Development of a Smart City Portal Based on Open Data Sources and Open Web Map Services

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Abstract –**The goal of the paper is to examine the potential of developing a smart city portal based on open data sources and open Web map services for the purposes of introducing smart solutions in less developed countries. In the paper we will introduce a smart city solution for Niš city named GinisLS, explain the concept and architecture behind it, and demonstrate its usage.**

Keywords –**Smart cities, open data, open web map services.**

I. Introduction

Technology has radically changed the way of life in the last decade, imposing itself as default companion in everyday activities. Today's cities are the engines of the new data economy, based on digital services such as on-demand transport, intelligent water management, responsive lighting, and distributed energy resources [1]. Such digital services, as a part of smart city environment, are rapidly replacing the legacy infrastructures and service delivery models [1]. Despite of this, probably the most valuable resource of a city are its residents [2].

Many definitions of smart city exist, but none has been universally acknowledged yet. There is a high level of agreement in the literature that there is no common definition of a smart city yet [3, 4]. According to literature, smart city and digital city concepts are mostly used and developed from 1993 onwards [4].The concept of smart city embraces definitions depending on the meanings of the word "smart", as intelligent city, knowledge city, ubiquitous city, sustainable city, digital city, etc.

According to British Standards Institution, smart city refers to the effective integration of physical, digital and human systems in the build environment to deliver a sustainable, prosperous and inclusive future for its citizens [5]. Giffinger et al. explained that smart cities use information and communication technologies (ICT) to be more intelligent and efficient in the use of resources, resulting in cost and energy savings, improved service delivery and quality of life, and reduced environmental footprint [6].

But what does it take to create a smart city? First of all, people that would recognize the importance of the concept and more prominently that would understand its significance in the context of the not so far away future. Secondly, strategies and well defined goals based on well assessed current state. Thirdly, experts that would implement adopted strategies, and fourthly: finances. The stronger the city is, economically and financially, the easier it is to direct its capacities towards planning better, smarter and more efficient resource usage.

As a consequence, becoming smart comes with a high price. Investments are enormous and custom solutions are extremely expensive. Developing countries around the globe share the same struggles and anticipations. Lacking in budgetary resources, they have a significantly limited investment power and are therefore far behind advanced world cities. Smart city concept requires high investments in not just one, but several areas: economy, environment, government, people etc. For cities in developing countries, such investments are very low on priority list, slowing them down in achieving any noticeable advancement and gaining any competitiveness value.

The paper is organized as follows. Section 2 describes the usage of open source technologies and their contribution to the smart city concept. In Section 3, GinisLS smart city portal is introduced, its architecture and usage are described. Conclusion is given in Section 4, followed by the list of cited papers.

II. Literature Review

Popularity of smart city idea has sparked growing skepticism across research and industry communities in the idealization of the smart city as a vendor-oriented vision of ICT-led urban growth [1]. Also, there are research groups which attempt to answer question whether it is the smart city idea utopia (according to companies and municipalities which promotes the smart city as a revolutionary utopia) or is it, on the contrary, an expression of the neo liberal ideology [3]. However, these concerns are also accompanied by growing recognition that, whether or not cities are 'smart', the proliferation of data-driven platforms requires governments to play a much more active role in the management of their cities' data assets [7].

The significance of smart city for developing countries is major: healthcare problems rise in last ten years (cancer, heart disease etc.), water availability and water consumption rise, rapid rise of waste generation and the rise of carbon footprint.

In the light of smart city requirements, challenges that are defined for developed countries need to be differently seen for developing ones. The final goal is the same for both country

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groups, developed and developing, but the roadmap towards achieving it is significantly different.

Increasingly popular open technologies, and particularly Internet enabled ones, offer a whole new perspective on becoming smart. Growing open data sources and catalogues represent valuable information storages that are freely available and could be successfully utilized in building smart cities portals. Open web map services, such as Google Maps and Open Street Maps (OSM), simplify expanding such portals with geographical dimension and spatial representation of gathered data. The open market and open initiative truly are a great source of possibilities for those not being able to purchase highly proficient but indeed expensive commercial solutions. Cities from developing countries are obvious candidates that with minimal investments could make a significant progression with open technologies on their way towards transforming into more intelligent environment.

