to recall the usage of the notification application that they used in the previous days. All participants stated that they could remember the usage well, as we conducted the comparison study immediately after the field study ended.

For each of the two tasks participants had up to 15 minutes and we informed them when that time was over. Participants could finish their exploration of each system and switch to the other condition if they felt they had used the website or application sufficiently. We randomized the order of exposure of the website and notification application. After completing both tasks, participants filled out the AttrakDiff questionnaire online. We provided a desktop computer with a keyboard, mouse and 23 inch screen for using the website and filling out the online questionnaire. Participants used their smartphone with the notification application as they did before in the field study. We provided no further instructions regarding the questionnaire as it aims to capture and investigate participants' first subjective responses.

Results

AttrakDiff provides three results for assessing the comparison. The first is a plot displaying average scores for the four dimensions (figure 4), the second plot depicts individual scores assigned to the 28 word pairs (figure 5) and the third is matrix comparing the general characteristics (figure 6).

The notification application received higher average values for all dimensions, see figure 4. The largest difference is found in the perceived hedonistic stimulus. The notification application was perceived to be more innovative, novel and captivating, although its was also perceived to be more demanding than

Figure 5: Detailed plot of the assigned scores for the individual wordpairs. Both applications received high scores, but overall the notification application was rated consistently higher or equal in some cases, except for the word pairs describing predictability, and undemanding or challenging use.

the website. This is probably due to the nature of the spatially triggered notifications as this is a new and innovative function that needs to be understood first. Scores for the attractiveness (ATT) and pragmatic quality (PQ) are similar for website and application, indicating that both systems were perceived overall as well designed and usable by our participants.

A closer look at the scores of the individual word pairs reveals that participants consistently assigned higher scores for the notification application for 26 of the 28 word pairs, see figure 5. Participants deemed the notification application to be more unpredictable and more demanding compared to the website, albeit the assigned values do not differ largely. The largest individual difference can be found for the word pairs that describe novelty and innovation potential. This is unsurprising as the concept of spatially triggered notifications about engagement opportunities was under investigation. Still, as participants assigned very high scores for the hedonistic identity (HQI) this indicates that participants could identify with it, finding it stylish, presentable and integrating. Nevertheless, the scores for the website are certainly good as well. Equal or close to equal scores were assigned for general manageability, presentation, and level of professionalism.

Overall, both systems were found to be pragmatic and attractive, while the notification application scored higher regarding the hedonistic stimulus and identity. Figure 6 depicts the general comparison in a matrix. The computed confidence rectangles are small, which means the participants have the same opinion in general. Differences between the developed mobile application and the official website are statistically

Figure 6: Matrix displaying the overall results of AttrakDiff in terms of hedonic and pragmatic quality. Both systems are suitable for obtaining information, but users found the notification application to be more desirable compared to the city's official website.

significant for the hedonic as well as pragmatic quality as the confidence rectangles are not overlapping in either dimension.

DISCUSSION

Designers or initiators of citizen engagement opportunities should not only rely on digital media, especially only on websites. The questionnaire of our first study revealed that all of our participants found articles in newspapers or radio broadcasts to be crucial while smartphone applications were the second highest rated channel our participants agreed on using. Cities' websites were deemed rather unimportant compared to social media networks and smartphone applications, an indication which we further investigated with our second comparison study. In the direct comparison of our second study, participants found the developed notification application to be more desirable compared to an official website that offers a set of similar functions.

Our results indicate that there is an untapped potential in digital channels with regards to "citizen apps". While the official website received similar scores for pragmatic qualities, the notification application was found to be more appealing and innovative, while also being more pragmatic. As our participants' average age was 25.6 years for the field study and 26 years for the comparison study, our results do not apply to the entire population. While younger generations may find smartphone applications natural and useful, attitudes of older citizens might differ considerably. As the notification application is ICT based, general considerations regarding the digital divide and access to technology apply as well. Only four of our participants expressed privacy concerns, even though their movement was tracked. This might be an artifact of the study. Participants knew they were part of a research project and had full control of the tracking function, which they could enable or disable at any time.

Based on the results we found that participants valued the smartphone application to obtain information about engagement opportunities. Participants liked implicitly triggered engagement notifications that are based on space, time and individual user preferences. However, we also found that

most of our participants (53%) consistently interacted with the triggered notification outside of the immediate vicinity of an engagement opportunity. Only 20% consistently interacted with them in situ, in the immediate vicinity of an engagement opportunity, within the geofence. 27% of the participants displayed no clear preference as they interacted either in situ or outside the immediate vicinity.

