Smart Solution for a Smart City: Using Open Source Maps in Municipal Waste Management

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Abstract. E-Government as an approach using smart technologies, has been analyzed in recent decades not only at the (inter)national level, but also at regional or municipal level. Electronic access to information and services provided by public administrations begins (and in many cases ends) at the level of municipalities, which should provide the widest possible range of their e-services to increase the quality of life of their citizens. In addition to traditional e-services in the form of providing information about municipal activities or processing documents, many municipalities in the Czech Republic also try to provide their citizens with e-Government in the field of cultural, social, and environmental, including the issue of waste management. The aim of this paper was to create an application for the inhabitants of one Czech municipality – the statutory city of Karvina, that will allow them to find out very quickly and easily where the containers for separated waste are located in their vicinity. Through the Joomla content management system, the website was created, the main element of which is a map supplement. On this map, there are marked container stations where, in addition to containers for municipal waste, paper, glass, and plastic, containers for metal, textiles, oils or electrical waste can be found.

Keywords: Content management system · E-government · Maps · Municipal waste management · Opensource · Smart city

1 Introduction

Municipal authorities increasingly choose to establish their online presence, by using technological management solutions, which ensure that the information they have, the content they produce and the services they provide are promptly available to citizens and businesses. This strategy of using information technologies in public administration at the national, regional and local level to improve the quality of services that governments provide to citizens and businesses is known as e-Government [1]. This e-Government agenda remains one of the most important innovation drives facing the public administrations of the 21st century [2].

Within this, the European Commission encourages and leverages the transformative, innovative, and collaborative potential of open source within its open source software

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strategy 2020–2023. This strategy puts a special emphasis on the sharing and reuse of software solutions, knowledge and expertise, as well as on increasing the use of open source in information technologies and other strategic areas [3]. Based on this approach, many municipal public administrations have adopted Open source Content Management Systems (CMS) for their websites, greatly reducing operating costs and ensuring scalability, advanced performance, and privacy to the users. CMSs represent one of the most powerful online content management tools today, by allowing one to create a web page in a short time, control who has access to information and who creates, alters, and stores content on the platform [4]. One of the most intuitive and versatile CMS's on the market is Joomla, used also by international and national organizations such as Harvard University, IKEA, Lipton, Danone, Porsche, or Peugeot [5].

The possibilities of using CMS based on open source software (OSS), such as the mentioned Joomla, are many in public administration; one of these areas is municipal waste management. In the last decades, waste represents difficult problems and requires the integration of various processes and measures into an intelligent (smart) and comprehensive plan [6]. Some major classes of waste include municipal, hazardous, industrial, medical, universal, construction and demolition, radioactive, mining, and agricultural [7]. Municipal waste consists mainly of waste generated by households, although it also includes similar waste from sources such as shops, offices and public institutions [8]. It is extremely heterogenous and includes durable, non-durable, packaging, and containers, food waste, yard wastes, and miscellaneous inorganic wastes [7]. Totals of European municipal waste generation vary considerably, ranging from 282 kg per capita in Romania to 845 kg per capita in Denmark [8]. Variations reflect differences in consumption patterns and economic wealth, but also depend on how municipal waste is collected and managed [9]. The waste should be collected, separated, stored, transported, transferred, processed, and treated; the administration of which is the main objective of municipal waste management [10]. Waste management is a rapidly developing area of the national, regional, and local economy [11]. The Czech Republic has been also done quite a significant move forward in waste management from its accession to the European Union (2004), among other things in the area of supplied e-services to its citizens.

In view of the above, it was the intention of the authors of this paper to create an application for the citizens of one municipality in the Czech Republic, the Statutory city of Karvina in the Moravian-Silesian region. This will allow inhabitants to find out very quickly and easily where the containers for separated municipal waste are located in their vicinity. Through Joomla CMS, a website was created, the main element of which is a map supplement. On this map, there are marked container stations where, in addition to containers for municipal waste, paper, glass, and plastic, containers for metal, textiles, oils or electrical waste can be found.

