The Usability of IVRs for Smart City Crowdsourcing in Developing Cities

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Abstract

The Public Safety Smart City Project explores the use of an interactive voice response (IVR) system by citizens of a city in a developing country to ease urban challenges arising as a result of growing urbanisation. Given that usability problems can prevent users from adopting and using any system, the IVR system was designed with the user in mind by endeavouring to meet key usability goals. The study sought to determine whether these citizens would deem such an IVR channel usable for telephonically reporting public safety matters and whether any noteworthy usability issues arose. By means of a survey, citizens who participated in this study assessed the system's usability. The survey results showed that from a usability perspective, an IVR system is an effective crowdsourcing channel for citizens to report such matters. In addition, the paper suggests recommendations for designing and building participatory crowdsourcing IVR channels for similar projects, from the end-user perspective, to avoid potential usability problems.

Keywords: crowdsourcing, smart city, interactive voice response, usability, developing country

1. Introduction

As a result of increasing urbanisation, cities face a series of challenges as their resources and infrastructure are placed under ever-increasing strain (Chourabi et al., 2012). Accompanying increased urbanisation is an increased chance of crime and social tensions, environmental and health risks, and government service provision challenges (SAIRR, 2013). To maintain service delivery levels, governments must seek alternative means to make more effective use of city resources and infrastructure to adequately serve the growing populace.

The Public Safety Smart City Project is a research initiative undertaken in East London, South Africa to explore the use of ICT tools to meet urban challenges arising as a result of growing urbanisation. Jointly undertaken by the University of Fort Hare (UFH) and IBM, this smart city initiative explores a way to enhance public safety in cities of developing countries by proposing and testing a voluntary participation crowdsourcing model for a developing country. Crowdsourcing, in contrast to a sensor-driven approach, is the method employed in this study to gather public safety data from citizens. In this model, citizens assist by reporting public safety observations that can be analysed to identify patterns so that authorities and city managers can respond quicker to public safety matters. By running cities more effectively, the endangerment of citizens' security and safety should be reduced.

An interactive voice response (IVR) system was created to be used as the channel through which citizens submit their public safety reports. Citizens were enlisted who then telephonically, via the IVR system, submitted one or more reports. However, a key aim when designing any such interactive system is to ensure that the system is usable, in other words, that it is easy, effective and pleasurable for the user to use (Preece et al., 2015). Thus, the IVR system was designed with the user in mind by endeavouring to meet key usability goals.

After the project participants had used the system for a period of time, a sample was requested, by means of a survey, to assess its usability. Key questions that sought answers were: "Would an IVR channel be deemed usable by citizens of a developing country for this purpose?", "Did any noteworthy usability issues arise?", and "What recommendations can be put forward for creating a usable IVR crowdsourcing system?"

The purpose of this paper is to show that, from a usability perspective, an IVR system is an effective crowdsourcing channel for citizens to report public safety matters for the purpose of enhancing public safety in cities of developing countries, such as the city of East London. It also aims to make recommendations for designing and building participatory crowdsourcing IVR channels for similar smart city projects, from the end-user perspective, to avoid potential usability problems.

This paper begins by providing relevant background information, including the value of smart cities and crowdsourcing and their significance in this project. In addition, it describes the technology employed in the project and the design of the speech user interface, along with the relevant underlying theoretical background. This is followed by a description of the methodology followed. The paper then provides an analysis of the survey results to assess the usability of the IVR system as perceived by its users. It closes with relevant recommendations and conclusions.

2. BACKGROUND

This section provides background information relevant to the Public Safety Smart City Project and to this paper. It describes two key concepts central to the project: smart cities and crowdsourcing. It also details the technology employed in the project as well as the design of the speech user interface used in the IVR system. The section concludes with a discussion of the underlying theoretical background for the study.

2.1 Growing Urbanisation

The majority of the world's population is now living in cities (McConnachie, 2012). In South Africa, two thirds of the population now resides in urban areas (SAIRR, 2013). By the year 2050, it is predicted that more than 80% of the population will be living in cities (McConnachie, 2012). As a result of increasing urbanisation, cities face a series of challenges as their resources and infrastructure are placed under ever-increasing strain (Chourabi et al., 2012). To maintain service delivery levels, governments must seek alternative means to make more effective use of city resources and infrastructure to serve the growing populace adequately.

2.2 Smart Cities

One such innovative way to enhance service delivery is IBM's "Smarter Cities" initiative (IBM, 2011). A "smart city" is a city that uses technology-based innovation in the city's planning, development and operation (Harrison & Donnelly, 2011). The goal is to meet the challenges experienced by today's cities and, more recently, to promote sustainability (Shaffers et al., 2011).

