Exploring the Use of Mobile Crowdsourcing by the Public Administration

VASILEIOS YFANTIS1, KLIMIS NTALIANIS1
[1]Department of Business Administration
University of West Attica
Agiou Spiridonos 28, Egaleo 122 43, Attica
GREECE
byfantis@yahoo.com, kdal75@gmail.com, http://www.uniwa.gr

Abstract: - Crowdsourcing has been extensively used in the private sector and recently adopted by the public sector. The current paper discusses the use of the mobile crowdsourcing in the public administration from both managerial and technological perspectives by exploring its current use and research challenges. The authors classify the mobile crowdsourcing in four categories, based on the application areas: Infrastructure maintenance, environmental reporting, critical situation reporting, and crime watch reporting. Each application area is examined for its research challenges and contribution in the crowdsourcing research area.

Key-Words: - Crowdsourcing, mobile devices, public administration, infrastructure, usability, trust

1 Introduction

The scope of this paper is to explore in a systematic way the potential use of crowdsourcing in public administration. The contribution of this paper on research level is the identification of innovating uses of crowdsourcing and the associated research challenges. Particularly, the analysis examines how mobile crowdsourcing helps the government to detect the criminality in public spaces, encourage public awareness during critical situations, and monitor environmental issues or even saving cost on infrastructure maintenance. Each crowdsourcing element is being analyzed on both technical and managerial level, for its research significance. Moreover, further discussion is followed about the common research challenges of all the crowdsourcing elements and potential ways to extend the use of mobile crowdsourcing in the public sector.

Estelles-Arolas resulted in the definition of crowdsourcing as «a type of participative online activity in which an individual, an institution, a non-profit organization, or company proposes to a group of individuals of varying knowledge, heterogeneity, and number, via a flexible open call, the voluntary undertaking of a task» [1]. Hazleen Aris and Marina Md Din, discuss the structure of crowdsourcing by defining its main elements as [2]: User, process,

task, content, platform, reward. According to Hazleen, users could be the creators of a task or the participants in a task. The participants are either active or passive participants and the active participants contribute on the crowdsourcing by providing the creators of the task with useful data that may lead to the solution of the problem. Passive participants usually are just observing the provided information and benefit of this. The process includes all the stages of the crowdsourcing, from its initiation to the completion of the task. The concept of task refers to the suggested problem for solving. Content, is the type of data that the active participants provide for the completion of the crowdsourcing. The reward could be an intrinsic or extrinsic [3] and the extrinsic is categorized into financial or non financial. The platform is the medium that connects the task creators and the participants.

The popularity of the mobile phone usage had an impact on academic research of crowdsourcing and several authors tried to formulate the mobile crowdsourcing. Daren C. Brabham explores the definition of the mobile crowdsourcing and characterized it as an «online, distributed problem-solving and production model» [4]. According to Yufeng and other scholars, mobile crowdsourcing refers to «the integration of smartphone-based

mobile technologies and crowdsourcing that offers significant flexibility and lead to a new computing paradigm» [5]. There are three stakeholders of this concept: Task publishers, crowd-workers, and crowdsourcing platform. So when a mobile crowdsourcing action takes place, a task publisher outsources a task to a crowdsourcing platform and the crowdworkers are submitting their feedback by using mobile devices as a medium.

2 Problem Formulation

The crowdsourcing on public administration is usually implemented through the use of mobile applications. The mobile crowdsourcing applications on public administration, explore several issues that refer to the key signals for the improvement of the citizen's everyday life such as criminality and public asset status detection. Dhruv writes about the mobile application called Project Jagriti, which is a platform for criminality reporting and particularly for violence against children [6]. This application was invented to encourage people report anonymously this type of criminality and help government to reduce the crime. The issue that the government faces in this case is that there are a limited number of policemen that are involved in the crimes against children. The competitive advantage of this application is that encourages people into crime reporting without extra cost for the hiring of more policemen. Njuguna and other researchers invented a mobile crowdsourcing application, called Afya Ya Barabara [7]. The application visualizes the data about the road condition in Nairobi and also receives tweets from the citizens that identify problems on the road surface. The main element of this application is that enables the monitoring of the public area (roads) by the citizens when the government cannot find the arising issues on time. Ouyang and other scholars discussed the use of the iSee mobile crowdsourcing application that targets and localizes illegal actions such as smoking and graffiti in public spaces [8]. In the recent years several authors have explored crowdsourcing in the public sector and from different perspectives [9] [10] [11]. Most of them discuss crowdsourcing from one of the perspectives that Hazleen and Marina discuss: User, process, task, content, plat-form, reward. The difference of our paper compared with the others, is the fact that we research crowdsourcing in the public sector with focus on a combination of two crowdsourcing elements: Platform and task.