Motivation to write this paper went hand in hand with its objective and was to promote the use of open source software at the municipal level. The creation of one from many possible websites can bring the benefits of local e-Government and its services closer to their citizens. Thus, they can actively and intuitively use the created map in the field of waste management. The result of this paper also became the inspiration and basis for the creation of other city websites in the leisure area.

This paper is organized as follows. Section 2 describes the state of knowledge in the field of e-Government in relation with municipal waste management. Examples of the use of open source software in domestic and foreign public administration are given in Sect. 3. The fourth part describes the creation of the map supplement itself and the next section presents the result - an interactive map of container sites. The last sixth part of the paper is a summary of the solved issue.

2 Current State of Knowledge

Smart e-Government is a rising conception that refers to developing Information and Communications Technologies (ICTs) in public sectors in order to achieve administrative efficiency [12], service improvement, and citizen centricity [13]. ICTs have become an essential tool for public and private organizations that make significant investments to support their activities. In the case of public administration from the mid-90´s, governments have started using ICT especially the Internet to provide better services to citizens. E-Government combines the intensive use of ICT with forms of management, planning and management, aimed at creating a more efficient and effective public sector to meet the needs of citizens optimally, by developing new electronic services (e-Services) [14]. Naser and Concha [15] claimed that e-Government is a tool of enormous potential in terms of public administration and democratic management. The e-Government bases its application in public administration, having as purpose to contribute to the use of ICT for the following: i) improving services and the availability of information, ii) improving and simplifying the processes of institutional support, and iii) facilitate the establishment of communication channels, which can increase transparency and citizen participation.

Przeybilovicz et al. [16] investigated the characteristics of the infrastructure and use of information and communication technologies of Brazilian municipalities reflecting on the possibility of developing e-Government and smart cities actions. The authors used the quantitative study of cluster analysis and identified four clusters: the technology-less, the concerned-on citizen, the concerned-on legislation, and the ICT supported. Although information technology has become one of the core elements of managerial reform and electronic government may figure prominently in future governance, there are some barriers and legal issues to the progress of municipal e-Government. Moon [17], in his study of US municipalities, identified widely shared barriers as a lack of financial, technical, and the privacy personnel capacities and legal issue. This study also indicates that the size of the city and manager-council government are positively associated with the adoption of a municipal Web site, as well as its longevity.

Zhang and Zhu [18] collected responses from more than thousands of urban and rural residents in China (Chongqing Municipality). Using a structural equation model, they obtained the result showing differences between use of e-Government within urban and rural groups as well as providing the e-services to them. Similarly, Bayona and Morales [19] studied the provision of e-services in small cities that belong to a small province of Ecuador. The results show that there is a difference between the e-services that offer the municipalities with different sizes, and it is necessary to improve them. According to Urs [20], most public services in Romania are provided by local public institutions, especially city halls. E-Government development is not a priority at central level, and

that essential national technological infrastructure is underdeveloped or nonexistent. Due to these shortcomings, even online services that work well in a local context will be difficult to replicate or integrate at the country level.

As significant determinants for successful development of electronic government initiatives at a municipal level, the importance of the infrastructure, the political capital of the mayor and the financial independence of the municipality was identified. Gonzalez-Bustamante et al. [21] analyzed the above level of electronic government and its determinants in the 188 municipalities of the five most densely populated regions in Chile. The factors analyzed are related to the dimensions distinguished by theory as necessary for the implementation of strategies of electronic government.

Another work has been implemented to simplify and improve co-existence between government and citizens. Bayona and Morales [19] presented a preliminary comparison of local e-government maturity levels between municipalities in some countries in Latin America. Successful models show significant progress in terms of citizen satisfaction, reduced bureaucratic attitudes in public institutions, and a significant saving of resources. Bernhard et al. [22] investigated the relationship between the degree of government in Swedish municipalities and perceived satisfaction among citizens in general. Using a large-scale quantitative study, these results were shown: There is a relationship between the degree of digitalization in a municipality and the perceived satisfaction among its citizens. Furthermore, this relationship is in parity with or even stronger than the relationship between citizen satisfaction and other crucial factors, such as educational level or median income. Similar results have been described by Budding et al. [23]. According to these authors, electronic service delivery has become an important issue in many municipalities, and using the Internet for service delivery is seen as an important element of municipal e-government in the Netherlands. They ascertained the strong relationship of municipal e-government adoption with demographic characteristics, such as population, population density, and both older age and younger age groups. In contrast, they did not find an influence of education and income.

