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Mobile Applications for Incident Reporting Systems in Urban Contexts: Lessons Learned from an Empirical Study

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ABSTRACT

Many governments are now promoting the use of mobile applications allowing citizens to report incidents in their neighborhood to the administration. Such applications are sought to sense the quality of the environment thus enabling authorities to promote safety and well-being among citizens. However, little is known about how users perceive incident reporting systems and which factors affect the user experience (UX) and the perception of risk. In this paper we present some lessons learned from an empirical study involving twenty users engaged in reporting urban incidents using a mobile application. A significant result from the present study is to point out how and which UX dimensions can be effectively used as triggers to motivate users to report incidents. Based on citizens' perception of urban incidents, we discuss how to build innovative incident reporting systems that can improve the communication between citizens and administrations.

Author Keywords

Incident reporting; user experience; mobile; government.

INTRODUCTION

After the pioneer work by the state of Virginia (USA) [6], many administrations world-wide started deploying mobile application for providing citizens with information of public interest (ex. weather forecasts, election monitoring, tourist information, traffic) [29]. The willingness (and need) of direct and on-site citizen involvement is often highlighted during natural disasters and massive accidents [27]. Nonetheless, citizens might also be interested in reporting urban incidents (e.g. broken street lamps,

water leakages) that affect the quality of life in the neighborhood.

Urban life differs from other aspects of human life and has many kinds of spatial and physical circumstances that pose challenges for interaction designers [2][5]. Today it is quite well known that the acceptance of m-government services¹ is directly related to the ability to address the citizens' needs [33]; and for that, usability and user interface design are key issues [39]. Nonetheless, little is known about how citizens perceive incident reporting systems and which user experience (UX) dimensions can be used as triggers for motivating users to use such applications. Moreover, even less is known about whether (or not) user experience affects citizens' opinions about the overall quality of the services provided by the local administration. Therefore, clear understanding of these questions is required to promote citizens as real sensors of their environment and increase their participation in m-government initiatives [8].

This paper presents some lessons learned from an empirical study involving twenty users engaged in reporting urban incidents using a mobile application. The goals of this study were (1) to identify dimensions that affect the users' experience and motivate users to report incidents to the administrations, and (2) to understand the challenges posed by mobile technology for building incident reporting systems in urban contexts. To make clear how this work contributes to current knowledge on the field, the next section presents an overview of existing incident reporting systems. Then, we present the definitions of UX dimensions that are addressed in this paper. Further on, we present the materials and methods employed in our study. Twenty participants took part in our experiment. For that, we have employed several evaluation methods such as user observation, thinking aloud protocol analysis, interviews and standard usability and UX questionnaires. The main findings are reported and, in the sequence, we discuss how our findings can be used to build innovative incident reporting systems for improving the communication between citizens and the citizen administration. Lastly, the paper presents conclusions and future work.

EXISTING INCIDENT REPORTING SYSTEMS

In a previous work [1] we have analyzed 23 existing incident reporting systems. That study focused on the front office (i.e. reporter tools) and not on the back office (i.e. officer tools). The

¹ M-government refers to the use of mobile technology for improving the communication between citizens and the government.

sample of applications covered national incident reporting services (i.e. United States of America, Canada, United Kingdom, Netherlands, Australia, New-Zeeland, Norway, South-Korea, Spain and India), city services (i.e. New Your City, Vienna, Copenhagen, Lisbon, and four French towns) and it included Web and mobile platforms.

We have found out that, despite the broad diversity of urban incidents that can be reported by those tools (more than 340), it was possible to identify a task pattern: (step 1) *users detect an incident*, (step 2) *then they create an incident report* (containing a description, a location, data and time of incident occurrence, and user identification), and ultimately (step 3), *users can follow up the incident and/or share that information with other users*.

Interesting enough, we could not find two applications that implement these tasks according to the same scenario. For example, whilst some applications allow users to type a textual description of the incident, in others users have to pick a description from a predefined list of incident types. In some cases, the textual description is replaced by a picture of the actual incident. Concerning the incident's location, interactive maps where users can *pinpoint the incident on* is supported by most applications analyzed. Automatic GPS geo-location is not always supported. A few applications allow users to *provide an address* while others support location by using *landmarks* (e.g. buildings or squares). Most of existing applications provide either support for sharing reports with others users. However, only a few allow users to subscribe for seeing the outcome of their incident reports (ex. when it has been fixed).

STATE OF THE ART

Before starting to design and develop a system, it is important to understand how people perceive and act on the environment and how user experience (UX) dimensions can affect the system acceptance and its usage. The concept of UX goes beyond usability but encompassing cognitive, socio-cognitive and affective aspects of the users' experience with artifacts. UX is commonly understood as being subjective, dynamic and context-dependent [20][21].