IBM's Meenaji Venkat states that one core function of a city is safety and security planning (McConnachie, 2012). Venkat states that in a smart city, analytics are used to analyse data gathered in a city in order to improve policing, identify threats, and determine how best to deal with such threats before they become dangerous or difficult to manage. For example, the city might alert citizens of looming danger as a result of traffic or weather hazards, deliver emergency support early, or deploy police to a growing crime hot-spot. Prof.

W. Richard Janikowski, in an IBM video discussion (IBM, 2012), states that cities that will meet the urban challenges of the 21st challenges will be those that use ICT tools to effectively provide for public safety for their citizens.

2.3 The Public Safety Smart City Project

In a smart city, one method to gather data from citizens is through crowdsourcing. Crowdsourcing, not to be confused with crowdsensing, can be defined as “a business practice that means literally to outsource an activity to the crowd” (Howe in Estellés-Arolas & González-Ladrón-de-Guevara, 2012, p.189).

Using the basic characteristics of any crowdsourcing initiative, as identified by Estellés-Arolas and González-Ladrón-de-Guevara (2012), the characteristics of the Public Safety Smart City Project are identified and depicted in Figure 1.

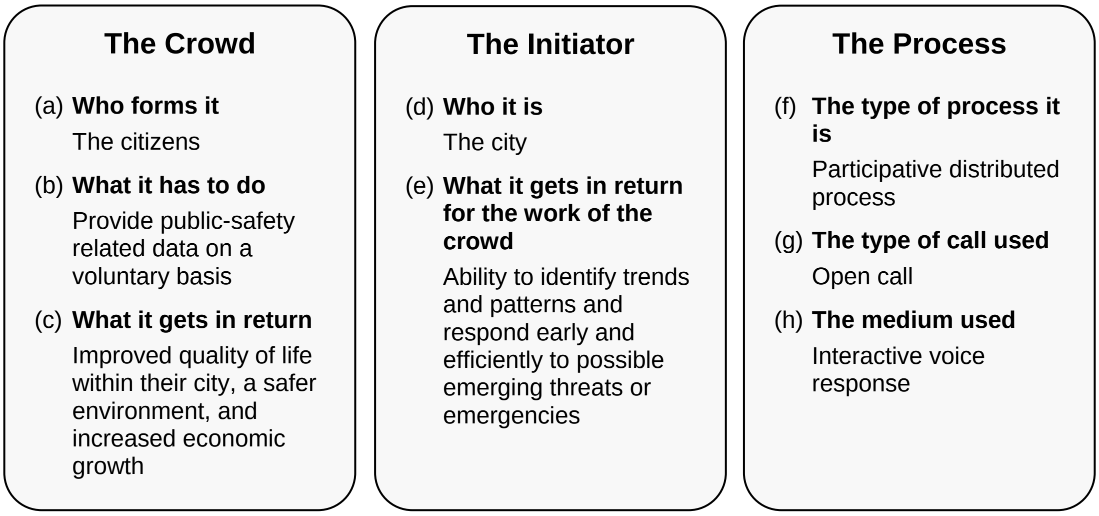

Figure 1: Basic Characteristics of the Public Safety Smart City Project
(based on Estellés-Arolas & González-Ladrón-de-Guevara, 2012)

The project can therefore be described as one that uses crowdsourcing to enable East London citizens (the crowd), in large numbers, to provide public-safety related data in spoken form on a voluntary basis, through the use of an IVR system. Thus, a voluntary participation crowdsourcing model is used whereby citizens choose what they wish to report and when they wish to report it.

For example, citizens may report heavy rains (that could escalate into flooding), anti-social behaviour (that could escalate into riot activity), or electricity cable wires that have become exposed after a storm (that could cause citizen fatalities). The aim is then to allow the city (the initiator) to aggregate and analyse this crowd-sourced data to identify trends and patterns, allowing public safety officials to respond early, efficiently and proactively to rising threats or emergencies before they become dangerous or difficult to manage. Thus, the city adopts a more proactive approach rather than a reactive one. Through such active participation, citizens are empowered with a “voice” that can improve their quality of life within their city, contribute to a safer living environment, and consequently increase economic growth. Hence, advances in ICT reshape the relationship between governments and citizens.

There are various benefits of using crowdsourcing in this way. As citizens use their existing fixed or mobile telephones, no additional hardware or software is needed. Thus, costs are kept low and observations can be reported conveniently, immediately, and from any location. In addition, the data received is rich qualitative data sourced from citizens about observations “on the ground” as they experience them. Clearly, this participatory crowdsourcing model is useful to generate various types of city-related data and thus is not restricted to only public safety-related data.