Governments around the world are increasingly relying on information technology, in particular the Internet, as a mean of communication with their citizens. Rooks et al. [24] stated, that the use of government websites is one of the fastest growing activities on the Internet. This set of technological processes is trying to change both the provision of public services such as the scope of interactions between citizens and the government [25]. The use of the Internet has allowed to overcome many of the technical barriers that impede smooth relations between citizens and the municipal public administration, allowing the disclosure of more detailed information, the increase in frequency and timeliness of the information provided, and decreasing costs of printing and distribution of information [26]. The adoption of e-Government is the result of the high degree of computer use and the growing number of people and organizations with access to the broadband Internet [27]. With the Internet, citizens are looking for more information about what is going on in their cities and are looking for more ways to hold their government representatives accountable. One of the best ways to provide transparency and make it easier for citizens to obtain the city services they require is to become an "open source city". An open source city is one that uses a variety of new tools, including apps, to make information available to citizens and interact with them as well [28].

3 Use of OSS and CMS in Foreign and Domestic Public Administration

The European society as a whole will benefit from the adoption of and OSS in the public sector: the citizen will not be required to buy proprietary software for accessing the information and services provided by the public administration. That, in turn, will increase the accessibility of public services. Public administration will increase trust and confidence by using recognized, transparent, and secure technologies [29].

3.1 Open Source in Public Administration

Thanks to the features of open source software, its use is associated with several advantages not only in the private sphere, but also especially in the public sphere [30]. The most obvious positive is the reduction of financial costs; OSS is available free of charge and thus eliminates the costs associated with the purchase of proprietary software and licenses to use it. Another advantage is the reduction of the risk of vendor lock-in. Related to this, the existence of open formats guarantees maximum compatibility and interconnectivity of systems, especially within e-Government, which is based on mutual reading and data exchange. It is the opposite of proprietary software, where each producer can come up with their own formats, making it impossible for other users who do not have their software to open these files. Significant benefits can also be observed in terms of quality and safety. Due to the openness of the OSS code, the institutions concerned may be able to examine it and check that the software is properly programmed for stability or security vulnerabilities. At the same time, thanks to the openness of the code, they can make any changes and adapt it to the needs of a particular institution.

The advantages of open source are used by public institutions both abroad and in the Czech Republic. One of the most well-known users of OSS in the public sector is the municipality of Munich. It started a plan to migrate to OSS in 2003 with the aim of finishing the migration of all its 14.000 workstations by the end of 2012 [29]. The municipality calculated that the current cost of its migration project is 11.7 million euros, while upgrading to a comparable environment based on Microsoft Windows and Office would have required 15.52 million, excluding costs of 2.8 million euros for license fees for upgrades recurring every three to four years for a Microsoft infrastructure [31]. OSS has been used by the French state police since 2005. Specifically, it was initially a transition from the Microsoft Office suite to OpenOffice. However, the transfer from Microsoft Explorer to Mozzila Firefox and the transfer of the mail client from Microsoft Outlook to Thunderbird gradually took place. In the last phase of moving to OSS, almost a hundred thousand computers were running the Ubuntu operating system, which is one of the many available Linux distributions. The total financial savings associated with the purchase of licenses were estimated at almost 50 million euros in the first five years since migration [32]. The Lithuanian police, which as the police in France, gradually switched from the MS Office package to LibreOffice and subsequently from the Windows operating system to the Ubuntu system, is also an almost identical case. The transfer involved a total of 8,000 computers [30]. An interesting example is the situation in Bulgaria, where the government passed a law in 2016 that stipulates that all new software acquired for government purposes must be open source basis [33]. In the

