

Creation of an Application Intended for Visualization and Graphic Interpretation of Museums Using Open Data

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ABSTRACT: Digitalization of the public sector, especially through open data, will be key to improving public services. Digitalization of the public sector is increasingly becoming an irreversible process, transforming the organization of public institutions and improving communication between users and institutions. Based on data from the Public Data Portal, a museum search application was developed that provides users with quick and easy access to information about museums in the Republic of Serbia. Through the use of data visualization libraries like Leaflet.js, Highcharts.js and D3.js, interactive maps and dynamic graphs are implemented. These tools provide efficient data display and improve user experience.

Keywords: E-government, Open data portal, Application, Data visualization

Date of Submission: 10-01-2024

Date of acceptance: 24-01-2024

I. INTRODUCTION

The phenomenon of digitization of the public sector is an irreversible process that affects the way public institutions are organized and communication relations between people and institutions. The high quality of services provided to citizens should be accompanied by good infrastructure and well-trained employees in order to provide digital services and solve any problems that may arise [1].

E-government refers to "the use of new information and communication technologies... by governments, applied to the full range of government functions" [2].

European countries are pioneers in the adoption of electronic government (e-government), which prompted the European Union to commit to providing all key public services via the Internet by 2030 [3]. However, there are significant differences between countries, stemming in part from disparities in funding and digital infrastructure, as well as political will in the broader context. While some countries provide comprehensive e-government portals that include access to health services, taxation or digital identification documents, others offer only basic services such as online forms [4].

E-government is defined as the use or exploitation of information and communication technologies by governments and public administrations for the purpose of designing, producing and delivering public services to citizens, businesses, other public agencies and non-profit organizations [5].

Within the project "Open Data – Open Opportunities", supported by the United Nations Development Program (UNDP), the World Bank, the Government of Great Britain and the Swedish International Development and Cooperation Agency (SIDA), the first national Open Data Portal was established in the Republic Serbia under the name data.gov.rs [6]. This portal is a central place where open data of public institutions are unified and made available to citizens, private and non-governmental sectors. Since its launch, the Open Data Portal has seen significant growth in the number of public institutions and available information. In just four months since the launch of the platform, the number of institutions and the volume of data have doubled. A particularly significant indicator of progress in this area is the index of open data, which ranked the Republic of Serbia first in the region and 41st in the world among all members of the United Nations. Open data has a key role in stimulating economic growth, making public administration more efficient and economical [7].

The paper used data from the Public Data Portal in order to collect information about all museums in the Republic of Serbia, without data about AP Kosovo and Metohija. These data served as the basis for the

development of an application that enables users to easily access information about all museums on the territory of the Republic of Serbia.

The goal is to make it easier for users to quickly view and easily access relevant information about museums. The tourist potential of the cultural and historical heritage represents a significant resource for the development of tourism in many countries. The focus of the work is providing information about museum destinations in the territory of the Republic of Serbia (without AP Kosovo and Metohija), highlighting their importance in the tourist offer. Tourism is increasingly becoming an indispensable part of the economy of tourism-developed countries, where the cultural and historical heritage is often a key motive for visits. Museums, as guardians of this heritage, play a central role in providing visitors with an authentic experience.

In order to provide comprehensive information about museum destinations, selected data visualization libraries were used. The paper analyzed the source code written in the programming languages Python and HTML, which enabled the collection, organization and presentation of relevant data about museums. Through this analysis, one of the ways in which technology contributes to the effective presentation of the cultural offer is shown.

II. DATA VISUALIZATION USING OPEN CODE THROUGH SOFTWARE TOOLS

In the modern digital age, a huge number of libraries provide users with the ability to effectively visualize data. Data visualization, as an essential process, involves the creation of diagrams, graphs, maps or images that together provide a graphical representation of information. This technique is not only a means of aesthetic presentation, but a key tool for facilitating the understanding of complex data and making informed decisions more quickly. Through the variety of available libraries, users have the opportunity to adapt their visual representations of data according to specific needs, which contributes to the efficient transfer of information and the improvement of analytical capabilities [8].

Nowadays, the application of data visualization is growing rapidly, becoming a key element in information communication. Data visualization provides citizens with a simple insight into data through visual displays. When considering what makes a good data visualization, key elements include interest, functionality, and integrity. These features make data visualization an effective tool for clearly and attractively presenting information to citizens [9].