Two trends receiving much research focus in the crowdsourcing domain are, firstly, the creation of information through mobile data collection and, secondly, the curation and the consumption of that data (Robson et al., 2011). The work of this project lies in both areas, capitalizing on the abundance of smart phones in the hands of citizens for reporting purposes, and the advancement of technology to enable quick aggregation and powerful, meaningful analysis of the crowdsourced data.

Therefore, the broad goal of the project is to propose and test a voluntary participation crowdsourcing model for a developing country to explore and evaluate the use of citizens as a source of information that can be used to support a city’s public safety operations and planning to make it a safer place. The project targets citizens in the city of East London only. It focuses on the end-user point of view in terms of user experience, motivating factors and adoption barriers. Importantly, the project uses the public safety context as the test case to develop a model that can be applied to the other key aspects of a city, such as energy and water, and transportation.

2.3.1 The Technology

Figure 1 indicates that an IVR system is used as the medium through which the crowd interacts with the system to submit reports telephonically. The IVR was developed in conjunction with IBM and uses a speech-based reporting interface with automatic speech recognition and a directed dialogue format. English was chosen as the supported language for both the speech input and output to allow analytics to be effectively performed on the public safety reports.

Speech-based interaction via basic fixed and mobile phones was chosen for a number of reasons, including:

- Smart phone penetration is low amongst the citizens in the area whereas basic telephone devices are very common. Thus, citizens do not require smart phones and special installed apps; only the most basic fixed or mobile phones are needed.
- The high illiteracy rate of the citizens makes text-based interaction, such as through written text messages, less accessible. Such interaction is also less convenient than a speech-based mode of interaction.
- A speech-based reporting interface via telephone is one that is familiar and easy to use.

Thus, such an interface is able to overcome many problems that are specific to developing countries, such as illiteracy and low disposable income amongst citizens. Consequently, it should therefore be able to reach the greatest number of citizens of a developing country, even the illiterate and poor.

2.3.2 The Nature of the Speech User Interface

Once the nature of the reporting task was understood, the prompts and call flows were designed. The structure of the interaction flow for the IVR system is depicted in Figure 2. The core part of the interaction flow is enclosed in a dashed box. The interaction flow uses a directed dialogue where the system initiates and directs the dialogue and where the response options are explicit. This is the most common dialogue style for speech-based telephony systems because it offers greater accuracy of the speech recognition (Karat et al., 2012).