Smart Governance is seen as a combination of political participation, services for citizens and functioning of the administration [8]. Smart Government is at service to its citizens 24 hours a day, offering services that would enable citizen to quickly obtain requested information without having any knowledge on back-office systems involved in providing the response. For Government to become smart it is not necessary to invest millions in technology, it is rather needed to be astute in making the best possible use of existing resources [9]. Being innovative and open for new technology solutions and concepts are leading drivers for introducing smart governance in developing countries. Open technologies again provide a colourful palette of possible solutions. Internet of things offers vast of open source Content Management Systems that could efficiently be used in developing smart government portal and integrating it with administrative bodies in back-office domain. Opening up data and enabling free access to governmental information is a trend and it has imposed as an important feature of smart government.

Open data platforms are also available (CKAN, OGDI etc.) offering tools for easy data upload and maintenance. Open map services, such as Google Maps and Open Street Maps, enable addition of geographical dimension to smart government portal and representing governmental data in spatial context, considerably increasing data understandability. Social and geo-social networks, such as Twitter, Facebook, Four Square and others, represent valuable open sources of users' opinions, experiences and comments that could be connected with other available governmental data and easily utilized in building smart city guides. Smart Government strongly stands behind smart city, addressing financial, environmental and service challenges that public offices are facing with.

The successful examples of open source technologies joint interaction for the creation of smart city portals can be found, namely: (1) Padova Smart city portal enables harvesting environmental data from wireless Internet of Things (IoT) nodes installed on street light poles and connected to the Internet through a gateway unit [10]; (2) PlanIT Valley, a project started in Portugal to enable the enhanced monitoring of the vital signs of urban life, the condition and performance of vehicles and infrastructure. It is a vision to build the world's greenest city and establish a working template for low carbon emission for cities [11]; (3) Smart Amsterdam resulted as a partnership between businesses, authorities, research institutions and the people of Amsterdam (https://amsterdamsmartcity.com), with focus on carbon emissions reduction, energy efficiency and behavioral change, and (4) Smart Barcelona is centered on the notion 'city of people' with an aim to improve citizens' quality of life [11].

III. Open Street Maps and Open Data sources for Smart Government Portal implementation

In our research so far, we have started to develop a smart government portal for the city of Niš, using OSM and available open data sources. Niš is a city in southeast Serbia, which is one of the Western Balkans' developing countries, and as such it could be used as a perfect example for demonstrating previously described concepts and solution approaches [12].

Our solution, named GinisLS Smart Nis Portal (GinisLS), represents a Web Geographic Information System (GIS) portal that integrates freely available maps provided by OSM, as well as custom maps provided by Republic Geodetic Authority of Serbia, with local databases and open data sources. Being deployed and publicly available, it represents a fully functional GIS portal that significantly contributes to city's efficiency, increases availability of city's services to citizens and helps citizens build trust regarding their government. The development of GinisLS portal has been

