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Involving Citizens into Mapping of Illegal Landfills and other civic issues in the Czech Republic

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Abstract: Today's smartphones can unlock the full potential of crowdsourcing and take eParticipation to a new level. Users are allowed to transparently contribute to complex and novel problem solving. Engagement of citizens is still challenging but the proliferation of smartphones with geolocation have made it easier than before. The paper introduces the environmental project called ZmapujTo available on the web portal www.ZmapujTo.cz. This project is primarily intended to fight illegal waste dumps in the Czech Republic. The idea is to use the potential awareness of the broader public about the environmental and economic drawbacks of illegal landfills. We developed a more efficient version of the web portal ZmapujTo using current specific information technologies, where we have extended its reporting capabilities. This new version enables reporting other civic issues, which is introduced in the paper. We also introduce "Ukliďme Česko" (Clean up the Czech Republic) which is a maiden event taking place in the Czech Republic. We explain how ZmapujTo is applied in this event and the ICT tools that are offered to volunteers and organizers for communication and management of the event.

***Keywords**:* Crowdsourcing; smartphones; illegal landfills; geolocation; web portal; GIS; mapping; human sensors

1 INTRODUCTION

Illegal waste dumping is a serious environmental concern in many countries (Brown et al., 2002; Europol, 2011; Hanfman, 2009; HCCREMS, 2013; Ichinose, Yamamoto, 2011; Kubásek, 2013; Kubásek, Hřebíček, 2013; Morita, Takagishi, 2002). These illegal dumps decrease the quality of human life in surrounding areas. Illegal dumping of garbage, discarded appliances, old barrels, used tyres, furniture, yard debris, oil, antifreeze and pesticides can threaten human health, wildlife and the environment.

Engaging citizens is challenging but due to the proliferation of personal smartphones with geolocation it is easier to develop a reporting system that can be used by every citizen. (Brown et al., 2002; HCCREMS, 2013; Kubásek, 2013; Kubásek, Hřebíček, 2013; Tasaki, et al., 2007).

Timely elimination of illegal dump sites can limit the extent and severity of the damage (soil and water contamination, hazard of fire etc.). It safeguards human health, prevents possible injuries (children, animals etc.), and discourages further uncontrollable expansion of such sites (Hanfman, 2009).

Solving these issues was the main reason for creating the ZmapujTo[1] project. The idea was to develop a simple environmental information system for all citizens of the Czech Republic as our contribution to information tools supporting eParticipation. This project was primarily intended to fight illegal waste dumps in the country.

The development of the ZmapujTo project started in the middle of 2011 and its web portal was released in the summer of 2012 (see Figure 1). At the end of the year, administrative functionalities for

[1] English equivalent of Czech words "Zmapuj To" is "Map It", available on www.ZmapujTo.cz

municipalities were added to the web portal and it was tested in pilot territories (Kubásek, 2013; Kubásek, Hřebíček, 2013). These features were fully verified by May 2013. After that we invited all Czech municipalities, city districts and other organizations responsible for disposal of illegal dump sites to use ZmapujTo.

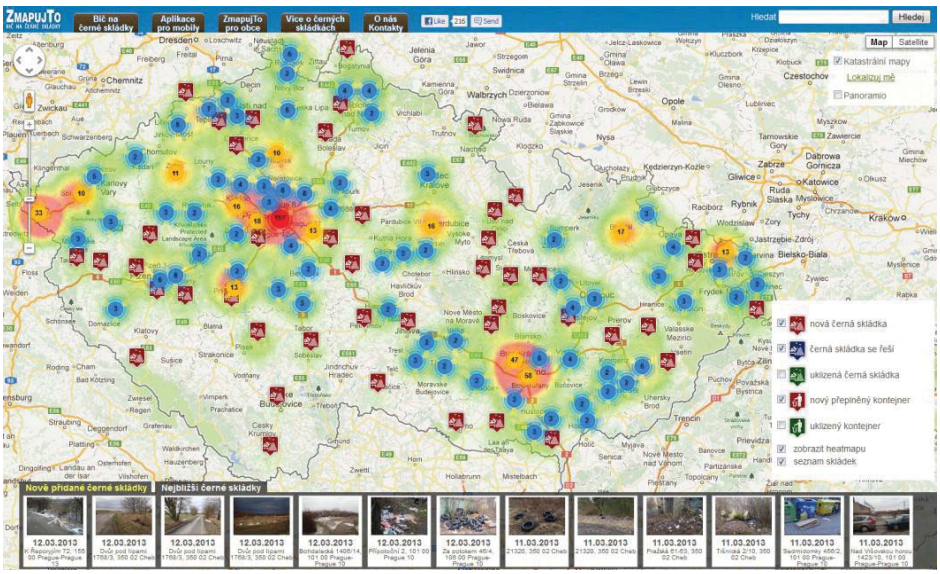

Figure 1. Web page of original version of ZmapujTo web portal (Kubásek, 2013)

The main contribution of this project is to leverage the knowledge of the broader public on the existence of illegal dump sites and their economic drawbacks. It makes efficient use of the municipality's financial resources for the disposal of landfills, helps to catch the person who started it and prevents any future relapse (Kubásek, Hřebíček, 2013) as done by (HCCREMS, 2013).

