Implementation of Geo-Crowdsourcing Mobile Applications in e-Government of V4 Countries: A State-of-the-Art Survey

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Abstract— In recent years, citizens have become an important source of geographic information and, therefore, geo-crowdsourcing, often known as volunteered geographic information, has provided an interesting alternative to traditional mapping practices which are becoming expensive, resource-intensive and unable to capture the dynamic nature of urban environments. In order to address a gap in research literature, this paper deals with a survey conducted to assess the current state of geo-crowdsourcing, a recent phenomenon popular with people who collect geographic information using their smartphones. This article points out that there is an increasing body of knowledge of geo-crowdsourcing mobile applications in the Visegrad countries marked by the ubiquitous Internet connection and the current massive proliferation of smartphones. This article shows how geo-crowdsourcing can be used as a complement, or in some cases a replacement, to traditionally generated sources of spatial data and information in public management. It discusses the new spaces of citizen participation constructed by these geo-crowdsourcing practices.

Keywords—Citizen participation, geo-crowdsourcing, e-government, participatory mapping, mobile applications.

I. INTRODUCTION

CROWDSOURCING in local governments could be defined as the use of new technologies in order to take advantage of citizen knowledge to find solutions to municipal problems [1]. Recent development in WebGIS and the proliferation of smartphones have created new opportunities to promote citizen participation in environmental monitoring [2]. The phenomenon of taking advantage of citizens as a source of geographic information is called geo-crowdsourcing.

Recently, geo-crowdsourcing has gained a lot of attention in e-government. As a consequence, new geo-crowdsourcing applications are proposed steadily. However, surveys of geo-crowdsourcing smartphone applications are rare and they focus mainly on general description of their functioning by an example of case studies. As far as we could determine, there is no comprehensive and balanced study on the current state of existing geo-crowdsourcing smartphone applications deployed in the Visegrad countries. Therefore, the goal of this article is to review the current state of VGI as crowdsourced data for the use of geographic knowledge production in public administration in the V4 countries. By doing so, the existing geo-crowdsourcing mobile applications for reporting civic

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issues deployed in the Czech Republic, Hungary, Poland and Slovakia are discussed, and a comparison among these is provided based on criteria such as accessibility through different types of devices and operating systems, anonymity of the citizens reporting an issue, simple and user-friendly interface in terms of categorization of the issues being reported, the possibility to use a web application, and the number of municipalities that use the application. Thus, the aim of this paper is not only to assess the available literature on geo-crowdsourcing mobile applications and present a view of geo-crowdsourcing mobile applications deployed in the V4 countries, but also to provide a comparative analysis among these apps identified by literature review and on-line search.

The rest of this paper is thus organized as follows. First, we discuss the phenomenon of geo-crowdsourcing, situating it in the broader context of e-Government. Then we explain the methodology, and present the current state of the most frequently used geo-crowdsourcing mobile applications to monitor civic issues in the Visegrad countries. We end this article by discussing the growing potential of geo-crowdsourcing use in the era of big data, and opening a discussion on the challenges of geo-crowdsourcing use in public administration.

II. CROWDSOURCING GEOGRAPHIC KNOWLEDGE

A. Volunteered Geographic Information

The term volunteered geographic information (VGI) was coined in 2007 by Goodchild [3] as the harnessing of tools and technologies of broadband communication, such as Web 2.0, geographic information systems (GIS), the Global Positioning System (GPS), graphics, and the Internet, to create, assemble, and disseminate geographic data provided voluntarily by large numbers of citizens. Goodchild [3] considers these individuals as intelligent sensors, each of them an independent synthesizer and interpreter of local information, altogether creating a living sensor network. According to Sui et al. [4] the phenomenon of VGI signifies one of the most fundamental changes in the history of human mapping efforts as it profoundly transforms the way how geographic data, information, and knowledge are produced and disseminated. The point is that in contrast to the traditional top-down authoritative process of geographic data production by governmental agencies, nowadays citizens play an increasingly important role in producing all kinds of geographic data through a bottom-up crowdsourcing process.

These individuals, equipped with information-sensing mobile devices, thus represent a dramatic innovation that has a profound impact not only on the creation of maps, but also on the discipline of geography and its relationship to the general public.

B. Geo-Crowdsourcing

As citizens are increasingly becoming an important source of geographic information, there are, unsurprisingly, a variety of terms in the literature emerging from different disciplines [5]. The phenomenon of VGI is often placed in the context of neogeography [6], geographic citizen science [7], crowdsourcing geographic knowledge [8], or more frequently geo-crowdsourcing [9], [10]. Although different scholars have surfaced to describe this new trend using different terms, ranging from VGI to geo-crowdsourcing, the general idea lies in citizen involvement in geographic knowledge production through crowdsourcing.