Notifications seemed to be considered useful and motivating: 67% of the triggered notification were accessed and 72% of the accessed notifications lead to an immediate exploration of the corresponding website of engagement opportunity. The results of the accompanying questionnaires corroborate these findings; participants agreed that location-based suggestions are useful and 86% still liked the feature after they used the notification application for ten days (10 strong agreements, 10 agreements). Furthermore, we found that almost all participants liked and used the individualization options that customize the notification triggers.

Limitations

A limitation of our study is that no clear differences were found in the ratio of accessed to dismissed notifications depending on the location. We assume that factors such as content, available time or presentation influence whether participants access a notification or not. To overcome this limitation, we are considering to include a short poll in the application after a user accessed or dismissed a notification. While these kinds of polls disrupt regular use, the insights gained in this way could help identifying the underlying reasons. Additionally, user activities and context could be provided to clearer establish types of use patterns. Furthermore, users could indicate if the notification was received too early or too late, as the engagement opportunity might only take place in the near future. Such issues could potentially be accounted for by introducing additional customization options.

The field study we conducted did not yield insights into why most of our participants interacted outside of the immediate vicinity of the citizen engagement. Reasons for this may be found in the general usage of smartphones. Notifications are only checked in bursts by some users [10] or notifications might be disabled entirely to avoid distractions [5]. Certainly, further studies are needed to understand the effect of spatially triggered notifications for citizen engagement. Reasons for dismissing notifications are equally important, as users already receive many messages on their smartphones [22]. They may thus just dismiss them reflexively to avoid being overloaded. Our application offers a mechanism to suppress re-occurring notifications to avoid this, but we have no data on how users' behavior might change over time.

Our analysis of the spatial occurrence of interactions with the notifications is rather straightforward as it only considers two cases: interactions in situ (inside the geofence) and outside of it. A deeper analysis taking into account distance to the engagement opportunity and time passed since the notification was triggered could provide better insights. Dingler et al. [9] found that people are highly attentive to their mobile phones, and 75% of triggered notifications from communication applications are attended within the first 12.5 minutes. 25% of

the triggered notification are attended to within the first 12 seconds. By considering traveled distance and passed time, more refined usage patterns might be identified, albeit several additional factors should be accounted for such as time of day or environmental conditions. Additionally, cases that prohibit the use of a smartphone, such as driving a car or riding a bike need consideration. For this kind of analysis considerably larger sample sizes and additional data are needed, preferably with more diverse participants.

CONCLUSION

We provide first insights into citizens' reception of notifications that are triggered based on space, time and individual user preferences. Our use case is based on informing citizens about engagement opportunities, as being aware of engagement possibilities is the most important step before any actual participation can take place [2].

Our findings indicate an untapped potential: most of our participants liked spatially triggered notifications and a smartphone application to find citizen engagement opportunities. In a direct comparison, they found the in situ proactive notification application to be more desirable and pragmatic than an official city website that offers the same information about engagement opportunities. After using our notification application for ten days, participants reported they felt motivated by the spatially triggered notifications, and they found the approach to be useful. However, feeling engaged does not necessarily imply actual engagement. Nevertheless, it is the first step towards participation.

Based on our initial analysis we found that 20% of our participants interacted with triggered notifications in situ while the majority of participants interacts with the triggered notification outside of the immediate vicinity of the engagement opportunity that triggered the notification. We found no clear differences in the behavior of accessing or dismissing notifications based on location or user types. While further studies are needed to better understand spatially triggered engagement notifications, initiators of citizen engagement opportunities should consider the role of mobile applications in their campaigns to raise awareness. A notification application that federates several engagement opportunities coupled with spatial suggestion mechanisms and individualization options might generate more attention than a website.

ACKNOWLEDGMENTS

We would like to thank the participants of the user study and con terra GmbH (for funding part of the research reported here). Additionally, the authors gratefully acknowledge funding from the European Union through the GEO-C project (H2020-MSCA-ITN-2014, Grant Agreement Number 642332, <http://www.geo-c.eu/>). We would also like to thank our anonymous reviewers for their feedback.

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