It is still controversial if user experience is measurable [22]. This work is following the pragmatic approach that it is possible to measure a set of dimensions that contribute to the overall user experience. What is important to note is that user experience and usability are independent dimensions: a limited usability should not lead to a bad user experience and it can lead to a positive user experience; similarly, good usability does not necessarily lead to a positive overall user experience. This can be easily seen in games where aspects of usability such as task performance does not necessarily imply a positive user experience with the game.

The literature in HCI describes a broad variety of dimensions that are associated with user experience. The six most commonly described UX dimensions in HCI literature include:

- *Visual and aesthetic experience*: it refers to the pleasure from sensory perceptions; how beautiful something is perceived [9]. It covers beauty [12] and classic aesthetic characteristics as clarity and symmetry [18]. It is also about how aesthetically pleasing and satisfying an interaction is [11]. It has been shown that system attractiveness and aesthetics do have a strong influence on the perceived usability of a system [10][34].

- *Emotion*: it has been identified as a key factor of UX [11]. The emotional experience is one of the main factors contributing to product experience, including feelings and elicited emotions [4][13]. Emotions are also considered important parts of the user's experience before, during and after interacting with interactive system [22] [24].
- *Stimulation*: this is as a hedonic attribute of a product, which can lead to new impressions, opportunities and insights [11]. Sheldon et al [36] state the need for pleasurable stimulation focusing more on joyful aspects of the interaction. Hedonic experiences are also known under the term *innovativeness* to describe the ability of a product to excite the user through its novelty [15].
- *Identification* addresses the human need to express one's self through objects [11]. This self-presentational function of products is entirely social; individuals want to be seen in specific ways by relevant others. Thus, using or owning a specific product is a way to reach a desired self-presentation. Identification can be seen as self-expression through an object to communicate identity. User personality is part of user experience in socio-cultural contexts, including self-image, attitudes, values, life-style and previous experiences [14].
- *Meaning and Value* refers to "Ideo pleasure" [16], values the product can satisfy. This means that products are sometimes chosen because they reflect or represent values that are important to the person. It covers two aspects of meaning: the experience of meaning and the meaning attached to a product [4].
- *Social relatedness/co-experience*: Hassenzahl [11] includes this dimension into identification. Relatedness is addressed by Gaver and Martin [6] under the term of intimacy, which is used to refer to nonverbal, inexplicit forms of communication. Jordan [16] describes it as socio-pleasure or something that deals with interaction with others.

User experience with mobile service has been defined as the combination of factors from service experience and user experience [38]. Service experience is affected by factors such as perishability, intangibility and the self-service nature of the services themselves [38]. There is a variety of factors that should be taken into account for any type of mobile based services, such as the coherence of the service integration, social navigation and interaction, the ability to dynamically change services, the intangibility of the service and the availability of multiple interaction styles.

Currently, the main mechanisms how individuals act in their environment are poorly understood in the field of environmental psychology [39] and unfamiliar to the HCI domain. Nonetheless, it seems important to know (1) how individuals perceive their environment, (2) how they discover incidents, and (3) how they transfer this knowledge to self-service systems.

Two concepts are important to understand how people perceive their environment: place identity and amenity. Place identity [33] refers to the cognitive aspects related to the perception of the environment including one's attitudes, feelings, ideas, memories, personal values and preferences toward the whole range and all types of physical settings. These aspects of place identity allow people to understand the environment they live in and their overall experience. In this way one can consider place identity as a structure of the self-identity, which means situated and self-

centered. Thus the same physical environment can be perceived differently by different individuals. For example, a handrail can be perceived as a help for elderly people and as an object to play with for kids. The concept of amenity refers to the ability of spaces to evoke emotional responses such as attractiveness and desirability. Amenity refers to any benefits of a property, especially those that affect attractiveness or value of places. Amenities include restaurants, parks, swimming pools, theatres, children's playgrounds, bicycles paths, etc. Amenities also include pleasant architecture, nearby activities, good schools or a low crime rate, all of which adds to the desirability of place and property. The concept of amenity explains how environmental qualities can have an impact on the hedonic and social perception of environment. The identification or perception of an incident is related to a mental contradiction between an expected state of the environment (influenced by the place identity of a person and the amenities given in that environment) and the real state of this environment. When this contradiction is too high, people feel the need to report this contradiction or correct it.

For Moles and Rohmer [27] the main role of the urban environment is to act as a mediator between individuals and the society. Such mediators exist on different levels ranging from a macro to a micro level. At the macro level the role of the urban environment includes building public transportation or the global management of the city. Individuals typically do not have a lot of influence on the macro level. On the micro level the urban environment refers to events and objects that individuals interact with in their daily actions, like taking a bus or enjoying a park. The role of a designer of any incident reporting systems is to improve the communication between the individual (individual's daily experiences on the micro level of the urban environment) and the local administration or government (on the macro level of the urban environment).

USER TESTING OF INCIDENT REPORTING SYSTEM

In this section we present the materials and methods employed to assess the high-fidelity prototype called UbiLoop that was used in the study. The prototype was developed in the context of the project FEDER UbiLoop. This study was run during summer 2012 inside the Campus of the University Paul Sabatier, Toulouse, France.