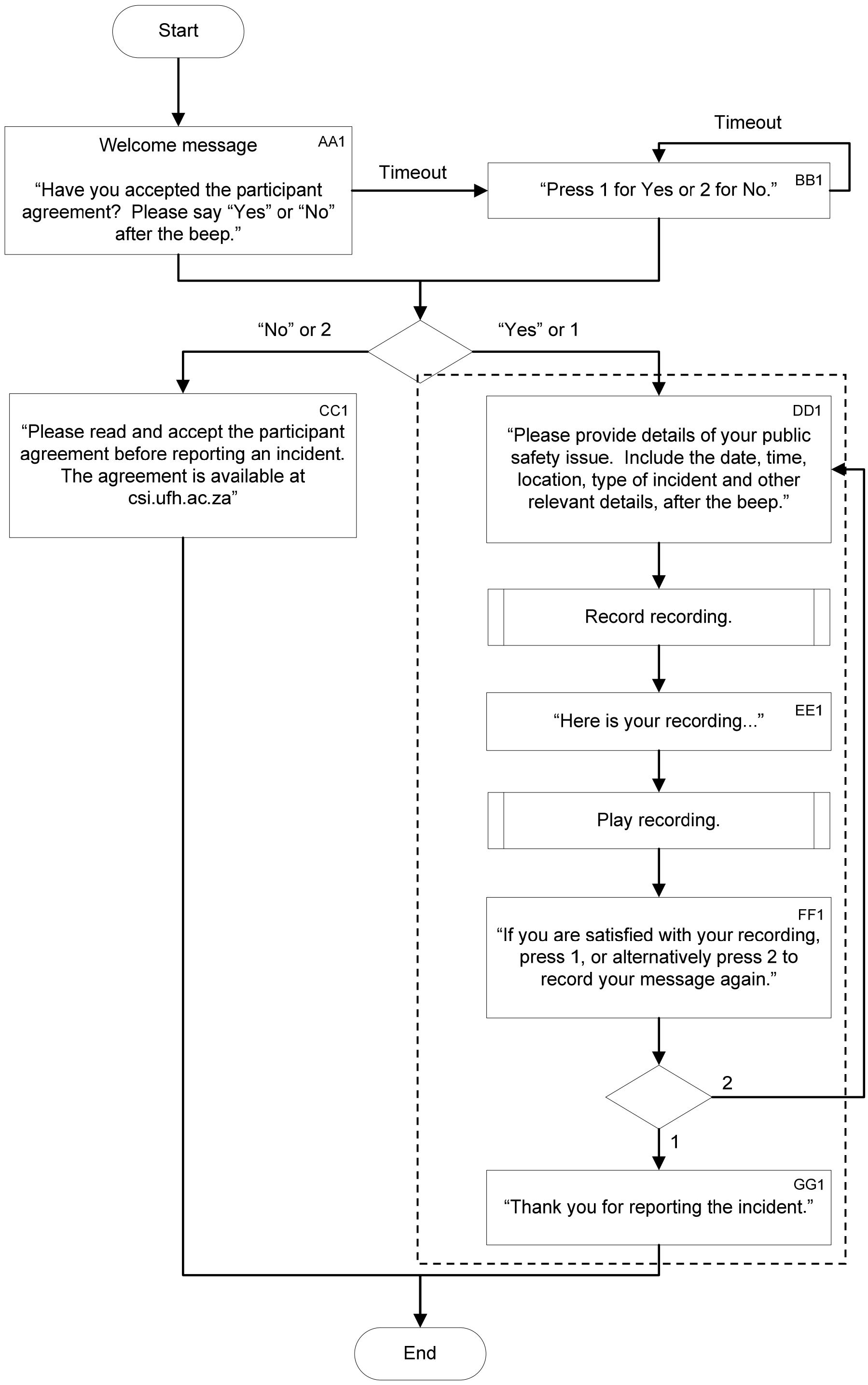

Figure 2: IVR Interaction Flow for the Public Safety Smart City Project

The flow comprises of seven key steps:

1. Prompt the caller to provide the required information after the beep is heard (DD1).
2. Accept speech input in the form of the user's spoken safety report.
3. Alert the user that their recording is about to be played back (EE1).
4. Play the recording back to the caller.
5. Prompt the caller to accept the recording or to re-record the message (FF1).

6. Depending on the input, either proceed to step 7, return to step 1, or return to step 5 (in the case of invalid input).
7. Thank the caller for their report (GG1).

The interaction flows (and the system as a whole) were tested extensively during a pilot phase and fine-tuned to ensure robustness in the event of incorrect or invalid user input.

2.4 Theoretical Foundation

The IVR system was designed with the user in mind to try to make it easy, effective and enjoyable to use. Thus, a key design objective was to develop a usable interactive system for citizens. The International Standards Organisation (ISO) defines usability as “the extent to which a product can be used by specified users to achieve specified goals with *effectiveness*, *efficiency*, and *satisfaction* in a specified context of use” (ISO, 1998). Preece et al. (2015) expand upon these goals, stating that a “usable” system has six goals, as described in Table 1.

Table 1: Goals of a Usable System (based on Preece et al., 2015)

Usability Goal	What it Means
Effective to use	How good the system is at doing what it is supposed to do.
Efficient to use	Whether the appropriate amount of effort is demanded from the user.
Safe to use	Whether the user is protected from dangerous conditions and undesirable situations.
Having good utility	How well the system provides the right kind of functionality to allow users to achieve their goals.
Easy to learn	How easy the system is to learn.
Easy to remember how to use	How easy the system is to remember how to use.

These goals closely conform to the ISO definition of usability but offer refinement particularly in terms of *satisfaction*. The IVR system was designed to meet each of these goals, as described in the sections below (reference is made to specific elements of the interaction flow shown in Figure 2).

2.4.1 Effective to Use

Given that a user will call the system with the only goal of reporting a public safety concern, it must support the user in achieving this goal with accuracy and completeness. Thus, poorly organised or complicated prompts were avoided. The interaction flow for reporting a safety matter was organised into three broad and simple steps:

1. Prompt for the information about the safety issue (prompt DD1).
2. Allow the user to record the message.
3. Obtain user confirmation (prompts EE1 and FF1).

As far as possible, the IVR system favoured speech input but supported touchtone input to cater for instances where speech input fails, for example, as a result of caller accent, speech disability or ambient noise (Lewis, 2011). Karat et al. (2012) advise that using an alternate form of input in this way can reduce frustration and thus improve the user experience. This correction strategy is discussed further below.