United States, a website has been set up that requires the source code of at least 20% of newly developed and deployed software within government agencies and institutions. The goal is to increase the reusability of existing software solutions and reduce duplicate software purchases. At the same time, this should lead to more innovation in government software. Financial savings are also significant: Federal IT savings could reach 3.7 billion US dollars from open source [34]. Since 2017, the public authorities in the capital of Albania have also switched to LibreOffice. Therefore, the Tirana authorities want to make the services more accessible to the population and, at the same time ensure the availability of their data and systems in the future. Migration affects about a thousand computers [35].

There are also numerous open source solutions available in public administration in the Czech Republic [30]. For example, the Czech POINT system itself uses SUSE Linux Enterprise Server for server operating systems and the open source Zabbix tool is used to monitor system operation. Many other departments of the Ministry of the Interior also use OSS for their systems. The Central Information Systems Department uses Linux operating systems, Firebird and Postgres databases, and Python and Java programming languages. The Department of the Chief Architect of e-Government manages the National Open Data Catalog, which is based exclusively on open source technologies and open standards; it uses the Ubuntu operating system, the Apache Solr search tool, the Nginx web server, and more. The Open Data Portal itself is created using the GitHub platform, which offers free hosting for open-source projects. On the portal you can find, for example, city plans, 3D building models, green passports, and many other documents. Open source tools are also used within the Czech Telecommunication Office; these include Debian, Apache, and Nginx web servers, PostgreSQL databases, Zabbix traffic monitoring and more. The pioneer of municipal use of OSS in the Czech Republic is the municipality of Grygov, where open source is used almost everywhere since 2006. Using open source has helped to reduce IT costs, and moreover, it allows Grygov to offer reliable and innovative e-government services [36].

Within the Czech Republic, there are also several initiatives aimed at promoting open-source technologies in public administration. One of them is the Open-Source Alliance, which was established to create optimal conditions for the use of open-source products in the field of government. Further, the NGO Open Cities, with seventeen municipalities as members, strives for maximum openness to their citizens and achieve this using various open source tools. Several projects have already been or are being set up within it: a solution for submitting applications for municipal subsidies and their administration, a tool for displaying the results of local council voting, or a modifiable template for creating city pages based on the WordPress content management system.

3.2 Content Management System in Public Administration

Most content management systems, which create and manage content on the Web, also operate on an open source basis. Currently, the CMS's represent one of the management technologies that best responds to this public administration needs, by representing a system that incorporates a whole panoply of tools that extend from the Web page to the most varied applications of content management [4]. Specifically, in public administration, content management promotes a substantial increase in flexibility through remote

and updated network access, as well as more selective control of which metadata should be used to steer information rightly, rules that regulate access, search possibilities, and the integration of different information systems [37].

The advantage of these solutions is their simple installation and management. These are basically web page interfaces and templates that are already pre-created and available as soon as they are installed. This eliminates the need to create the own pages from scratch. After installing the CMS, it is possible to get universal websites that can be further customized through templates or by installing add-ons. Web administration is handled by a simple interface, as well as content editing and publishing. Webmasters and content creators may not have a knowledge of the HTML, CSS, PHP, or Javascript languages commonly used when working with websites.

Choosing a specific CMS is possible from dozens of different options, where the OSS-based operation allows to be downloaded and tested for free. The most widely used CMS in the world is WordPress. Its share of the CMS market is around 65% [38]. According to statistics, WordPress is used on a third of websites on the Internet. Second is Shopify (less than 7%), followed by Wix (3.3%) and Squarespace (less than 3%). Joomla is in fifth place with a share of about 2.5% now (a decrease from second place since 2020), but it was the market leader until WordPress came along. The mass popularity of blogs has caused less interest in systems other than WordPress. However, other CMS still use a large number of websites around the world. In the case of Joomla, there are almost two million websites. Here, the installation, administration, and creation of content is very simple and can be done even by a person without experience with the operation of the website. Unlike WordPress, which is focused on creating blogs, Joomla is also suitable for more complex websites. The advantage is also a lower risk of hacker attacks, which focus more on the more widespread WordPress. Other positions within the CMS market are Drupal (1.9%), Adobe Systems (1.6%), Google Systems (1.5%) or Bitrix (1.2%).