The concept of crowdsourcing is not new. The term was coined by Howe [11] and described as a means to outsource a function, previously performed by employees, to a larger network of people in the form of an open call. The primary components of crowdsourcing are that of organization, the crowd itself, and a platform to link the two together and to provide a host for the activity throughout its lifecycle [12]. As stated by Cupido and Ophoff [13], the organization component in this context is government, the crowd component refers to citizen as a part of an online community, and the platform is the technology that plays the vital role of a facilitator.

C. Geo-Crowdsourcing Mobile Applications

Nowadays, there are platforms specifically designed for mobile crowdsourcing. Mobile devices such as smart phones, tablets, and in the nearest future also glasses and watches with integrated GPS, microphones and cameras have become ubiquitous communication and computational platforms [14]. Given the fact that by using smartphones citizens can access the Internet and run various types of applications [15], it provides a great opportunity for the development of nearly costless mobile observation networks. As stated by Fienen [16], different types of spatial and non-spatial data from different data sources can be loaded and represented in the application in a very convenient and seamless way. As soon as a user takes a photo, his/her position can be recorded automatically through GPS. Pressing a few buttons, the report will be captured with its photo category, and detail [17]. The reports can then be sent to the responsible organization in order to offer people better services in the society. Not only do these versatile gadgets allow citizens to obtain useful information through ubiquitous mobile connection but also grant them the capability to record vivid details of their lives by a variety of embedded sensors such as camera, microphone, and GPS [18]. With the help of GIS-based crowdsourcing mobile applications, it has never been so convenient for ordinary people to share the geographical knowledge about their environment with the public.

D. The Use of Geo-Crowdsourcing in e-Government

As public administrations are under pressure to do more with less, they are finding innovative ways how to fulfill their duties and tackle their municipal problems [1]. They have therefore embraced new technologies, such as for example geo-crowdsourcing mobile applications, to increase the efficiency, transparency, and quality of public services and citizen participation [1]. According to [19], [20], taking advantage of citizen knowledge, and engaging them to address complex issues, could save public money and lead to more legitimate choices. Citizens know the reality and the problems they are facing on a daily basis in their environment. They have the knowledge public administration officers can never have; not to mention the fact that geo-crowdsourcing is producing novel, and in many cases valuable, sources of geo-information [21], [22] that would not be possible to acquire in any other way. As confirmed by Haklay [23], geo-crowdsourcing is becoming especially important where there's a lack of authoritative geographic information. Adding the value of such a novel source of geographic information, there is evidence that public administration officers can use geo-crowdsourcing as a mechanism to not only supplement traditional data sources and inform the decision makers but also to build local capacity and support collaboration with the citizens.

Despite the fact that citizens´ knowledge provides a rich source of up-to-date information, the use of which can reduce the cost of the decision-making process [19], there is evidence that geo-crowdsourcing has to be considered as a complement rather than a replacement for other citizen involvement initiatives that are still necessary in public management, such as identifying problems or setting goals and objectives [20].

The use of GIS capabilities by the public together with the widespread and easy access to mobile technologies has emerged in the past decade [24], [25]. Recently, there has been an increase of crowdsourcing initiatives in the public sector [26], and the exponential growth of using geo-crowdsourcing in e-government is observed even in the Visegrad countries.

III. Methodology

In order to analyze the current state of geo-crowdsourcing mobile applications for reporting civic issues that are deployed in the Visegrad countries, we first conducted a systematic literature review. This literature review was performed using the Google Scholar, IEEEXplore, SCOPUS and Web of Science databases to identify articles relating to geo-crowdsourcing use in e-government in V4 between 2008 and 2017. Because of the number of terms describing the phenomenon of geo-crowdsourcing we decided not to restrict the literature search only to this term. In line with the goal of our research, we employed combinations of a variety of keywords subdivided into two groups: (i) terms that refer to geo-crowdsourcing based on the research of Dr. Linda See [4], for example, "volunteered geographic information", "VGI", "crowdsourcing geographic information", among others, and (ii) terms, that cover the geographic area being examined, such

as the "Visegrad countries", "V4", the "Czech Republic", "Hungary", "Poland", and "Slovakia". The keywords from each group were combined to identify articles containing one or more keywords present in each group. Our search covered the title, abstract and keywords. Through literature review we found out that there were hardly any articles dealing with geo-crowdsourcing mobile applications in the selected geographic areas. A total of 8 articles focused on the selected topic were found. These articles can be divided into two groups, one dealing with the geo-crowdsourcing application ZmapujTo deployed in the Czech Republic, the other dealing with geo-crowdsourcing applications used in Poland. No articles discussing the implementation of geo-crowdsourcing in e-government in either Hungary or Slovakia were found. A detailed list of the literature we found is shown in Table I.