Our incident reporting system at a glance

UbiLoop was conceived as smartphone application. It was created using the free and open source framework PhoneGap² that supports the creation of embedded mobile applications using standardized Web technology (e.g. HTML, CSS and JavaScript). Thus UbiLoop is also available as a Web application but the experiment was performed using the embedded smartphone app. UbiLoop was deployed under iPhone and OS Android smartphones. Moreover, the user interface is delivered in French because this corresponds to the mother tongue of target users in the study.

Following the task pattern previously identified for incident reporting systems, UbiLoop users can fill a form with information describing: the nature of the incident (what it is about), when the incident occurred, its location, who identifies the incident and what are the expected outcomes. Only the nature of the incident and its location are mandatory. It is noteworthy that such

information can be provided by different means, for example, location can be informed by a geo-location positioning system or an address and incident descriptions might contain photos, videos or just a textual user report. Other optional tasks supported by the application UbiLoop are related to the definition of users' preferences (such as whether users want to inform their identity or keep it anonymous whilst reporting an incident), history and outcomes of previously reported incidents, and discovery of incidents reported by other users in the neighborhood.

Figure 1 shows some screenshots that illustrate the main functions supported by the prototype. Figure 1.a depicts the icon that identifies the application in the smartphone environment. Figure 1.b shows the main menu when the application is launched; this menu enlists (from top down) several options allowing users to: start an incident report, inspect incomplete reports waiting for user validation, visualize history of previous reports, configure preferences, and visualize incidents reported by other users.

In order to inform the nature of an incident, users must navigate a menu featuring a taxonomy of categories and types of incidents (see Figure 1.c and .d). Such taxonomy helps guiding the users through the types of incidents supported by the application (therefore, treated by the local administration). The hierarchical menu reduces ambiguous initial entries that would be difficult to identify if the users had to type the nature of the incidents every time.

It is interesting to notice that every incident type might require several levels of accuracy for information; for example street addresses are relevant for the identification of broken lamps in the street but the exact location is less relevant when reporting noise caused by airplanes. Similarly, some incidents such as potholes can be done anonymously while for others the administration may require user identification (e.g. citizens reporting noise caused by neighbors should identify themselves to prevent spams and false alarms).

Most incidents reported with UbiLoop do not require the exact time to be correctly identified and treated by the administration. Moreover, it would be difficult to set the exact time when incidents occur, such as a pothole in a street lane. Whilst data and time of when users send the report are systematically recorded, date and time of occurrence of an incident is only required in a few cases such as when users inform when they intend to place a bulky waste to be collected by the garbage collector service.

UbiLoop is tailored to show a user interface that requests only the minimal information to correctly identify the incident and, for that, fields in the form change accordingly to the incident type. This is easily done because the set of alternatives is limited and the rules describing the information required are also described in a taxonomy. In case the incident type is not enlisted, the user interface provides an alternative based on a free form where users can add the information they want.

As part of the description, users can provide evidence of the incident such as photos. By clicking on the button *camera* (Figure 1.e), users take a picture with the smartphone and then immediately return to the application to complete the incident description (Figure 1.f). Similarly, it is possible to connect to global positioning systems (GPS) to get the exact user location.

They can also indicate the location by typing an address or selecting the location of the incident (e.g.: to allow users to report incidents without being physically present) in an interactive map (see Figure 1.g).