Our research initializes with the information seeking on popular databases so as to find the current status of the research area. The choice of the databases is mainly influenced by the popularity of the database and its relevance to the research perspective. We discuss the subject from an IS perspective, so we include three popular databases that have been used by many scholars: Google Scholar, Scopus and Web Of Science.

3 Problem Solution

The research for academic works on the popular databases resulted in an initial sum of records. The sum of academic records was filtered until we concluded in the final number of records for further analysis. This is the process that was followed:

1. Identification: 330 records were identified based on the keywords and 3 duplicated records were removed.
2. Screening: 327 records were screened and 259 records were excluded because they did not meet the search criteria of document type and language. Most of the results were re-moved from Google Scholar because it suggested articles that have academic content, but come from non academic resources such as websites, newspapers and other resources.
3. Eligibility: 68 full text records were accessed and 46 records were excluded because there were not relevant to the subject of our research.
4. Structuring: 22 records remained and were structured into themes/categories for further analysis.

22 records remained and were structured into themes/categories for further analysis. The 22 remaining records were categorized by dividing the existing bibliography based on the application areas of mobile crowdsourcing in the public administration. After reading the literature, we concluded that the following application areas of the public administration have been found: Infrastructure maintenance, environmental reporting, critical situation reporting, and crime watch reporting. Infrastructure maintenance refers to information which is associated with the road condition, buildings and other assets of a city. Environmental reporting is considered information which is relevant to the weather condition and the green areas of an administrative area. The critical situation reporting is a type of information that discusses the information feed during emergent situations such as natural disasters and political

crises. Crime watch is an application area relevant with information that deals with safety and security of an area.

3.1 Infrastructure maintenance

Harding and other scholars wrote a paper where they discuss the design for civic engagement and trust in ICT design in the domain of civic urban maintenance [12]. In this case, the scholars discuss about infrastructure maintenance type of application which embeds citizen's opinion about the infrastructure maintenance of an administrative area. The first part of their hybrid research methodology included interviews with stake-holders of the civic engagement: Citizens and civic authorities. The second part of the methodology included an experiment by developing and testing a prototype system. This is a fair methodological approach because it takes into account the needs of all the stakeholders, moreover the first part bridges to the second one by using the survey's results for the design of the prototype system. On research level, the authors view the subject from a behavioral and design perspective, which are two paradigms of the information systems research [13]. So on crowdsourcing research level, the authors contribute to the requirements of an information system for crowdsourcing by suggesting, trust as an element that might be useful for the design of the platform. Lack of trust between the citizens and the civic authority is the main finding of this paper: The civic authorities have concerns of litigation from the public and the citizens are worried about the management of their personal information from the government. This mistrust is a research challenge because if the scholars identify the factors that influence trust in a crowdsourcing system, then the crowdsourcing process will be improved.

Another application is discussed by You and other authors [14]. They discuss CITY FEED, a mobile system for citizen collaboration towards the solving of city issues. In terms of methodology, the scholars are using the case study tool which succeeds in exploring the system mainly from the task assigner's perspective. However, we believe that the authors could use additional tools such as a survey in order to augment their work and research the task participant's side as well. On crowdsourcing level, the research emphasizes on the task assigner's side (service cost, platform's analysis mechanism) and underemphasizes on the participant's side (citizen satisfaction, open information access). The contribution of this work on crowdsourcing, is the fact that it considers the

maturity of the system by analyzing its main processes: Task publishing, transacting, interacting, collaborating, and evaluating. Particularly, the analysis of each process will potentially lead to the identification of the advantages and disadvantages of the system. Therefore, the authors identify the following research challenges regarding the crowdsourcing mechanism of CITY FEED: The improvement of the platform analysis mechanism, the widening of the information feeding sources and the credibility of the crowdfeeds. The arguments of data credibility and trust are also present in the work of Harding etc. where there is mistrust between the task assigner (civic authorities) and the participants (citizens). Both works identify trust as an important element of crowdsourcing regarding the interaction between the task assigner and the participant. The mistrust between the two stakeholders reveals an information security concern about the role of each side regarding the implementation of crowdsourcing.