Regarding the practical use by CMS, the study of Louraço and Marques [4] aims to analyze the acceptance of CMSs by professionals from municipalities belonging to the Comunidade Intermunicipal da Lezíria do Tejo. WordPress is used by the official Swedish website or the White House website. Destefanis et al. [39] showed that the number of Italian public administrations that use Open Source CMS is increasing about 5% per year. Joomla was used in more than half of municipalities in 2012. Joomla is a key CSM tool for the design of municipal websites of the MuNet program that the Organization of American States has implemented in several countries of Latin America, specifically the municipalities of Patzún (Guatemela), David or San Miguelito in Panama are examples [40].

4 Problem Solving

For the implementation of OSS has been selected one Czech municipality (Statutory city of Karvina), which is trying to digitize its public administration and introduce smart elements within the framework of improving its municipal e-Government. The solved issue was focused on the area of waste management, namely providing e-services in the field of waste containers. This was selected based on a survey of the city's website, where sufficient user-friendly and clear information were absent.

4.1 The Study Area and Open Source Tool

The Statutory city of Karvina, located in the border Moravian-Silesian Region on the territory of historic Teschen Silesia, was chosen to implement the open source tool. It is a city with a strong spa and mining tradition dating back to the late 18th century. At the same time, a university, namely the School of Business Administration of the Silesian University in Opava, is located here. The city of Karvina is divided into nine city districts and has approximately 52,000 inhabitants, not only Czech but also Polish and Slovak origin.

As the city presents itself as a municipality in which smart elements are being introduced, including the expansion of digitization and e-Government, its website has been explored and ascertained that in some areas (maps of parks, sports grounds, playgrounds or waste containers) the introduction of "smart" elements is at a very low level. Therefore, the area of waste management was chosen, because the information on the location of containers for separated waste was only given in the form of tables with given street addresses. One possible way to expand or improve the presentation of this information was to show the location of individual containers using the interactive maps based on open source.

In the city Karvina, there are 274 container sites. There are usually one to six containers for municipal waste and one to three containers for plastics, paper, and glass in the designated places. Individual containers for bio-waste, metals, textiles, small electronics, and used respirators can also be found at several selected places. Larger kitchen appliances, consumer electronics, cooling systems, garden tools, and implements are then taken by the residents to the collection yard, or they have a high-volume container delivered for a fee. Since 1965, the company Technical Services Karvina has been taking care of the collection, transport, and disposal of waste in the city, as well as the operation of the collection yard.

To create a website, it was most appropriate to use an open source CMS. With its help, it is easy and without the necessary financial investment to create a website that will meet the requirements for an information website about containers, i.e. the presence of a map supplement.

For the purposes of this paper, Joomla CMS was chosen as a proven tool for creating and managing websites. This tool is the most suitable for the purpose of creating a website of waste management, the main part of which is a map of container sites. Joomla offers a relatively large number of different map accessories, which are usually available for free. Another reason to choose this system is the user interface for web administration. It is clear, friendly, and improves with each new version of the system. Web administration can be performed from a computer, but also from a mobile phone or tablet. At the same time, most of the available templates are responsive, so the web view adapts to the screen dimensions of the device on which the web is browsing. The look of the site can be changed in a few steps, as well as adding the additional features such as maps, galleries, discussions, and more [41]. Other Joomla features include content approval for subsequent publication, user group management, content publishing scheduling, automatic web content search, banner management, add-on installation support, or multilingual support.

4.2 Process of Installation

Before the installation and subsequent use of the content management system, it was necessary to ensure that several requirements were met. The so-called hosting is necessary for the operation of the content management system, which is a virtual space on a web server on which the created web pages are placed. In the case of Joomla, hosting is required to support the PHP scripting language in which Joomla is written. In addition, MySQL database support is required for data storage purposes. Another requirement is the use of an open source Apache Web server, which processes PHP instructions to work with the database and for displaying web pages. The last requirement is support for XML and a software library for data compression called *zlib* [41].