² PhoneGap. Available at : <http://phonegap.com/>

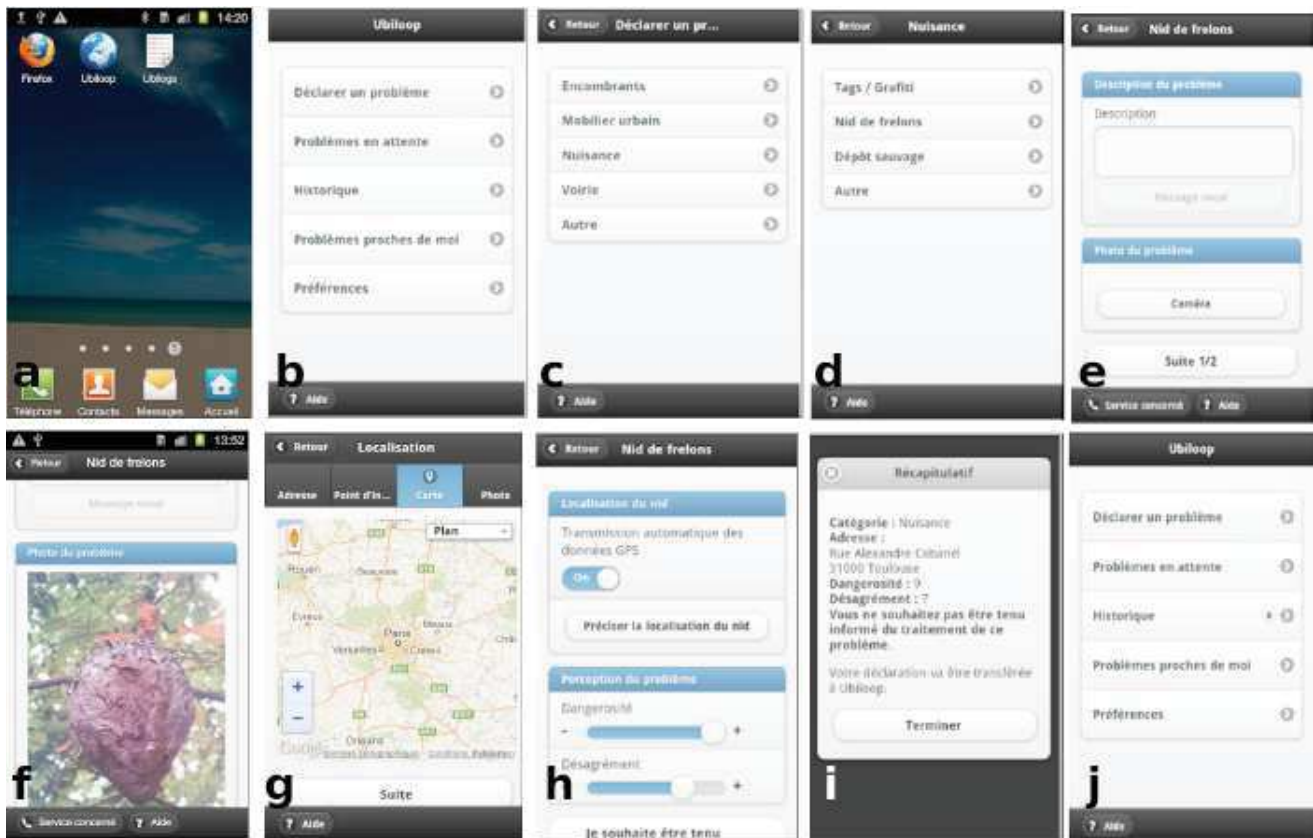


Figure 1. Screenshot from Ubiloop: a. application in the smartphone environment, b. main menu, c. selection of category, d. selection of incident type, e. textual description, f. photo taken by the user, g. incident location on an interactive map, h. perception of danger and inconvenience, i. summary before sending report, and j. main menu featuring a counter of reported incidents.

In order to better understand the urgency and inconvenience, users are systematically prompted to inform the incident's perceived degree of danger and the disturbance it causes (Figure 1.h). They can create and edit a report several times before effectively submitting it. However, if citizens want to follow up the outcomes of their report they should explicitly request it during the submission process. Before submission, users are given a short summary of their report (Figure 1.i) that, once sent, will appear in the menu *history* (Figure 1.j).

Research questions and hypothesis

The goals of this study are to (1) identify and verify dimensions that affect the users' experience and motivate users to report incidents to the administration, and (2) understand the challenges in terms of usability and user experience for using mobile technology for building incident reporting systems. Our hypothesis are (1) *that a mobile phone application enabling users to report incidents can be used by experienced mobile phone users* and (2) *that aesthetics, emotion, identification, stimulation, meaning and value and social connectedness are important dimensions of user experience for the area of incident reporting with mobile phones.*

Methods

The participants of the experiment were asked to move around the campus and use Ubiloop to report the incidents they might found

in the way. In order to understand how users would react to the task of incident reporting, we have employed the following methods:

- **Observations of users and thinking aloud protocol** were employed during the test. Visual observations were also supported by video recording. **Log file analysis** was employed to collect user traces and assess task performance. Moreover, usability was assessed by counting the number of successful incident reports provided by users and time spent for making reports.
- **Semi-directed interview** using open questions were used to prompt the users to talk about their experience after the usage of the prototype. Users' comments were recorded and transcribed, then analyzed and coded according the grounded theory approach [7][19]. The definitions of user experiences were used as codes for interpreting segments of text (i.e. transcription of user comments). To reduce the risk of misinterpretation, the coding was double checked by an independent evaluator. In addition to these open questions, users were asked to indicate three things they liked and three things they didn't like in the prototype.
- **Standard Usability Scale (SUS)** [2] was used to assess to which extent participants perceive the application as usable. The word "system" in the 10 questions was replaced by "Ubiloop".

- **Self-Assessment Manikin (SAM)** technique [17] was used to collect additional evidence of users' emotions associated with users' affective reaction to the use of our prototype. SAM features three sets of five drawings of a simple character, each set representing the range of states in the pleasure, arousal, and dominance dimensions. Participants are then asked to identify the character in each set that represents their current state in that particular dimension. This technique has been successfully used during the assessment of interactive systems [18].
- The standard **Attrakdiff** questionnaire [6] was used to assess pragmatic and hedonic qualities.