An active involvement of municipalities in the ZmapujTo project had many advantages. The authorities were able to improve the citizens' awareness so that they took into account the issue of illegal dump sites seriously and helped municipalities to saves expenses of finding new dump sites in their territory. Moreover, a timely discovery of new illegal dump sites reduced the expenses of their disposal as well. The GIS application allowed an easy surveying of the dump sites even in difficult terrains, including a map visualization and the identification of the owners. Responsible authorities could obtain maximum information about the illegal dump site without visiting this site personally.

We analyzed and evaluated the use of the first version of the web portal ZmapujTo at the end of 2013. We proposed, developed and implemented a more efficient version of this web portal. The new mobile applications have been ported to three major mobile platforms now. The main improvement of new ZmapujTo is the extension of reporting related to additonal issues, such as damaged pavement, malfunctioning street lighting, dangerous building, etc. We shall introduce this new version and the used technology in the following chapters.

In the final chapter, the event called “Ukliďme Česko” (Clean up the Czech Republic) will be introduced. This is a pioneer event and project in the Czech Republic that is to be closely connected with ZmapujTo application. We also describe ICT tools which improve communication between volunteers and organizers and simplify the management of regional cleaning events.

2 WEB PORTAL ZMAPUJTO FRAMEWORK

In this chapter we shortly explain the framework of the original Web portal ZmapujTo and introduce the technology of interactive map (see Figure 1) which enables detailed viewing of reported issues. We use several advanced GIS technologies to improve the visualization of reported illegal dumps (see Figure 2).

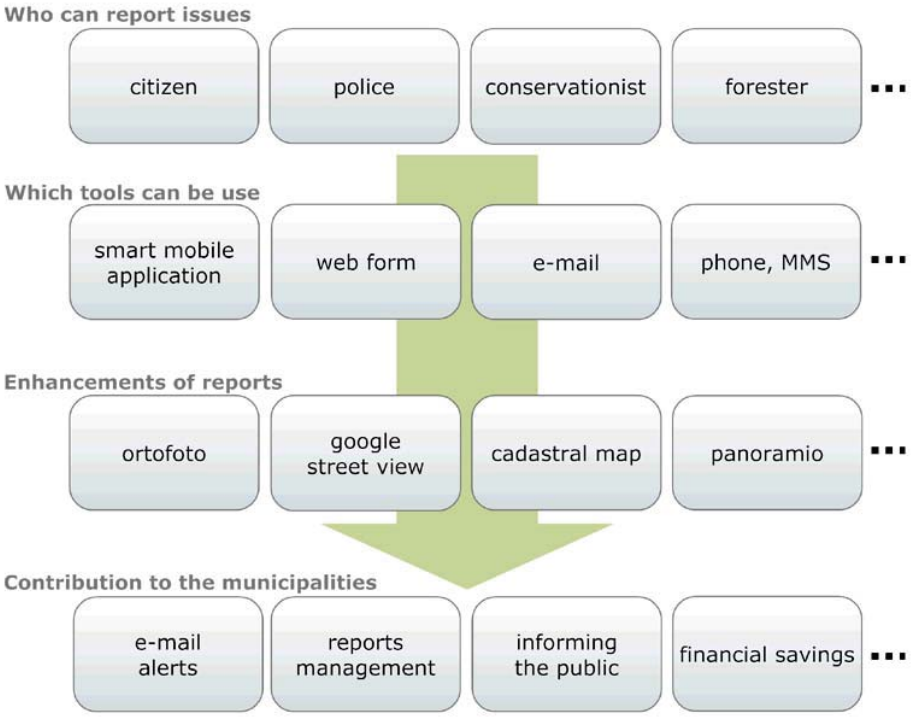

Figure 2. Framework of the project ZmapujTo (Kubásek, 2013)

The first one is the *Google Street View*[2] , which enables users to get a very detailed overview of the situation around the reported illegal dump. The Google Street View is a feature of *Google Maps* that provides 360° panoramic street-level views and allows users to view parts of selected cities and their surrounding metropolitan areas at ground level. The Google Street View displays photos that were previously taken by a camera mounted on an automobile, and can be navigated using either the arrow keys on the keyboard or by using the mouse to click on arrows displayed on the screen. Using these devices, the photos can be viewed in different sizes, from any direction, and from a variety of angles. Due to the fact that illegal dumps are mostly located near roads, we found the Google Street View as a useful tool to add a situation overview about the reported illegal dump.