The role of location in infrastructure maintenance is being explored by Zeile and other researchers [15]. Zeile presented the RADAR SENSING app which allows citizens to provide location based data by using their mobile phones; the scope of this application is to gather scientific data about the urban patterns and city structures. The scholars used the method of experiment by developing a mobile application and testing it with the help of the citizens. On the contrast with Harding, who uses a hybrid research methodology, Zeile and the other scholars choose experiment because they focus on the submitted data quality. Particularly, the authors identify several problems that are relevant to the sub-mitted data on the crowdsourcing campaign. First of all, the crowdworkers are not a heterogeneous group which means that their data contribution may look alike and there is the risk of biased data. The second point of the authors is the detection of the wrong data due to GPS problems and how to delete them. On research level, the authors contribute in the crowdsourcing by identifying the problem of the homogenous data which encounters the issue of trust between the task assigner and the task participants. This also a research challenge because data accuracy in crowdsourcing has also been mentioned by previous authors such as You. Consequently, data accuracy, and trust are research challenges that should be taken into account from other scholars in order to improve the outcome of crowdsourcing.

Another application for roads condition and safety is the one discussed by Aubry and other co-authors [16]. Aubry suggests Crowd Out, a mobile

crowdsourcing service for road safety in cities. Actually, this is a mobile service which enables citizens to report on road condition, illegal parking and other traffic issues. The authors explore this application by using an experimental method through testing the app in France. The contribution of this work on crowdsourcing is the fact that the crowdsourcing data are accessible from both task designers and task participants. So, both target groups are able to review the data and suggest potential solutions to the traffic issues. The research challenges here as mentioned by the authors, are data credibility, anonymity and privacy. It is obvious that data credibility is again an important issue because the previously mentioned authors also investigate this issue.

Except the road condition, other urban matters have been discussed by Balena [17] and Barron [18]. Both authors discuss the city maintenance and the public spaces by creating a mobile application. Balena uses an experimental research methodology through the developing an internet-based mobile application and then testing it in Italy. His work is mainly a technical description of his technique with practical implications for the city's maintenance. The research challenge for Balena is that the adoption of the crowdsourcing for public spaces may be linked to the sense of belonging to a virtual community. In this respect, there is a potential hypothesis that the variable of "virtual belonging" affects positively the crowdsourcing for public spaces. Baron also uses an experimental methodology by developing a mobile platform that manages the public participation reports and enables interaction between the citizens. Baron argues that the knowledge share between the citizens and the authorities will improve their relationships. On crowdsourcing level, he focuses on the design of the platform and the usefulness of the NFC sensors to report problems to the government. The research challenge for Baron is the improvement of the analysis of the platform's data, as a tool to facilitate the logistic processes in the local government.

3.2 Environmental reporting

Stevens discusses an application which allows citizens to collect data about noise pollution by using their smartphones [19]. This is a type of environmental reporting application because the crowdsourced data are relevant to the physical environment of the humans. The specific data (noise measurements) are being shared with the community so as to create a noise map. The authors

use experiment as a method to validate their theories by developing the NoiseTube mobile platform. The authors have several worries about their re-search effort because upon the writing of the paper, the research was still in process, so the experiment was not completed. The contribution of this paper in crowdsourcing lies in the fact that it shows how crowdsourcing is being used to solve a scientific issue without complex skills as a requirement for the citizens. There are several research challenges for the authors, one of those is usability. Precisely, there are usability issues with the use of the smartphone as a data noise collector, especially when the phone is inside a pocket. The limitation of the smartphone as a crowdsourcing medium raises the issue of multimodality in crowdsourcing. It seems that mobile crowdsourcing lacks in terms of data quality unless an improved medium is chosen. The coordination of crowdsourcing is also another research challenge, which the authors discuss in their work. The scholars are in a search of a flexible subsystem that offers more freedom to the users about the place and the time of the noise collection. The third research challenge for the authors is the quality control of the data contribution and the trust towards the crowdworkers. Data accuracy and trust are also mentioned in the work of Zeile.

Indri discusses another environmental reporting application of crowdsourcing, the evaluation of the citizens' performance for the creation of an ecotourism map [20]. Specifically, Indri evaluates the characteristics of the mobile application's user interface by using structured observation as a research method. This is a research method which is mainly used for social research, so this methodology is definitely a contribution to the crowdsourcing research area because it examines crowdsourcing from a sociotechnical perspective. Indri recognizes people as a Geo-crowdsourcing sensor by taking into account usability as an aspect of crowdsourcing. Moreover, literacy skills and age are additional elements that the authors mention when discussing about the success of the crowdsourcing campaign. These skills lead to a research challenge because the authors strongly support the argument that the required education for the task participants would be a better choice than improving the design of the mobile devices. In this respect, a new research hypothesis would suggest age and education positively affect the E.R. crowdsourcing.