Furthermore, the system used recorded natural speech throughout, as research shows that users generally prefer recorded natural speech to synthesised speech (Lewis, 2011).

2.4.2 Efficient to Use

Given lengthy and numerous prompts, a user may simply decide to drop a call. The "input form" was therefore flattened to a shallow structure so that callers would not have to provide required information one piece at a time. For example, instead of separate prompts for the date of the incident, the time of the incident and location of the incident, one prompt was used. Thus, the interaction flow was kept as concise as possible by designing three simple and short steps in the flow to allow the user to report a safety matter with very little effort. In this way, task efficiency was increased.

The initial prompt in the interaction flow was kept short and simple because a concise initial prompting style is generally preferred over a verbose style (Lewis, 2011). In fact, all the prompts used were concise to increase task efficiency, but not overly concise to the extent that the interaction became impersonal and non-conversational. This introductory segment does not include a statement of purpose as callers would have familiarised themselves with the system upon registering on the project's website before calling. It also begins with the word "Welcome" to make it clear to the caller that they are conversing with a machine because humans are unlikely to begin a conversation with the word "Welcome" (Lewis, 2011).

To further enhance efficiency as recommended by Lewis (2011), speech barge-in - where system speech stops as soon as the system detects speech input - is supported. The system does not notify the user in the introductory segment that barge-in is supported as research has shown that callers will naturally barge-in when the system pauses between speech (Lewis, 2011).

As can be seen in Figure 2, the initial prompt mentions only speech input. In striving for a simple interface, prompts (particularly initial prompts) should primarily mention speech as a mode of input or be entirely neutral (Lewis, 2011). Thus, specific mention to both speech and touchtone input should therefore be avoided. However, for numeric string prompts, Lewis (2011) encourages "say or enter" prompts as most callers will opt for touchtone input when given the option. Whether mention is made of touchtone input or not, both touchtone and speech should be supported where possible, as mentioned earlier (Attwater in Lewis, 2011).

Error declarations in the event of speech input errors arising from the initial prompt were avoided. Thus, in the case of speech recognition failures or timeouts, the system reverts to a touchtone-type re-prompt as an alternative (as suggested by Karat et al., 2012). In doing so, it should be obvious to the user that the system failed to successfully recognise the caller's speech input. Lewis (2011) has found that a "re-prompt" approach such as this (i.e. without an error declaration) is often the best solution, serving as a suitable safety net. It must be noted that the system still supports both speech and touchtone input. Thus, callers who are familiar with the interaction flow and are proceeding through the flow with ease can do so quickly. This also helps to avoid speech prompts that mimic touchtone-style prompts (i.e. in the form of "for option, do action") that tend to be longer than necessary and, according to Lewis (2011), are generally best avoided.

2.4.3 Safe to Use

The system allows the user to replay their recording in order to confirm its correctness or to re-record it, thus serving as an explicit confirmation. In systems where the consequences of errors are not significant, there may not be a need to confirm user input (Lewis, 2011). The explicit confirmation in this IVR system provides a means of recovery in the event of a recording error or poor quality of a recording (prompts EE1 and FF1). This helps to minimize errors and quality issues in caller input that can have a direct impact on the subsequent analysis of the caller data and the action taken.

2.4.4 Having Good Utility

The system was designed to provide all the functionality needed to allow the user to report a public safety matter telephonically by using the IVR channel.

2.4.5 Easy to Learn

It was necessary that citizens of varying backgrounds and literacy levels be able to easily learn how to use the system to report a safety matter. Such citizens include those who have never used an IVR system before. A directed dialogue format was used so that users merely had to follow the prompts and respond accordingly using simple inputs in the form of speech and their keypad. All telephone users are already familiar with this type of interaction and thus should find the system easy to learn.

2.4.6 Easy to Remember How to Use

As the nature of the interaction should be familiar to all telephone users, there is little need for users to make an effort to remember how to use the system or for the system to coach them to recall how to use it. The caller need not remember any commands as the interaction is directed entirely by the system prompting the user for the needed input at each step.

By striving to meet each of these six usability goals when designing this IVR, it is believed that the overall usability of the system would be maximised making it easy, effective and enjoyable to use.

3. Research Methodology

The broad goal of the Public Safety Smart City Project is to propose and test a voluntary participation crowdsourcing model for a developing country in the context of public safety. This paper focuses specifically on the usability aspect of the IVR system that was developed and employed as a mechanism to collect public safety-related information from citizens.

A quantitative data collection method was used in the form of an online questionnaire distributed to participants. This section describes how participants were enlisted and how the survey was conducted.