The methods were used to collect data for the different usability and user experience dimensions are shown in Table 1. A demographic questionnaire was also distributed before the user testing sessions to assess age, education, experience with smartphones, experience with incident reporting systems and involvement in associative activities.

Table 1. Properties, dimensions and methods used in the study.

Properties	Dimensions	Methods
Usability	<i>effectiveness</i>	Observation of users performing tasks
	<i>efficiency</i>	User traces (log file analysis)
	<i>satisfaction</i>	Attrakdiff, thinking aloud protocol, semi-directed interview, SUS
User Experience (UX)	<i>visual and aesthetic</i>	Attrakdiff, semi-directed interview
	<i>emotions</i>	SAM, semi-directed interview
	<i>stimulation</i>	Attrakdiff, semi-directed interview
	<i>identification</i>	Attrakdiff, semi-directed interview
	<i>meaning and value</i>	Attrakdiff, semi-directed interview
	<i>social relatedness/ co-experience</i>	Attrakdiff, semi-directed interview

User testing scenarios

In order to make sure that all participants would report similar incidents during the test, we create some scenarios that highlight specific context of use for reporting incidents with smartphones. The kind of information requested from the user varied slightly for the different scenarios:

- **Broken street lamp:** This incident was chosen to explore situations that would be difficult to illustrate with a picture. Broken street lamps are often noticed during the night which makes taking a photo almost impossible as many smartphones do not have a flash or the camera does not cover long distances. This scenario requires users to describe the problem and indicate their perception of danger and disturbance. In this scenario, the location is automatically inferred from the embedded GPS.
- **Broken bench in a park:** This scenario explores the precise location of an incident. It also prompts people for their involvement with (a priori) minor incidents. It requires the problem's description, degree of danger and disturbance,

geo-location and. User can also provide photos of the incident.

- **Garbage disposal:** Waste removal is performed by different services in the city of Toulouse: garbage trucks collect on a regular basis any waste that fits into the standard waste containers, a second service picks up waste that exceeds standard sizes, and a third one collects garbage thrown away in the environment. This scenario explores if users are able to detect which service to call when they see a garbage disposal. It requires the description of the problem, degree of danger and disturbance, location by an interactive map and photos.
- **Hornet nest:** This scenario depicts a hornet nest close to a playground with some hornets flying around the children playing there. It is aimed to explore the influence the perceived danger has on the incident. It requires the description, degree of danger and disturbance, location by an interactive map and photos.

Procedures and set-up

At first, the participants got a short introduction about the experimental study, they were then asked to sign an agreement to participate in the experiment and to fill in a form with demographic data.

In the sequence, participants were asked to think aloud and they received a smartphone (either IOS or Android, accordingly to their familiarity with one of these platforms). They were asked to wear sunglasses with a camera, so that it was possible to determine where they were looking at. Figure 2 illustrates the materials used for collecting user traces during the user testing which included a sunglasses camera, a voice-recorder and a logging tool.



a. Sunglasses camera b. Recorder c. Logging/Tracing tools

Figure 2. Tools used for collecting data during the experiment.

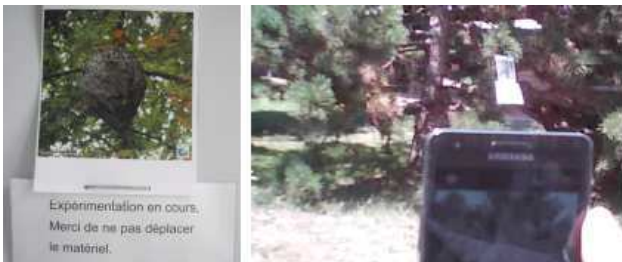
Participants were then trained during 5 minutes on how to report a broken street lamp using Ubiloop. Then, they were asked to perform the following tasks:

- Task 1: provide identity and setup user preferences;
- Task 2: report a broken bench;
- Task 3: report a hornet nests;
- Task 4: report a garbage disposal; whilst performing this task, users were voluntarily interrupted by a (simulated) technical problem (loss of network connection). The interruption occurred just before sending the report and it was aimed to investigate users' reactions to interrupted work. After the interruption, users were invited to walk until an office room where the study was completed. Arriving at the office, users were prompted to resume the task.

Except for task 1, participants were asked to perform the tasks while following a predefined route in the campus. The route was populated with posters prompting users to report fake incidents

that refer to the scenarios previously presented and illustrated by Figure 3.

After reporting each incident, users were asked to describe the difficulty of the task on a scale from 1-5 (5 is the most difficult) and tell what they would change to make that task easier. In addition to these predefined posters, users were free to report any other incident they could see in the campus (and the route had many real incidents such as potholes, posters, public turned on during the day...).



a. Poster of hornet nests. b. User taking a picture of a poster.

Figure 3. Materialization of scenarios through posters prompting users to incidents.