Another scholar, Kanhere, explores environmental reporting crowdsourcing and discusses the contribution of data from the citizen's side by using their mobile phones and the sharing of the data for

the environmental monitoring through useful statistics [21]. Kanhere adopts an exploratory methodology of research by discussing the participatory sensing applications and contributes in crowdsourcing research by raising the importance of the device's sensor. Moreover, data quality, and context of use are the initial research challenges that the authors refer to. The fact that the crowdworkers contribute data on volunteer level, it means that there is no obligation from their side to submit complete data. Moreover, the context of use during the crowdsourcing process may affect the outcome of the research because both users and mobile devices may be affected by the context such as weather conditions. Privacy and trust are additional challenges since the users are worried of their private data leaking and the task assigners are afraid of trusting volunteers that may contribute malicious data.

Wiwatwattana explores the application of the mobile crowdsourcing towards the weather forecast verification and uses the citizens as an information hub to verify the weather conditions [22]. Wiwatwattana uses a case study research methodology and contributes in crowdsourcing research because many scholars emphasize on the technology and underestimate the data verification. The scholar also discusses the data accuracy on crowdsourcing and question about how we can accept crowdsourcing data for the sake of a new trend instead of verifying their value and accuracy. So, the research challenge here is the importance of the data accuracy versus the use of an innovative medium of data collection.

3.3 Critical situation reporting

Hupfer and his co-authors who created the MoCoMapps mobile application to allow the citizens contribute data points and share the data with scientists that would create a map out of these data [23]. One of the scenarios of use is the emergency response where the citizens are called to submit critical situation reporting. The authors use the method of experiment by using and testing prototypes of the mobile application. The authors contribute on crowdsourcing research by mentioning the value of collective design in a crowdsourcing system. Collective deigning from a crowdsourcing point of view may depend on the size of the device and its special features such as screen resolution, colors, etc. However, as previously mentioned Indris underestimated these technical features [20] and argues that education overlaps the lack of the device's technical features.

In this case, the research challenge is the device's technical features as an influential factor for the design of a crowdsourcing system.

Additionally, Sweta in 2014 described a disaster management system that enables the citizens to report on the effects of a potential disaster on their location [24]. The system is a mobile critical situation reporting platform and can also be hosted at many free websites which their main subject is disaster. The authors are using experiment as a research methodology by developing and testing the mobile application. On the crowdsourcing research level, the authors focus on the successful operation of the platform with a minimal degree of literacy skills required. The usability of the platform makes it easier for the interaction between the task assigners and participants without any special technical knowledge. One of the research challenges is data accuracy. One common problem in crowdsourcing is the GPS malfunction, so the question if the GPS feature could be optional for the task participants. Another research challenge mentioned by the authors, is the role of the social media on crowdsourcing because this is a cheap and easy way to share and verify information. It would be interesting for other scholars to investigate the production cost of a crowdsourcing campaign through the social media.

Therefore, Liao explores the situation awareness in smart cities with an efficient operation of the smartphone sensors that the citizens use [25]. Liao uses experiment as a methodology by developing and testing a critical situation reporting application which assigns sensing tasks to the citizens. The contribution of the author on crowdsourcing research is the fact that with their algorithm reduces the response time in crowdsourcing tasks. According to the author the research challenges are security and privacy, especially in larger scale experiments. In this case a research for a new heuristic algorithm maybe could mitigate these risks.

3.4 Crime watch reporting

Crime watch reporting is a research area that covers the concept of monitoring activities that are relevant to a potential illegal activity. Ariffin evaluates six mobile crowdsourcing applications for crime watch based on criteria that were found important and deal with the system and its users [26]. Ariffin uses an exploratory type of research methodology by conducting a non systematic literature review. The evaluation criteria are platform centered and are not

relevant to the other elements of crowdsourcing such as task assigners and task participants. The contribution of his research in crowdsourcing is the fact that he offers an introduction to crime watch reporting crowdsourcing for the new readers. The research challenge for the author is to perform a systematic literature review, which will be used from future scholars to promote the importance of crime watch reporting and also verify his evaluation criteria of the applications.