TABLE I
SUMMARY OF LITERATURE ON GEO-CROWDSOURCING MOBILE APPLICATIONS DEPLOYED IN THE VISEGRAD COUNTRIES

Application	Reference
ZmapujTo (CZ)	Kubásek, M., & Hřebíček, J. (2014). Involving Citizens into Mapping of Illegal Landfills and other civic issues in the Czech Republic. [27]
ZmapujTo (CZ)	Kubásek, M., & Hřebíček, J. (2013). Crowdsource Approach for Mapping of Illegal Dumps in the Czech Republic. IJSDIR, 8, 144-157. [28]
ZmapujTo (CZ)	Brus, J., Vrkoč, J., & Kubásek, M. (2016). Design of decision support tools for the quality assessment of illegal dumping notifications based on crowd-sourced data. [29]
ZmapujTo (CZ)	Havlik, D., & Schimak, G. (2014). State and trends in mobile observation applications. [15]
Dej Tip, Lepší místo, Plznito, ZmapujTo (CZ)	Haltofová, B. (2017). The use of geocrowdsourcing to report civic issues in the Czech Republic: a comparative analysis of geocrowdsourcing mobile applications. [30]
NaprawmyTo, ESIM, Interwencje (PL)	Czepkiewicz, M. (2013). Systemy informacji geograficznej w partycypacyjnym zarządzaniu przyrodą w mieście. Zrównoważony Rozwój–Zastosowania, 4, 120. [31]
NaprawmyTo, (PL)	Henryk, G. (2015). Efektywność partycypacyjnych instrumentów zarządzania miastem. Ruch Prawniczy, Ekonomiczny i Socjologiczny, 77(1 Problemy rozwoju współczesnego miasta/Developmental issue of a contemporary city), 273-286. [32]
NaprawmyTo, (PL)	Miłosz, A., & Peek, B. (2014). Mapowanie i analiza miejsc problemowych z perspektywy rowerzystów w Krakowie. Transport Miejski i Regionalny, (9), 10-14. [33]
Warszawa 19115, Mapa Porządku Miasta Gdańska (PL)	Szelągowska, A. (2014). Miasta 2.0 we współczesnej gospodarce. Zarządzanie i Finanse, (4), 407-420. [34]

Given the fact that the analysis was only conducted until December 2016, a growing trend is possible.

Our research has indicated that the body of knowledge regarding this topic is very limited. Therefore we conducted an extensive online keyword search using the Google search engine, which we chose for its comprehensive coverage across all the V4 countries. The combination of keywords was used in the same way as in the literature review. However, more keywords were used (each translated to the Czech, Hungarian, Polish and Slovak languages), for example: the civic issues reporting application, the public participation application, and others. These searches were conducted in December 2016, and produced 23 geo-crowdsourcing mobile applications.

We admit that the results may not be exhaustive since the geo-crowdsourcing phenomenon has been studied using various terminologies. Nevertheless, we believe that our approach results are an accurate depiction of the current state of the geo-crowdsourcing mobile applications use in e-government in the V4 countries. Moreover, given the fact that the analysis was only conducted until December 2016, a growing trend is possible.

TABLE II
SUMMARY OF GEO-CROWDSOURCING MOBILE APPLICATIONS DEPLOYED IN THE VISEGRAD COUNTRIES

State	App.	Access	Anonym.	Issue Cat.	Web	N°*
CZ	ZmapujTo	Android, iOS, WP	N	Y (24)	Y	1384
CZ	DejTip	Android, iOS, WP	Y	Y (14)	Y	-
CZ	Hlášení závad Bohumín	Android	N	Y (15)	Y	1
CZ	Lepší Místo	Android, iOS, WP	N	N	Y	97
CZ	InCity	Android, iOS	Y	Y (11)	N	40
CZ	T-mapy	-	N	N	Y	12
CZ	Problem Report	Android, iOS	N	Y (7)	Y	12
CZ, HU, PL	Výmoly, Výtlky, Kátyúvadász	Android, iOS, WP	N	Y (3)	Y	-
CZ	City Monitor	Android, iOS	N	Y (5)	Y	3
SVK	City Monitor	Android, iOS	N	Y (17)	Y	41
SVK	Odkaz pre starostu	Android, iOS, W	N	Y (10)	Y	64
PL	Mapa Porządku Miasta Gdańska	Android, iOS	Y	Y (20)	Y	1
PL	NaprawmyTo	Android, iOS	Y	Y (34)	Y	14
PL	Warszawa 19115	Android, iOS	Y	Y (11)	N	1
PL	CiTTy	Android, iOS	Y	Y (35)	Y	1
PL	Legionowo Porusza!	Android	N	N	N	1
PL	ESIM	Android, iOS	Y	Y (9)	Y	1
PL	Interwencje	Android	N	Y (7)	N	1
PL	Alertownik	Android, iOS	N	Y (13)	N	4
HU	Budafok-Tétény	Android, iOS	N	Y (10)	N	1
HU	Óbuda Ügyintéző	Android, iOS, WP	N	Y (8)	N	1
HU	Járókelő	Android, iOS	N	Y (19)	Y	15