There are several ways to get web hosting that meets the above requirements. The first way is to use the web hosting services of a specialized company. This eliminates the need for customers to install it by themselves, and, conversely, they can use the functions for automatic system installation, or rent hosting with an already pre-installed CMS. The second option is to have own web server. However, this is a rather demanding solution, which is why companies or organizations often resort to renting web hosting services that provide all the operational issues. Another way to use Joomla CMS is the possibility of the cloud. On the official Joomla website, it is possible to create a fully functional website for free using a cloud platform. The last variant for Joomla installation and operation is the so-called local installation, where Joomla is installed directly on a personal computer. This variant is suitable for creating and testing a website. For our purposes, this last method of content management system installation was chosen, and after testing and launching online was transferred to the web hosting form.

Before the CMS installation itself, it was necessary to install a server application on the computer; the XAMPP software package was used for this purpose. It contains the OSS, which is necessary for creation of a local web server (Apache server application, MariaDB database, and PHP scripting language). In addition to these parts, the MySQL database and phpMyAdmin to work with the database were needed to install. In the next step, the installation location was selected, and then the installation itself was performed. The next step before installing the content management system was to create a database called *joomladb*, in which the website data will be stored, using the phpMyAdmin utility, as a part of the XAMPP package.

The installation of the Joomla CMS itself took place in three steps - filling in the site name and login details for the administrator; setting up the database (type, host name, username, and password); and last but not least, a summary of the settings using templates. Finally, to complete the installation and gain access to the site, it was necessary to delete the installation folder, which is a security feature.

4.3 Selection of the Map Supplement, Customization and Allocation of Website

After the CMS was installed, it was possible to start creating an application. The main component of the generated waste management page is a map with the location of container sites. Basically, the Joomla system does not contain an add-on for embedding maps on the web, so it was necessary to add this feature additionally. Total of 7,619 of these features are available and include extensions for uploading photo galleries

and presentations, supporting social networks, writing and publishing articles, as well as extensions that do not relate to web content. These are various modules for web administration, traffic analysis, web navigation, or security management.

Dozens of different maps embedding add-ons can be found in the Maps and Weather extension tab, the most suitable of which are listed in Table 1. The main criterion for selecting this add-on is whether it uses Google Maps or OpenStreetMap to render the map. Using Google Maps and exceeding the monthly limit of possible map loads, the service is charged. On contrary, using OpenStreetMap is completely free. Other criteria taken into account by choosing a map add-on, include the possibility of customizing map markers, the presence of a manual or documentation, or language support for the add-on.

Table 1. Comparison of the map supplement.

Title of supplement	Free	Support of OpenStreetMap	Manual	Support of Czech language
My Maps Location	No	Yes	Yes	No
Hotspots Pro	No	No	Yes	No
GMapFP	Yes	No	Yes	No
Phoca Maps	Yes	Yes	Yes	Yes
Phoca Maps	Yes	No	Yes	No

Among the twenty most used map add-ons, there are only two that use OpenStreetMap, the others are focused only on Google Maps. Of these two supplements, one is paid and one is available for free. The paid add-on My Maps Location from JoomUnited developers offers a module with options for customizing the appearance and layout of the map, a sophisticated search system. The second add-on is Phoca Maps (made by Czech developer Jan Pavelka). Unlike My Maps Location, it is available for free. It is a simpler add-on in terms of a number of different customization options, settings, and functions, but it is sufficient for the needs of the application. Its interface is clear, the advantage is also the presence of the Czech localization. To install add-ons, content creation, graphic design of the website, and other activities, it is necessary to access the website from the position of administrator.

The next step was to create a map in which container station markers were later inserted, using the forms. Maps can be created with this add-on and can be used at the same time, each with its own settings and custom markers. Creating a map involved specifying its name, initial coordinates, zoom level, dimensions, and description. The last step before placing the map on the website, was to create map markers that will indicate the location of the container sites.