The last step in the experiment included the administration of questionnaires SAM, SUS and Attrakdiff, and the semi-directed interview, which explicitly asked participants to talk about:

- Incidents that they might have seen but that they could not declare with Ubiloop;
- Whether (or not) incidents reported during the user testing were representative of what the users would like to report in the real life;
- What kind of incidents they would like to report beyond those currently supported by the tool,
- The users' interest for an application such as Ubiloop;
- Three positive and three negative things in Ubiloop;
- Three words for describing Ubiloop.

Participants

We have used a convenience sample to recruit twenty participants (11 male and 9 female) ranging from 21 to 57 years ($M=34.95$; $SD=11.29$). We have recruited experienced and frequent smartphone users to prevent problems arising from first time experience with the devices. Seven participants (35%) have iPhones whilst thirteen (65%) use Android as operating system.

All participants were familiar with a variety of services on their smartphones including: making a phone call, text messaging, sending email, accessing the Internet, taking pictures, using the GSP, and downloading applications (e.g. weather forecast apps). None of them knew the application before the user testing session. Participants lived the same metropolitan area for at least 1 year. Among the participants, 9 were home owners, 10 were tenants and just 1 still lived with their parents. Only six participants declared to be engaged in associative activities, from which 2 worked for a neighborhood association.

Results

All participants successfully completed the tasks. The average user performance and difficulty given by users for each of the tasks are presented in Table 2.

Table 2. Metrics used to asses user tasks.

Tasks	Average duration	Average difficulty (1 easy-5 difficult)
Provide identity and user preferences	2m36s (SD=1m34s)	2.3 (SD=0.7)
Report a broken bench	2m15s (SD=58s)	1.5 (SD=0.8)
Report a hornet nests	3m12s (SD=1m6s)	1.7 (SD=0.8)
Report garbage disposal	2m03s (SD=1m03s)	2.3 (SD=1.2)

Task 2 has been performed faster than the training task (average of 2m32s, $SD=1m44s$) when participants had to report a similar incident (i.e. a broken street lamp). Task 3 was slightly longer (average 3m12s, $SD=1m36s$) which can be explained by the fact that users had to locate the incident using an interactive map; the automatic geo-location was disabled to avoid the danger of getting users too close of hornet nests. After excluding the time used by the interruption, we observed that the task was faster when compared to previous tasks. All users easily recover from the interruption. The improved user performance can also be explained by the fact that users were becoming used to the application. We can expect improvements in the users' performances with time, even if users have already considered the incident reporting to be reasonably quick. Users judged all tasks as relatively easy (ranging from 1.5 to 2.3 on the scale from 1: easy to 5: difficult).

During the test users spontaneously talked about their own experiences with urban incidents and they said they would report those incidents if they had an application such Ubiloop. In total, the 20 participants cited 81 incidents (average 4.05, $SD=2.9$) that could be classified in 29 incident types; only 1 participant did not mention any other incident beyond those that are proposed by the tasks. Among 81 incidents, 18 participants mention they experienced problems with broken benches; 18 mention with hornet nests and 15 mention problems with broken street lamps. These findings confirm that the scenarios used in the user test are frequent in real life and that the users might feel stimulated to report their experiences if they had an application to do that.

Sixteen participants (out of 20) agree that the taxonomy proposed for the incidents is easy to understand. Only 3 participants said they would like to organize the menus describing the taxonomy of incidents by themselves.

The results of the SUS score are also very positive as the average score is of 83 points (min=67.5, max=97.5). This means that the current version of the prototype is considered usable. However, two participants judged the application's usability as average. This might be explained by a few usability problems that were reported by users during the thinking aloud protocol. These problems are mainly related to the setting of user preferences and lack of guidance for recovering from interrupted reports.

Accordingly to the participants, the main interests of incident reporting systems such as application Ubiloop are: simplify the information exchange with administrations ($N=9$ participants), become an active citizen ($N=9$), improve the quality of their environment ($N=7$), reduce the efforts for monitoring incidents in the city ($N=3$) and reduce costs in the detection of problems in the city ($N=1$). It is noteworthy that many users mention the quality of their environment as a target for the tool. Most importantly, they said the tool could simplify the communication with the administration.

Concerning the questionnaire SAM, the results shows that the application leads users to a positive emotional state. The dimension *pleasure* received a score of 7 (SD=1) similarly to the dimension *dominance* (7, SD=2). However, *arousal* is pretty low with a score of 2 (SD=1). In general, the small standard deviation shows that user's answers are coherent. However it is interesting to notice that the values for *dominance* vary more (between neutral and positive dominance). Overall, the SAM score indicates that users might obtain a moderate pleasure when using our prototype to report incidents and have the feeling of being in control of the system.