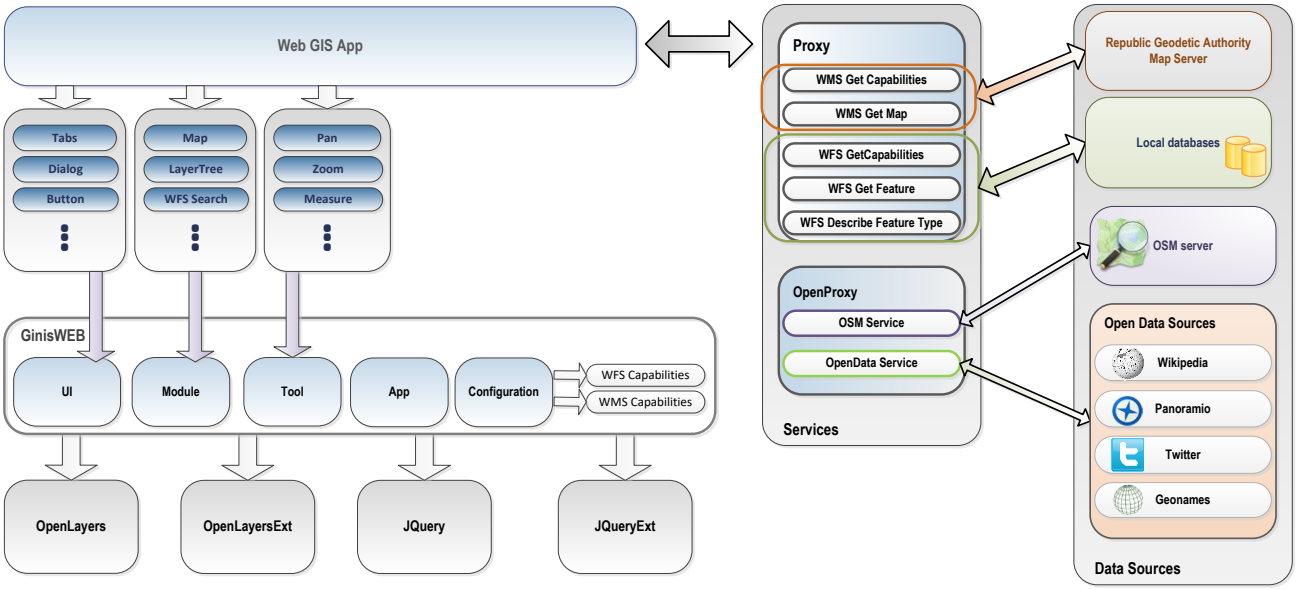

Fig. 1.GinisLSWebGIS architecture

driven by previously described and agreed main challenges for smart city development, as a practical attempt of demonstrating how open technologies indeed help implementing some of the smart city concepts aspects.

GinisLS Web GIS portal is designed to enable simple linking and integrating with standard types of spatial Web services. Built upon standard client-server architecture, it is comprised of a Web server component, GIS server and a Web GIS client [13]. GIS server is responsible for providing geo-referenced data and maps, and it communicates with OSM for obtaining maps of Niš region, but it also communicates with other Web Map Services (WMS) and Web Feature Services (WFS) for obtaining other providers' maps, concretely Republic Geodetic Authority of Serbia.

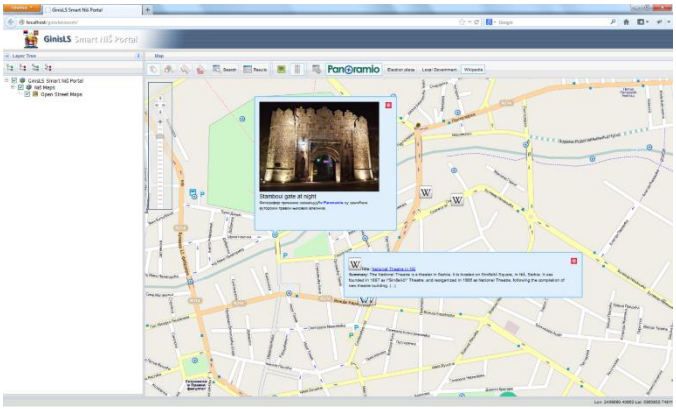

Fig. 2. Wikipedia and Panoramio tools

GinisLS Web GIS client, depicted on Fig 1, is a Web application specialized for visual representation and querying the data obtained from GIS server. This client relies on Open Layers framework and JQuery Javascript library. Because of its modular architecture, it successfully combines the advantages of centralized data control with advanced user interface, at the same time representing highly scalable solution that could be easily modified and extended with additional functionalities.

GinisLS client communicates with external data sources through Proxy and Open Proxy services. Proxy service is responsible for obtaining maps from custom providers and feature information from local data sources. OpenProxy service consists of two components: OSM and Open Data services, and is responsible for communicating with open data sources. OSM service requests maps from OSM server, while Open Data service communicates with Wikipedia, Geonames, Panoramio and Twitter for obtaining open available data.

GinisLS portal integrates the existing local data sources with external ones, such as Wikipedia, YouTube videos, Panoramio images, Geonames services and others, offering the possibility of custom geo-referencing and pinpointing dynamically obtained information to a concrete location. It provides data organized in different layers: maps, touristic information, investment locations, election places, Panoramio images, Wikipedia sources and others (Fig 2).

Touristic representation of a city is an important aspect that directly influences the promotion of city's offerings and its rating among potential visitors. Allowing tourists to have an insight into city's cultural heritage and make an impression of its atmosphere, most certainly contributes to growth of touristic visits. This feature could also be observed as one aspect of city's smart economy as increased touristic visits directly influence increased city's income, thus helping decrease the urban poverty.

GinisLS portal provides an excellent tourism support by enabling users to visualize touristic sights: theatres, movies, hotels, libraries, museums, national monuments, sport clubs and others, available from local databases. By including Local Government layer, map area is being populated with suitable markers pinpointing to exact locations of contained features. As shown in Fig 3. each marker is clickable and provides additional information regarding the object it is related to: object's name, type, address, contact, visiting hours, brief description.

Smart economy city aspect is even more addressed by offering the possibility of reviewing potential and ongoing investment locations. By simply including the Investments layer, a set of markers spreads on the map area indicating the exact locations of potential construction plots. For each location, user will be provided with additional information by clicking on a marker: location status (available, occupied, in the process of construction, finished etc.), location description, obtained permits, general construction plan information, as well as related YouTube video materials. This feature offers benefits to both investors and citizens.