3.1 Citizen Engagement

Mobile and fixed line telephone users in East London were enlisted through various means, including advertising in newspapers and social media and distributing flyers. These participants were required to register on the project's website and accept the participant agreement. Participants who wished to be entered into a lucky draw to win an incentive supplied their contact details as part of the registration process.

Once registered, participants were expected to make telephone calls to the IVR system. The system guided them through the process of reporting public safety matters that they observed in the city. After a period of time, a convenient sample of the participants were requested to complete an online survey to, amongst others, assess the usability of the IVR system.

This three-step participation process was depicted on the project's website as follows:

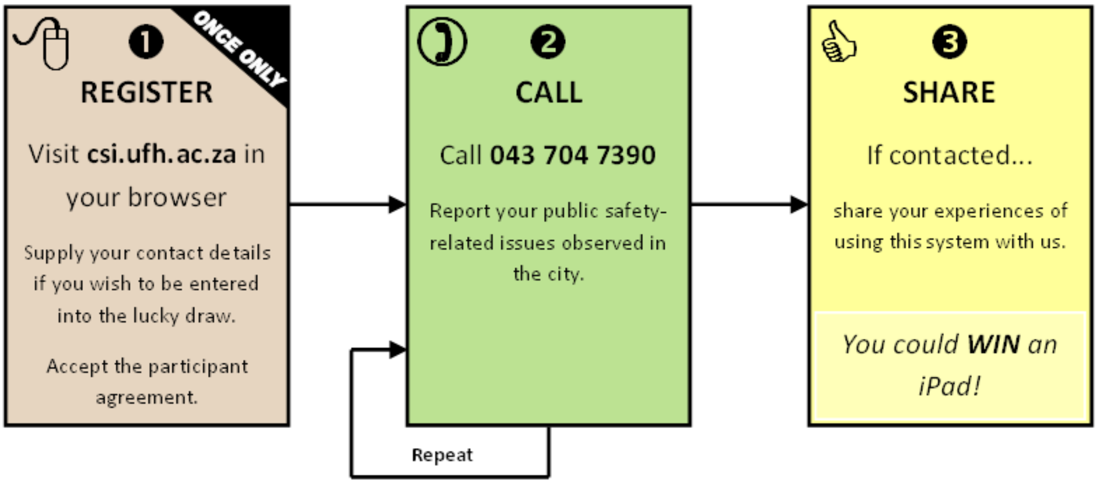

Figure 3: The Three-Step Participation Process in the Public Safety Smart City Project

3.2 The Survey

The research instrument used in this study was a formal, online survey. The questionnaire was sent to a convenient sample of the registered participants who were literate and had access to the Internet. A group of 50 participants completed the survey on line.

The questionnaire specifically focused on assessing the perceived usability of the IVR system (refer to Table 2). The criteria for assessing the usability were derived from the usability goals put forward by Preece et al. (2015) and described earlier. Each item (except the last) uses a five-point scale ranging from "strongly agree" to "strongly disagree". The last item aimed to obtain insight into the respondents' preferred mode of input, namely voice input or keypad input.

The quantitative survey data was collated and analysed to evaluate the perceived usability of the IVR for public safety-related participatory crowdsourcing in East London. The survey results and the analysis of these results follow.

4. Analysis and Results

The questionnaire focussed specifically on the usability of the IVR system, as experienced by citizens, the results of which are shown in the table below.

Table 2: Survey Results Relating to the Usability of the IVR System

Question [Perceived Usefulness]	Agree	Disagree	Median	Mean
I found this system useful as a means to report public safety issues by the general public.	78.05%	4.88%	2 (Agree)	1.83 (Agree)

Question [Perceived Effectiveness]	Agree	Disagree	Median	Mean
The system did everything I would expect it to do to allow me to report public safety issues via the	72.09%	6.98%	2 (Agree)	2.05 (Agree)

phone (i.e. it is effective).				

Question [Perceived Ease of Use]	Agree	Disagree	Median	Mean
I found this system easy to use.	80.49%	4.88%	2 (Agree)	1.90 (Agree)

Question [Perceived Efficiency]	Agree	Disagree	Median	Mean
The number of steps (or amount of effort) needed *within one call* to successfully report an issue was acceptable.	70.73%	7.32%	2 (Agree)	2.24 (Agree)

Question [Perceived Learnability]	Agree	Disagree	Median	Mean
I learned to use this system quickly.	80.00%	7.50%	2 (Agree)	1.98 (Agree)

Question [Perceived Memorability]	Agree	Disagree	Median	Mean
I will easily remember how to use this system.	84.62%	7.69%	2 (Agree)	1.77 (Agree)