The analysis of UX dimensions took into account the AttrakDiff, thinking aloud and the interview. Similarly, the results obtained from AttrakDiff are very encouraging. All participants (regardless age, level of education, genre or experience with smartphones) provided very similar scores, indicating that the overall users' perception of application is coherent. The application was perceived as pragmatic, which means useful, usable and generally task-oriented. The hedonic qualities are good but the UX could be improved by improving the dimension *stimulation* and *visual aesthetics*. Moreover, the analysis of users' comments during the semi-directed interviewed provided additional information about UX dimensions. Based on the transcripts, a corpus of 420 segments of text was classified according to references to UX dimensions. The coding was supported by the MaxQDA 10 software [24]. The number of segments and participants are given in Table 3.

Table 3. Segments encoded from the semi-directed interview.

UX dimensions	Number of segments	Number of users
Stimulation	89	20
Identification (to smartphones)	63	19
Identification (to incidents)	101	19
Meaning and value (reliable evidence of incidents)	57	18
Meaning and value (overall service)	45	19
Meaning an value (individual commitment)	9	7
Social relatedness / co-experience	82	18
Identity	28	14
Visual and aesthetic experience	12	10
Emotions	14	10
Total	420	<i>N=20</i>

Hereafter we illustrate the findings by excerpts of participants that are labeled as Nx, where x is the given participants number.

Stimulation. We have observed that the dimensions *identification* and *stimulation* often appear together. The fact that users found the incident in the menu of the application stimulates them to report it, as said by N7: "If the categories of incidents are clear, this should encourage people to report incidents..." N13 said: "The type of incidents should be ranked by the potential danger because I think that the degree of danger would prompt people to push the button [and report important incidents]..." In overall, participants often mentioned the following factors as triggers for reporting an incident: possible danger, inconvenience, frequency of incident occurrence and proximity to the place they live and/or work. The *identification* to an area also plays a role with respect to the *stimulation*, as N5 said: "People in the countryside must have

a different menu, so they would be keen to use the application to report incidents frequent in their specific area..." Even the most reluctant participants said they would report important incidents, as N12: "This [system] might push some people to report everything. I wouldn't do that [report incidents] except if the incident is really important."

Identification. *Identification* here refers to the use of the smartphone and/or the act of reporting incidents. Participants very quickly saw themselves using the application in their smartphone and they report their habits with other applications. For example N20 said: "If there is too much text to write I immediately change to voice recognition. So the system should not request me to write much." N13 envisages localizing the incident as s/he used to: "I would like to have an interactive geo-location of incident as in Google Maps..." Similar comments were reported with respect to the language, management of photos, management of types of incidents, expected type of feedback from the administration (e.g. email, SMS) and history management. Users are aware that the network coverage can affect the interaction, N14 said: "[the availability of the application under a smartphone] would encourage incident reports that I have seen during the day. However, it must have a good network. If so I would even think about reporting incidents I have seen when I was in the beach..." Interestingly, many users said they would like to report the incident in situ, as stated by N10: "I would return to the place of the incident to report it..."

Meaning and value. This dimension refers to *reliable evidence of incidents*, *overall service*, and advantage from *individual commitment*. User N1 thinks that providing user identity adds value to the system: "People should always identify themselves as this would prevent fake incident reports..." Nonetheless many participants are concerned by privacy, N18 said: "I would be upset if I had to provide my identification every time... anonymous reports should be allowed in some cases..." Increasing citizenships is mentioned by N11: "I feel that when using the system I can contribute to the society..." and N19: "I see that... I can easily report problems that are close to me... and there is a kind of active participation in this act [of reporting incidents]..." Other participants mention that the UbiLoop should be a relief for existing hot lines. The system is valued more if users get feedback from the outcomes of their reports, especially if feedback is provided by a human, as pointed by N18: "If there is a person providing feedback I would use the system more often. I would feel that my claims were listened to..." Users value the fact that the system can help people to report incidents that have not been seen by the administration, N14: "...The local administration cannot be everywhere... So help the administration [to see where the problems are] is a good thing..."

Social relatedness/co-experience. This dimension is influenced by the crowdsourcing approach used by the system to collect incidents. Participants feel that if there were many users reporting an incident, the administration would pay more attention to the reports. They also expressed the need of sharing incident with others, see N13: "This weekend I saw a hornet nests and I thought I should have left a message to other people passing in the area..." Getting feedback from the administration is judged important, N5 said: "The service is useful if it is done in both sides... It must have some feedback to people reporting incidents, so that they know that someone with take care of their reports..." Feedback becomes more important as the perception of danger increases, as prompted by N11: "Notification should be sent systematically to inform that the incident has been received [by

the administration]. A mail explaining when the incident will be treated must follow. If the problem is a hornet nests they should also inform all people around when the problem has been solved...”