The *Panoramio*[3] is the second information technology, which enables geolocation-oriented photo sharing. Its goal is to allow users to learn more about a given area by viewing the photos that other users have taken at that location.

The third information technology enables the integration of *cadastral maps* of the Czech Republic[4] to the web portal ZmapujTo. This technology can simply identify the owner of the illegal dump site and project a specific plot of this. The municipal authority can thus directly contact this owner.

The map of illegal dump sites provides a set of layers which can be explored by the users. The user can select from the menu of ZmapujTo portal, the following layers: an *ortofoto layer* (it displays satellite images), a *hybrid layer* (it displays a merger of normal and satellite views) and a *terrain layer* (it displays a physical map based on terrain information). This map can also integrate three-party map layers e.g. *Bing maps*, *Yahoo maps* or *Open Street maps* and a *heat map* (it is graphical representa-

2 http://maps.google.com/intl/cs_cz/help/maps/streetview/
3 http://www.panoramio.com/
4 http://nahlizenidokn.cuzk.cz/

tion of data where the individual values contained in a matrix are represented as colors). The heat map enables to visualize the frequency of illegal dumping in the given region.

3 NEW APPLIED TECHNOLOGIES IN ZMAPUJTO PORTAL

We gained a lot of experience using the initial version of ZmapujTo portal since 2012 and we have collected a list of opinions, proposals and criticisms. For example a lot of municipalities wanted to extend the types of reports (we had only one possibility to report illegal dumps, so they proposed to extend reports e.g. about overloaded bins). Some authorities closely cooperated with their city police department to help monitoring illegal dumps in their cities. They were interested to integrate a reporting system directly into the police information and communication systems etc.

Figure 3. Welcome page of new ZmapujTo

We agreed with users that a new version of ZmapujTo portal was necessary to develop. Main properties of this new version are: extension of report types, extensive list of mobile platforms which will allow running ZmapujTo mobile application, and improved web page to employ responsive design paradigm and enable use e.g. tablets or phones to browse and manage reported issues.

We analyzed state-of-the-art information and communication technologies (ICT) and decided to use a single page application approach of SPA[5] technology in order to improve the web portal response time and selected the AngularJS[6] JavaScript[7] framework. We also applied JavaScript language in cooperation with NodeJS[8] (JavaScript event-driven runtime) and Express[9] (the web application framework for nodeJS on the server side).
We decided to leave traditional relation databases and used document base NoSQL[10] database MongoDB[11] to store the data. This is a document-oriented database which enables easier development and is ready for possible scaling.

5 http://en.wikipedia.org/wiki/Single-page_application
6 http://angularjs.org/
7 http://en.wikipedia.org/wiki/JavaScript
8 http://nodejs.org/
9 http://expressjs.com/
10 http://en.wikipedia.org/wiki/NoSQL
11 https://www.mongodb.org/

We selected the DigitalOcean[12] platform for hosting (it offers SSD cloud servers from $5 per month). We have reached response delay under 70 ms on user frontend events (e.g. map zoom, filter apply) with the selected ICTs.

We also developed the new mobile application with Sencha Touch[13] HTML5 framework and ported it to Android, iOS and Windows Phone devices through Apache Cordova[14].

4 EFFICIENT REPORT MANAGEMENT IN ZMAPUJTO

The key issue of the ZmapujTo reporting system is the communication with municipal authorities. In the new ZmapujTo portal, the responsible municipality will receive information about the reported issue by e-mail. Municipal authorities have two possibilities to solve this event:

1. Either to answer directly to this email with response. Mostly it is information on whether they are aware of this issue or not. These responses are automatically processed and the content of these response e-mails are inserted directly to the record list of specific events;