Question [Caller Satisfaction]	Agree	Disagree	Median	Mean
Overall, I was satisfied with this automated system for reporting public safety issues. I would be comfortable using it again to report such issues.	80.95%	9.52%	2 (Agree)	1.98 (Agree)

Question [Preferred Mode of Input]			
Which mode of input did you prefer to use?			
I preferred to speak my commands	**I preferred to use the phone's keypad to make selections**	**Median**	**Mean**
36.0%	64.0%	2 (Keypad)	1.63 (towards keypad)

The results show that the vast majority of respondents (78.05%) felt that the IVR system was useful for reporting public safety issues by the general public. 72.09% of respondents felt that it was effective for facilitating this and therefore good at what it is supposed to do. 80.49% felt that it was easy to use. It can be inferred that keeping the call flows and prompts simple created a favourable user experience, and that preferring speech input (and supporting touchtone only when speech input fails) did not hinder the achievement of the users' goal of reporting an issue effectively. Users also seemed content that the prompts used recorded speech instead of synthesized speech, thus agreeing with previous research by Lewis (2011).

The majority of respondents (70.73%) felt that the IVR system was efficient. They felt that the number of steps (or amount of effort) needed within one call to successfully report an issue was appropriate, thus emphasising the importance of simple call flows and uncomplicated prompts. Respondents were therefore generally satisfied with the flattened "form" structure used whereby all aspects of a safety issue were recorded as one input instead of via a series of individual prompts for each aspect (e.g. date, time and location), thus increasing efficiency of the reporting process. It can also be inferred that the concise initial prompting used as well as the concise prompting used throughout also contributed to the system's efficiency. Unnecessary prompts, such as announcing speech barge-in support and touchtone input support in the initial prompt, were excluded to further increase efficiency. It is difficult to establish whether this affected other aspects of usability or whether or not any users naturally used speech barge-in or seamlessly progressed through the call using speech input only without reverting to touch-tone input. However, interestingly, the results show that 64% of users preferred to use their phone's keypad to make selections, indicating that a large number of users did revert to touch-tone input possibly as a result of speech recognition failures (e.g. as a result of background noise or signal degradation), timeouts or simply out of preference. It would be interesting to establish why this preference exists given the natural and familiar input channel of the telephone. However, it appears that this "re-prompt" approach, as advocated by Lewis (2011), indeed served as an acceptable and effective safety net that respondents seemed generally comfortable with.

The majority of respondents (80.00%) felt that the system was easy to learn. This might be attributed to the fact that 62.7% of these callers had used at least one other IVR system before. The remaining 17.30% who had not used an IVR system before still felt that the system was easy to learn. This may be attributed to the fact that speech via telephone is natural for users of varying backgrounds and literacy levels and that a directed dialogue format was chosen to guide callers through the reporting process.

84.62% of users felt that they would easily remember how to use this system. Given the familiar form of interaction and channel involved and that the interaction is directed entirely by the system without requiring the user to remember any commands, this result was expected.

An interesting finding was that the majority of respondents (64%) preferred using their phone's keypad for input instead of using voice to speak their commands. This emphasises the need to support both modes of input even though voice input may seem to be the most natural mode of input using a telephonic channel.

Overall, 80.95% of callers were satisfied with the system for the purpose of reporting public safety matters and would be comfortable to use it again.

Based upon the ISO 9241-11 standard's definition of usability (ISO, 1998), the three specified goals, namely *effectiveness*, *efficiency*, and *satisfaction*, are achieved given the resultant perception ratings of at least 70% each. Thus, these results provide strong indications that the citizens surveyed deem the IVR system usable and are very comfortable with using it as a crowdsourcing channel to report their public safety observations.

5. RECOMMENDATIONS

This paper aims to show that, from a usability perspective, an IVR is an effective crowdsourcing reporting channel for use by citizens for the purpose of enhancing public safety in cities of developing countries, such as the city of East London. However, to ensure participation by citizens, such a system must be usable. For any system to be usable, it should satisfy the six usability goals established by Preece et al. (2015): effective to use; efficient to use; safe to use; having good utility; easy to learn; and easy to remember how to use. These goals served as the basis for the design of the IVR for this project to promote its usability. Through an empirical study it was found that a very high number of project participants perceived the system to be usable and would be comfortable to use it again. These findings therefore confirm the importance of meeting these usability goals when implementing a participatory crowdsourcing system in a city with developing characteristics.

To achieve a usable IVR system for the Public Safety Smart City Project, a series of contributing factors played a key role in helping to achieve each of these usability goals. Figure 4 depicts the causal relationships between these factors and each of these goals.