Identity. The UX dimension *identity* is slightly influenced by the professional habits of the participants, as shown by N19: “*I think that most important is to send good and relevant information. But I am aware this perception might be influenced by my current job...*” Nonetheless, participants reported the application promote the feeling of citizenship. Participants believe that this kind of system would change the people behavior, as said by participant N5: “*Incident reporting can make people to think about problems. If people can see incident reported by other users, people will have a better perception of the reality in their neighborhood.*” Two participants (N16 and 14) recall the success of such system depends on the citizen’s willingness to provide information and that is not a widely shared characteristic. Participant N16 said: “*I don’t think I would spontaneously report incident. I do for this study, but I don’t think I would use in my daily life. I see incident every day and I have never called anyone to tell about it. This is not in my personality.*”

Visual and aesthetic experience. Overall, participants consider that a good quality of the pictures of the incidents (taken with Smartphone) will be an important aspect to establish a trustful relationship with the local administration. The score provided by the Attrakdiff indicates that the *Visual and Aesthetic* dimension of our prototype could be improved. However, when analyzing users’ comments, we noticed that the user interface is rather standard but this is something that is expected for the kind of tasks supported by the tool. The participant N12 says “*The [user interface] is clean which is pretty good because this [application] is just for reporting incidents.*” Other participants have stronger opinions about the design, such as N14: “*The style should be improved. It would be possible to make it fun and look more professional...*”

Emotions. The results show that our prototype raised positive and negative *emotions*. Most of participants appreciate the fact that the prototype would take their opinions into account, as N18: “*I like the idea that, using the system, I can share with the local authorities the point of view of cyclists...*” The participant N12 thinks that “*it is pleasant to use it*” and N8 reinforce this positive feeling by saying that “*There is something playful in the use of the application.*” However, this kind of application also raised negative emotions that are directly linked to cultural and social aspects such as the fear of a “*big brother effect*”; see N7’s comment: “*I don’t like the idea that we should report everything. If this behavior becomes excessively frequent in the society, I would be very upset.*”

INTERPRETATION OF RESULTS AND DISCUSSION

The findings of the user testing allowed us to make some conclusions about the usage of our prototype and about users’ expectations about this kind of service. All measurements (successful tasks, task performance and satisfaction) indicate that the prototype is usable, at least for experienced mobile users. This conclusion is supported by the SUS score (average 83) and the findings of the thinking aloud protocol. The results of the questionnaire SAM and Attrakdiff are generally positive too. The results indicate that use of the application is pleasant and usable, but users need an extra motivation to use it. This is clearly indicated by a low SAM score for the factor *arousal* (average=2, SD=1) and it is confirmed by the thinking aloud protocol and the semi-directed interview.

Both hypotheses were confirmed: the application overall is usable and the six identified user experience dimensions were identified as important dimensions for this domain. It is interesting to notice that, during the semi-directed interviews, users freely talked about UX dimensions even though usability aspects are not in the core of their discourse. Overall, the various user experience dimensions are the primary motivations for using the service. *Stimulation* and *identification* with the incident are key elements for motivating users to use the service. *Social relatedness* and *co-experience* are important to convince users to re-use the application. On the other side dimensions like *emotion*, *visual and aesthetic* experience and meaning and value are important during the usage of the application

The availability of the application on smartphone is valued positively by users and it could be used as a factor for motivating to report incidents. For example, there is an important *identification* between users and their smartphone. However, there are important challenges for using mobile technology for building incident reporting systems. For example, most users reported they want to be able to report incident in situ, which might expose users to danger (ex. getting too close to incidents such as hornet nests, potholes can expose users to danger).

Beyond that an important aspect is that users see the simplification of their relationship with the local administration as the primary interest in using the application. For example, they highlighted the fact that the system should be conceived not only to collect information from users (in a crowdsourcing manner) but users also expect to get feedback from administration. The application would allow them to be active as a citizen and by that improve their immediate living environment. These social aspects should inspire innovative service in the domain of mobile government.

CONCLUSIONS AND FUTURE WORK

This study provides some fresh data about how citizens perceive urban incidents and that are the motivating factors that push them to report incidents to the city administration. Overall, participants easily talk about urban incidents but they do not often report incident to the city administration.

Participants perceive incidents as something that reduce their quality of life. However, users seem to need an extra motivation to report incidents, in particular those that do not affect them directly. Such motivations have been analyzed in this paper in terms of UX dimensions. One of the central findings is that different user experience dimensions are more or less important during the various phases of using the application. While stimulation and identification in general do contribute to the willingness of the citizens to use the application and social relatedness is clearly contributing to the willingness to re-use the application after an incident report. Emotion, aesthetic, meaning and value on the other hand do support the process of incident reporting with the mobile phone application. All participants seemed very concerned by the visual and quality aesthetics of the applications, which has a strong impact of the design of the application.

Nonetheless, the results might reflect a specific culture and further studies should be done in other to generalize the conclusion for other countries. In near future, we expect to collect similar evidences from other countries about the impact of UX dimensions on the design of user incident report systems. Our future work will also focus on this aspect to describe in more

detail how the different UX dimension change in terms of importance for the various steps during an incident report and what UX dimensions overall do support an increased activity to become an active citizen.

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