Peuchaud uses a case study research method and researches the information obtained by social media as an alternative medium for information regarding sexual harassment incidents [27]. His main contribution on crowdsourcing is that specifies his research in a specific illegal activity: sexual harassment. So, the authorities who are interested in reducing this crime may benefit from Peuchaud's research. Criminality and other political crises are emerging issues; however, are the mobile phones always used for emergent issues reporting? It seems that the research challenge here for the author is the fact that other technologies might be also useful for crowdsourcing during an urgent situation. So, crowdsourcing research could be extended in crime watch reporting by taking into account the medium as well.

Shields explores the use of the mobile phones as a crowdsourcing tool on political crises [28]. By using a case study methodology, he supports the argument that mobile phones are extensively used for individual use but not for information contribution at political crises. Context of use on crowdsourcing level seems to be the real world problem for both Peuchard and Shields because they do not have enough empirical data to answer the question if the crowdworkers would use their mobile device during an urgent situation. In this case, the research challenge is the context of use (e.g. risky situation) for mobile crowdsourcing.

4 Conclusion

Our work has a practical value because it targets the public servants who deal with the administration and seeks opportunities to improve their work performance. Moreover, mobile services vendors and public budgeting decision makers will benefit from the paper by inspecting business potentiality for the existing areas of public administration.

The current paper discusses the mobile crowdsourcing in four different thematic areas: infrastructure maintenance, environmental reporting, critical situation reporting, and crime watch reporting. The first area is the infrastructure

maintenance which is relevant to the maintenance of the city's tangible assets. An important research challenge is the quality of the user's submitted data, since data accuracy [15] is discussed by the authors. Zeile supports the argument that wrong data are a problem which derives of the manipulated data entry by the users or a bad GPS signal. The potential risk for the decision makers of the city is the financial loss due to wrong predictions about the maintenance of the assets. Another research challenge is the lack of trust between the task assigners and the task participants [12] [14]. The citizens feel that civic engagement will lead to nowhere since they do not believe that the authorities are trustworthy entities. Another challenge is the privacy worries [16]. The testing of Aubry's mobile application about the city's traffic caused worries about the content of the photos that the task participants share.

The second application area is environmental reporting, which discusses the use of the mobile crowdsourcing in the physical environment of the citizens. Here, we find common research challenges with the infrastructure maintenance, such as trust [19] and data challenges: Data contribution [19], data quality [21], and data accuracy [22]. The data orientated challenges of environmental reporting reveals the need to improve the research in crowdsourcing, but from a data perspective. However, the new research challenges for crowdsoucing are: Usability [19] user's literacy skills [20], context of use [21]. Usability refers to the mobile phone's ability to collect data, which sometimes depends on the type of data. Literacy skills from the user's side are considered by Stevens a requirement in order to participate in crowdsourcing. Moreover, the context of use is important because the surrounding environment may affect the user's behavior towards crowdsourcing.

The third application area is the critical situation reporting where the citizens are called to report on emerging issues such as disaster events. On crowdsourcing level, the researchers comment on the design and use of their platform, including technical issues such as missing two-way communication. Hypothetically, the platform is very important in emergency situations because the crowdsourcing medium may save lives. However, most of the authors refer to previously mentioned nontechnical factors and research challenges such as education [23] [24], privacy [25] and data accuracy [24]. Consequently, in the critical situation report, there are few or no new research challenges

compared with infrastructure maintenance and environmental reporting.

The fourth application area is crime watch reporting where the citizens report on criminal incidents. This application area also deals with critical situations like the third application area; however, it discusses only incidents with a criminal nature from a legal point of view. The scholars mostly explore this research area from the crowdsourcing process perspective by considering mobile crowdsourcing a tool for the political crises [28] or an alternative medium of information [27]. The technical elements of the mediums are also discussed by Ariffin [26] and the willingness of the crowdsourcing participant to use the mobile device during a criminal incident [27] [28]. In this case the research challenges are location and the device of the crowdsourcing. The latter is a challenge which questions the nature of mobile crowdsourcing. Are mobile phones suitable for mobile crowdsourcing? What about using other mobile devices such as tablets or wearable devices?

An augmentation or a research challenge for the current paper is to move from categorizing the application areas of crowdsourcing to categorize the research challenges of the authors. An initial observation is that the research challenges are technical (mostly data orientated) and non technical such as privacy, trust, education and usability. Although, this is obvious from the screening of the papers, it is advised to follow a structured methodology for the validation of our findings. Potentially a content analysis method would detect all the research challenges and their categories based on keywords with special weight.

According to the empirical research of Morschheuser, an interesting approach to increase the motivation and participation in crowdsourcing, is the implementation of gamification [29]. Gamification refers to the implementation of game design elements in non game contexts [30] and can be an innovative concept in the public sector as well [31].

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