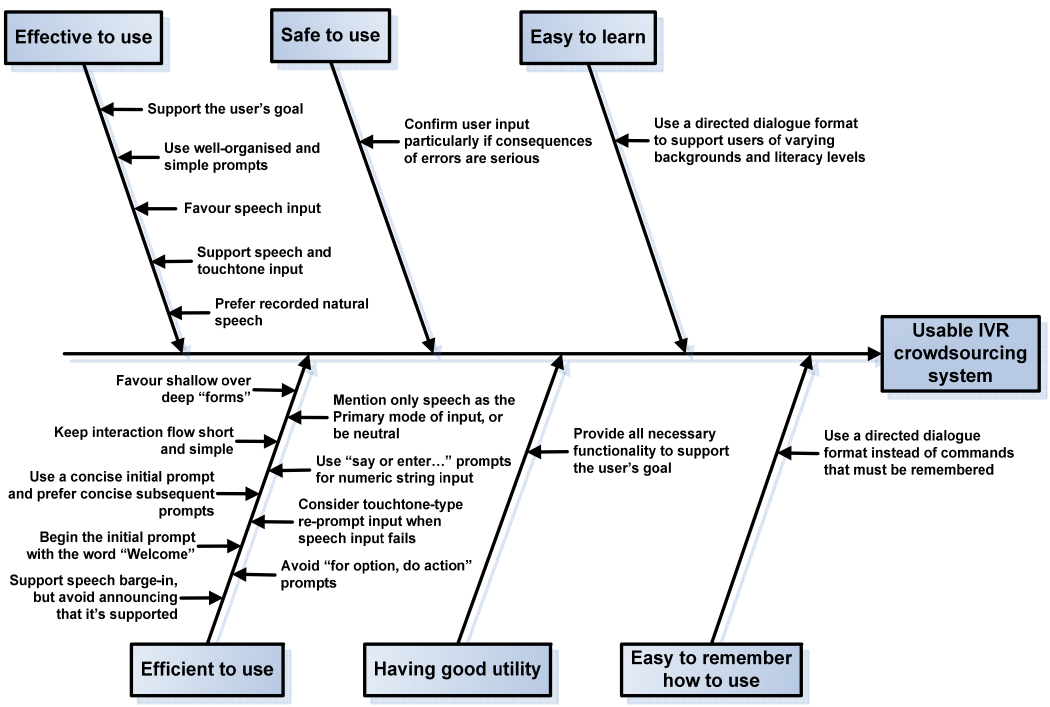

Figure 4: Recommendations for Creating a Usable IVR Crowdsourcing System

Based on the analysis of the survey results and the theoretical content presented above, this study suggests that this depiction can serve as a recommendation to designers of similar participatory crowdsourcing IVR systems to help meet system usability objectives from the end-user perspective, so as to avoid potential usability problems.

6. Conclusion

As a result of increasing urbanisation, local governments must seek ways to make more effective use of city resources and infrastructure to adequately serve the growing populace. Thus, there is a need for cities to work smarter and become smart cities. In the Public Safety Smart City Project, citizens assist by using an IVR system to report public safety observations that can be analysed to identify patterns so that authorities and city managers can respond quicker to emergencies or growing public safety concerns.

This paper shows that from a usability perspective, an IVR system can be an effective crowdsourcing channel for citizens to report public safety matters for the purpose of enhancing public safety in cities of developing countries, such as the city of East London. However, any IVR system used by citizens for reporting purposes needs to be usable for them to be satisfied and comfortable with using it. When such a system depends upon repetitive participation by citizens in order to make accurate decisions about emergency responses and improving public safety, usability is especially important.

Given the theoretical content and empirical findings detailed in this paper, the paper proposes that satisfying the six usability goals established by Preece et al. (2015) is important when designing an IVR for a participatory crowdsourcing system for a developing city. Furthermore, key contributors for meeting each goal have been identified and proposed. It is suggested that these contributors and their causal relationships serve as recommendations for building participatory crowdsourcing solutions for similar projects to avoid potential usability problems.

The study also led to a specific finding of particular interest that may be worthy of further investigation, that of keypad use for input. While one may expect voice input to be preferred given its familiar and convenient nature, the opposite may appear to be true. This suggests the importance of supporting keypad input for such systems. It would be interesting to establish why a preference for keypad input over voice input exists. However, as it appears that the more literate, educated users may favour keypad input, it would be worthwhile to explore the provision of a mobi site as an additional reporting channel to operate in parallel with the IVR.

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