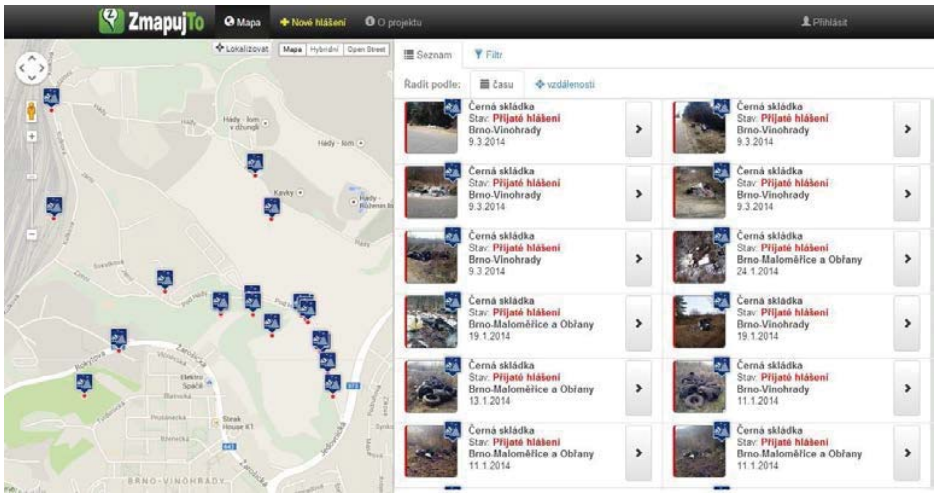

Figure 4. Reports management and interactive map

2. Or to log-in into ZmapujTo web portal and process the report directly in its administration interface (Figure 4). The aim of this application is to provide a simple tool, which will give to the authorities actual information about reported issues in their district. The administrator of the municipality assigned to a specific issue can change its status – e.g. when they are preparing to solve this issue, change location of this issue and leave comments as well. The administrator can also use the statistics of the district and a widget, which can be placed on the municipality web site and thus inform the visitors of the web site that the municipality is involved in the project, and how many issues have been reported and solved.

Currently, 250 municipalities and institutions from the entire Czech Republic are involved andhave access to ZmapujTo administration. The rest of the municipalities are informed via e-mails.

5 VOLUNTARY EVENT

This year,and for the first time, an event called “Ukliďme Česko” (Clean up the Czech Republic) takes place in the Czech Republic . It is inspired by past events from abroad (e.g. “Let’s do it!”[15]), and hopes

[12] https://www.digitalocean.com/
[13] http://www.sencha.com/products/touch
[14] http://cordova.apache.org/

to address the continued lack of success in cleaning the dumps. The main goals are to warn and inform the public about the problems of illegal dumps and subsequently clean them up with the help of volunteers in a manner similar to (HCCREMS, 2013). The cleaning is scheduled for 16th and 17th May (Figure 5).

This cleaning event collaborates closely with the ZmapujTo project and uses its platform for mapping and registration of illegal dumps. The event is driven by volunteers, municipalities and non-governmental organizations.

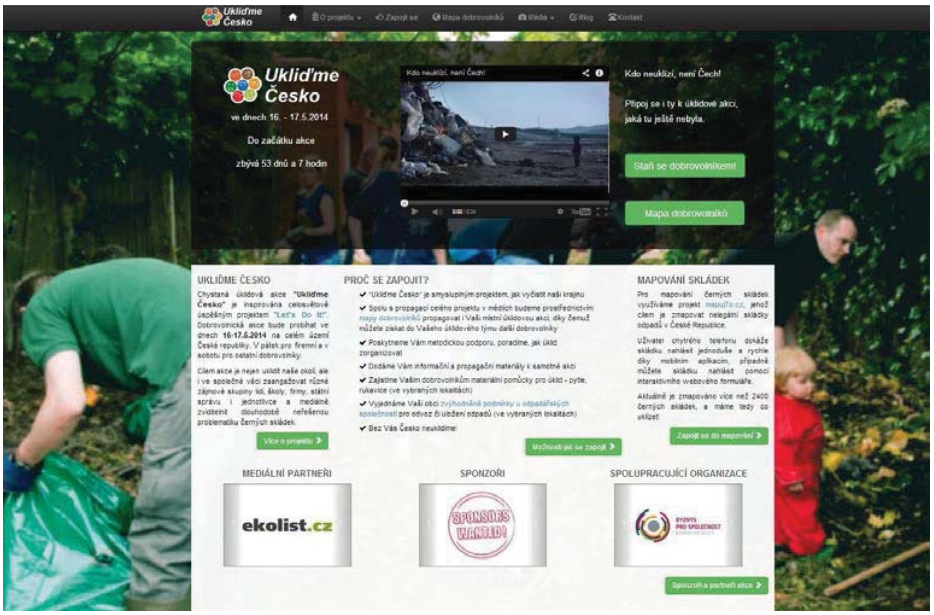

Figure 5. Web page of cleaning event

“Uklidme Česko” participants are going to be divided into groups, with having at least one organizer per group. The organizer is responsible for arranging group meetings in order to discuss various issues regarding the event. The entire group, including the organizers, take part in thecleaning during the event. A web portal (http://mapa.uklidmecesko.cz/#!/mapa) has been set up to keep track of the participants. It includes a map of the Czech Republic (based on Google Maps) and a registration form (Figure 6).