Investors could obtain an insight regarding possible

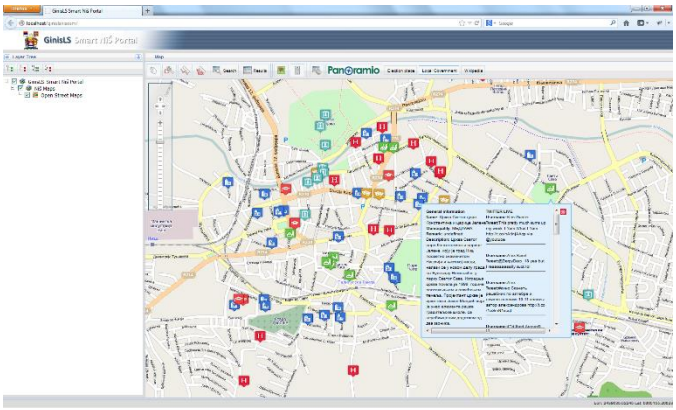

Fig. 3. Visualization of city's touristic sights

construction locations, while citizens could keep up with urban plans that affect their living surrounding and at the same time be updated about possible buying locations. City's Administration becomes more efficient by utilizing this feature as assistance tool for overseeing construction resources with the purpose of better planning of urban land exploitation for housing requirements.

Open data sources truly represent significant sources of freely available information that cities could quite efficiently utilize for bringing government closer to citizens. Users are valuable volunteers that on daily bases upload vast amount of newly generated content contributing to growth of open communities such as Wikipedia, Geonames, Twitter and Panoramio. Wikipedia is the world most used online

encyclopaedia and a source of large number of user edited articles related to almost any known topic. Geonames, the best known worldwide geographical database, provides suitable Web services towards Wikipedia, enabling simple articles obtaining based on provided spatial context.

GinisLS provides Wikipedia tool that populates visible map area with Wikipedia articles related to available city objects and pinpoints them to objects' locations. After clicking on a marker, a pop-up window appears with article preview, offering the possibility of reading full article on official Wikipedia page. In such way, a user could easily obtain additional information regarding objects of interest and from a popular and reliable source.

Having in mind the increased popularity of Twitter, micro-blogging network community, we have included tweets as additional touristic sights' description, thus enabling users to not only get general data and historic facts on objects of interest, but also to have an insight into other experiences and impressions, regarding these objects (Fig 3). That kind of information highly increases data reliability as well as users' trust in such provided context, but more importantly it represents a way for including youth into portal's content creation, recognizing their social importance and acknowledging their opinions. This aspect contributes to smart people and smart living concepts as well.

Panoramio is one of the greatest photo-sharing communities that enable users to upload their photos and link them to geo locations. It provides a suitable API for accessing the imagery content and thus enables free of charge data utilization. We have used the API and implemented Panoramio tool that populates visible map area with markers referencing available Panoramio photos, similar to addition of Wikipedia articles. By clicking on Panoramio map marker, a pop-up window opens displaying a photo with available related description and linking to an official Panoramio Web page where it can be previewed in original size. Wikipedia and Panoramio tools increase portal's reliability, data understandability and provide better context for users browsing the portal. In such way they contribute to better educating citizens about city's locations and indirectly add to smart people city's aspect.

IV. Conclusion

As been thoroughly discussed previously in the paper, there are six city aspects that most accurately define 'smart city' concept: economy, governance, people, mobility, environment and living, each addressing specific city issues. Vast of available open technologies truly make their implementation easier, which is especially convenient for developing countries. In this paper, we have presented a part of open data sources and open Web map services and their potential of being used for introducing smart solutions in developing countries. Our smart city solution, named GinisLS, uses open data sources and free mapping libraries. It represents a fully functional GIS portal capable of improving local government efficiency and increase availability of local government services with minimal costs. Although we believe our solution makes a step forward in a city becoming smarter, to cite Boyd Cohen, opening twenty databases for public use does not make a city smart. To transfer this statement into the scope of this paper, utilizing open Internet enabled technologies to build a smart portal does not mean that the city has classified into smart cities group. Going smart is a long-term process that needs to begin with years of planning and strategizing, as it requires a thorough cooperation between all city's authorities and a 180° shift from what is being known as normal city functioning. Nevertheless, initiatives, such are those described previously in the paper, most definitely place a city on the road towards becoming smarter.

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