*App = application, Access = Accessibility, Issue Cat. = Categorization of reported issues, Web = Presence of web application, N° = Number of municipalities using the application, Y = yes, N = no.

Table II presents a comprehensive summary of geo-crowdsourcing mobile applications for the monitoring of civic issues deployed in the V4 countries. All the identified applications are categorized by countries and subsequently analyzed with respect to factors considered as essential to make a successful geo-crowdsourcing application. Based on

the literature review [35], these factors were considered as critical: accessibility through different types of devices and operating systems, anonymity of the reporting citizen, simple and user-friendly interface (categorization of possible issues), and a web application. In order to provide a comprehensive analysis, additional factors were observed: the number of municipalities using the application.

IV. Findings

As a result of our analysis we have identified 23 geo-crowdsourcing mobile applications. As can be observed in Table I, almost a half of these applications are deployed in the Czech Republic, while only two applications are used in Slovakia.

Based on our research, being accessible is one of the most important factors in every geo-crowdsourcing project. As stated by Sharma [36], a geo-crowdsourcing application should be easy to access. As there is a vast variety of computers and mobile devices with various operating systems, the application would therefore be more widespread if it was accessible through different types of operating systems, such as Android, iOS or Windows Phone. Each of the analyzed applications is available for Android, almost a half of the applications work on iOS, and only 7 applications are accessible on Windows Phone.

According several research projects [14], the motivation of the crowd to participate in geo-crowdsourcing projects increases if privacy of the users is respected. We can see that 14 out of the 23 identified applications allow their users to report anonymously, while 9 applications require user registration either by filling out the registration form, or by logging-in to their Facebook or Google+ accounts.

The application interface is one of the factors that have a very important impact on attracting users. Therefore, as users feel comfortable using the application, a simple and user-friendly interface leads to an increase in participation [37], [38]. To be able to make a user-friendly and intuitive interface, having friendly tools such as categorization of reported issues needs to be taken into account [39]. While an overwhelming majority of applications categorize the reported issues, the number of possible categories varies considerably from 3 to 53. Moreover, none of the analyzed applications categorize civic issues in the same way.

Offering people the possibility to report civic issues also via web applications is also very important as it helps get the citizens involved without the use of smartphones. As our results show, almost one quarter of the identified applications only run on mobile devices, not on websites.

Concerning the number of municipalities enabling their citizens to use a geo-crowdsourcing mobile application to report civic issues, we observed that geo-crowdsourcing was gaining popularity mostly in the Czech Republic where there are more than 1,500 municipalities using these applications, followed by Slovakia with more than 100 municipalities involved. The most frequently used application is "ZmapujTo" (translated as MapIt) which is used by 1,384 Czech municipalities. The interesting fact about the "ZmapujTo"

application is that it was inspired by the Slovak application "Odkaz pre starostu" (translated as Note for the Mayor), and the Hungarian application "Járókellő" (translated as Pedestrian).

The findings also suggest that while in the Czech Republic and in Slovakia, one geo-crowdsourcing mobile application is used by many municipalities, in Poland and Hungary, municipalities tend to have their own applications. This fact has consequences for the citizens willing to report civic issues, because while, for example, in Slovakia, citizens can only use one application to report civic issues in multiple cities, in Poland, citizens need to download multiple applications, each deployed by a particular municipality.

V. Discussion

The results of our research further indicate that there is one geo-crowdsourcing application ("Výmoly" in Czech, "Výtlky" in Polish, and "Kátyúvadász" in Hungarian, generally translated as Potholes) deployed in three of the four countries being analyzed. This issue relates to the more general question of whether one common geo-crowdsourcing application would be more effective and worthwhile not only within one state but possibly also across more countries. This question is undoubtedly difficult to answer but it could be a suggestion for future research.

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