A potential volunteer can use an interactive map on the web portal to learn how to register him. Dark-colored points are drawn on the map to show all the registration points. Each of these points contains information about the number of registered participants (organizers and volunteers separately) in a particular location. Therefore one can check whether there is any organized group already present in his place of interest or whether it is necessary to establish a new one.

Those interested persons can register to one particular point at any part of a city or a village. The enrollment can be performed as “*organizer – municipality*”, “*organizer – private person*” or “*volunteer*” using the respective forms on the web portal. Thanks to the registration in this information system, organizers gain access (password required) to their account created directly on the web portal. Each organizer can set a number of volunteers, choose a meeting point and an cleaning area. This organizer’s account also mediates communication with associated volunteers and with other organizers, for example from their neighborhoods. Candidates for volunteering are able to see the organizer’s name (or organization they are registered under) in this web application.

[15] http://www.letsdoitworld.org/

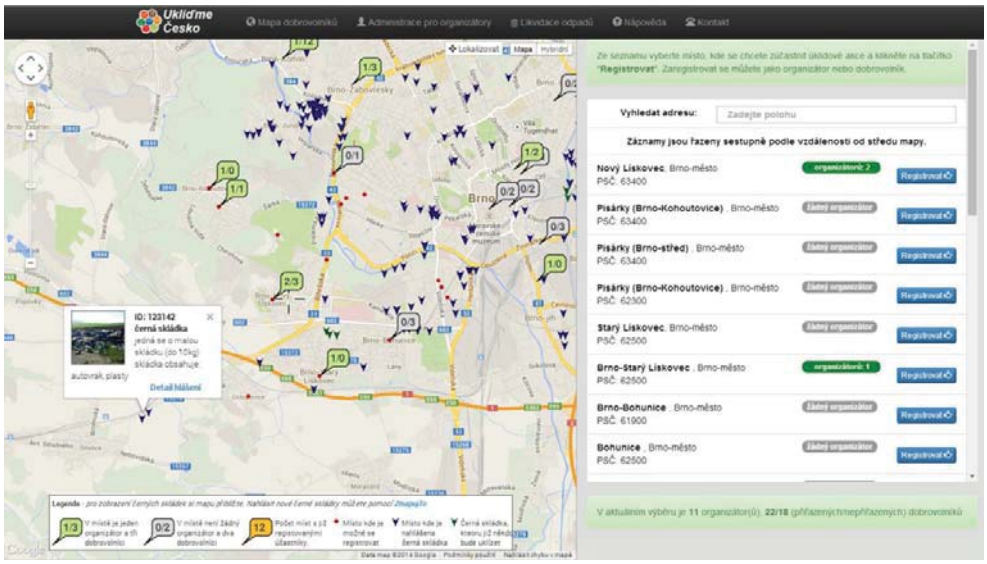

Figure 6. Interactive map of volunteers integrated with illegal dumps from ZmapujTo

5 CONCLUSION

The ZmapujTo.cz project for mapping illegal dump sites was started in mid 2011 as an eParticipation project and became the most popular environmental project in the Czech Republic. It fulfills its aim to inform the public of the Czech Republic about the dangers related to illegal dump sites, motivates the public to report them, and offers municipalities and other organizations a tool for administration of these reports.

We followed various feedbacks collected from users and developed a new version of ZmapujTo web portal with state-of-the-art information technologies. Extension of report types and automatic communication with all municipal authorities in the Czech Republic are its main benefits. The user-friendliness has been improved by using up-to-date and more efficient technologies.

Following the international 'Let's do it!' project, we are organizing a voluntary event called "Clean up the Czech Republic ". We want to involve more inhabitants into monitoring illegal dumps issue as voluntary "human sensors". They can take advantage of the ZmapujTo mobile application and web portal to do so. The web portal for the event enables people to join the project as organizers or volunteers and mediate communication among them. It also serves as an information source about the number of participants in particular areas of the Czech Republic.

Currently we are three weeks away from the start of the cleaning event and we have already registered 250 organizers from the whole country. Based on feedback from the organizers who used the interactive map of volunteers, we can already state that the system fulfills its purpose.

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