During the installation of the CMS, a basic template with a preset appearance and structure of the pages was set. The form (Logo) allowed to insert an image into the site header. The last step in creating the site was to insert the map plugin itself.

At the time when the website was created, it had to be placed on the internet to make it available to visitors online. Therefore, it was necessary to transfer it from the local server to the actual online hosting. For the selected free hosting (Endora), a third-order domain was used, and the address of the website was used: containerykarvina.tode.cz. Further, it was necessary to pack the folder with the content management system files in a zip file. Then the created database was exported, a zip file with a prepared content management system was uploaded to the Endora website, unpacked, and a new database was created. The database server address had to be rewritten to the Endora server address (received after domain registration) and saved. After that, the whole process of moving the website from the local server to online hosting was completed, and the finished website was made available.

5 Result: Final Website

The result of all steps discussed in the previous section, was the creation of an application based on the Joomla content management system with a map complement of container sites. The intention was to support the smart municipal waste management of



Fig. 1. Final web site with the map (maps of containers).

the Statutory City of Karvina using the e-map of containers. The map shows the container locations where, in addition to containers for municipal, paper, glass and plastic waste, containers for metal, textile, oil or electrical waste can be also found (see Fig. 1).

By clicking on a specific brand, the details of the brand with the name of the site will be opened, namely address and quantity of each container (see Fig. 2). There can be found the name of the street with the house number and the kinds of containers - if they are available (and how many) or not. The map also includes links to the pages of the Department of Municipal Services and to the pages of Karvina Technical Services, in case of need to contact the institution.



Fig. 2. Map details (Notes: V Aleji 722 – name of the street with the house number, Kom. odpad – municipal waste, BIO – bio waste, plasty – plastic waste, sklo – glass waste, papír – paper waste, kov – metal waste, textile – textile waste, elektro – electrical waste).

6 Conclusions and Discussion

E-Government also usually represents an alternative instrument that offers new means or methods of work for those who can and/or want to use them, although it is apparent that more duties are prescribed for public administration and businesses rather than for citizens [42].

The potential of open source solutions used in public administration is considerable, not only can it bring big financial savings, but thanks to the use of open formats it will also ensure better interconnectivity of various e-government systems and better availability of services for citizens. Thanks to the openness of the source code of open source software, public administration institutions can then check the quality and level of security of individual tools as well as make any adjustments to their own needs.

Based on the stated objective of this paper, the use of open source tools within smart solutions in public administration (namely waste management) of the statutory city of Karvina, the content management system Joomla was selected, which was proved to be effective for the creation of the website. Its advantage is easy installation and administration; at the same time its possibilities and functions can be very well expanded with the help of various paid and unpaid accessories. Another positive feature of this add-on is the ability to use OpenStreetMap, unlike most other add-ons focused exclusively on Google Maps. However, in general, the Joomla content management system and the selected Phoca Maps add-on are more than sufficient.

Using the Joomla content management system, the map of container sites within the municipality waste management was created. The map shows container stations which, in addition to containers for municipal, paper, glass, and plastic waste, also displays containers for metal, textile, or electrical waste. The resulting website is available to users at the address: www.kontejnerykarvina.tode.cz.

Limitation of this paper can be seen in the used system: the absence of importing map markers into the map add-on Phoca Maps. When the insertion of larger number of markers into the map are needed, this can be a problem. However, some paid add-ons offer solutions of this problem, as well as more advanced branding options.

In the future, the application could be expanded in terms of content, such as statistical tables and figures of the total waste collected per year. Dozens of different supplements can be found for this agenda. Another option is to extend the focus of the application to other facilities managed by the Department of Municipal Services: maps of parks, sports grounds, or children's playgrounds, etc.

This website (and others of this type) can also serve as inspiration for the implementation of this e-Government tool for other cities in all areas of providing e-information to their citizens. In general, the use of open source content management systems can be recommended as a tool to simplify or support the implementation of processes within e-services.

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