With all this in mind, we come to recognize the important features of data visualization that are closely related to attracting the attention of users to better understand the presentation of information [10]. There are a number of data visualization tools that are based on the JavaScript language, and most of these tools are available through JavaScript libraries. The process of data visualization itself includes the creation of diagrams, graphs, maps or images, which represent information graphically for easier understanding.

Libraries can be classified according to different criteria. When it comes to criteria, we can group them according to the type of data being visualized, software licensing, and the types of graphs used in the development of the application. For the application's functionality, the following libraries were used:

2.1 Leaflet.js

The creation of interactive web maps was achieved using the open source JavaScript library Leaflet. With the help of this library, a simple map can be created using only a few JavaScript expressions, but the Leaflet library also supports the creation of complex maps with hundreds of expressions.

The Leaflet library is designed with a focus on simplicity, performance and usability, providing efficient functionality on desktop computers and mobile devices. In addition, it is characterized by extensibility with large datasets, ease of use, and a well-documented API, making it an accessible and useful tool [11].

Web maps consist of many different layers. Layers can be classified into two groups:

- Background layers – consist of grid images or vector tiles.
- Foreground layers – consist of vector layers (points, lines and polygons) that are adjusted for a specific web map appearance.

A library must be included in order to be able to use the objects, functions, and methods it provides. The inclusion of the library in the user application is done with the help of the <script> command. When including the library, it is started when the application is loaded, defining objects, functions and methods. After that, it can be used in subsequent scripts that are executed in the application [12].

2.2 Highcharts.js

Highcharts is a JavaScript library, a powerful tool often used to create interactive graphs and charts on web pages. This library includes all standard chart types, it also stands out through its ease of use and flexibility, making it the most used tool among developers worldwide [13].

The Highcharts library allows the source data to be post-processed in the client part of the system to improve the performance of the graphical interface and user access.

The development process using the Highcharts library requires first creating a container, then rendering and placing the chart into the container. The chart is connected to data from external memory with the help of the get function, which is of a certain format, and then the variable in which the chart is saved is passed as an argument to the data function [14].

Implementation of data sources that have CSV format (such as the dataset that can be found on the open data portal of the Republic of Serbia) must be converted to JSON format so that the Highcharts library can process them. This conversion can be done with the help of the Python programming language.

2.3 D3.js

The D3.js library, which stands for "Data-Driven Documents", is a powerful JavaScript library that is often used for dynamic data visualization on web pages. One of the key features of the D3.js library is the ability to bind data to the DOM (Document Object Model) and automatically update HTML elements based on that data. This approach makes D3.js an extremely powerful tool for creating interactive visualizations that dynamically adapt to changes in data in real time [15].

D3.js is characterized by three key features: compatibility with other JavaScript libraries, efficient debugging mechanisms for debugging, and high performance that optimize the execution of visualizations. This library provides developers with the means to easily integrate, maintain and optimize, setting high standards in the development of interactive web applications [10].

III. DATA SEARCH APPLICATION

The development of this application resulted from the research and analysis of data from the Open Data Portal of the Republic of Serbia [6]. On this portal, the authors found a lot of interesting information, especially about museums around the country; deciding to use this data, they created an application dedicated to museum search.

The application is a centralized place where information about museums is easily accessible. The authors used these data to emphasize the importance of museums as central institutions in the preservation of cultural heritage, history and traditions of different localities, cities, communities and societies. This approach allows users to access key information about museums in one place, thereby promoting awareness of their importance in the wider context of culture and heritage. The application that was made for that purpose was written for the Ubuntu operating system [16], and the client languages that were used were Python, HTML-for the appearance of the application, as well as CSS for a better and more beautiful arrangement of it [17].

The Ubuntu operating system from the Linux family is an extremely popular and reliable solution for a wide range of users. It is characterized by openness, ease of use and regular updates. It is often used in business environment and server platforms due to its stability and security.

The integration of the Ubuntu operating system with Apache HTTP Server provides users with optimal performance, security and scalability, making this combination an extremely effective solution for various scenarios in the server environment, key to modern web hosting. Apache, as the leading open web server, provides robust support for the HTTP and HTTPS protocols, enabling efficient serving of web pages and applications [18]. Its adaptability, support for extensions and modules make it an ideal choice for hosting diverse web content [19].

When it comes to the implementation of the museum view application, the client part of the system is described in detail later in this chapter, including the relevant part of the code. On the other hand, the server part of the system hosts the museum browsing application on an Apache web server, thus ensuring reliable and efficient content availability to users.

On Fig. 1 shows the appearance of the Ubuntu operating system where the text editor is started, in which the code for the application is written.

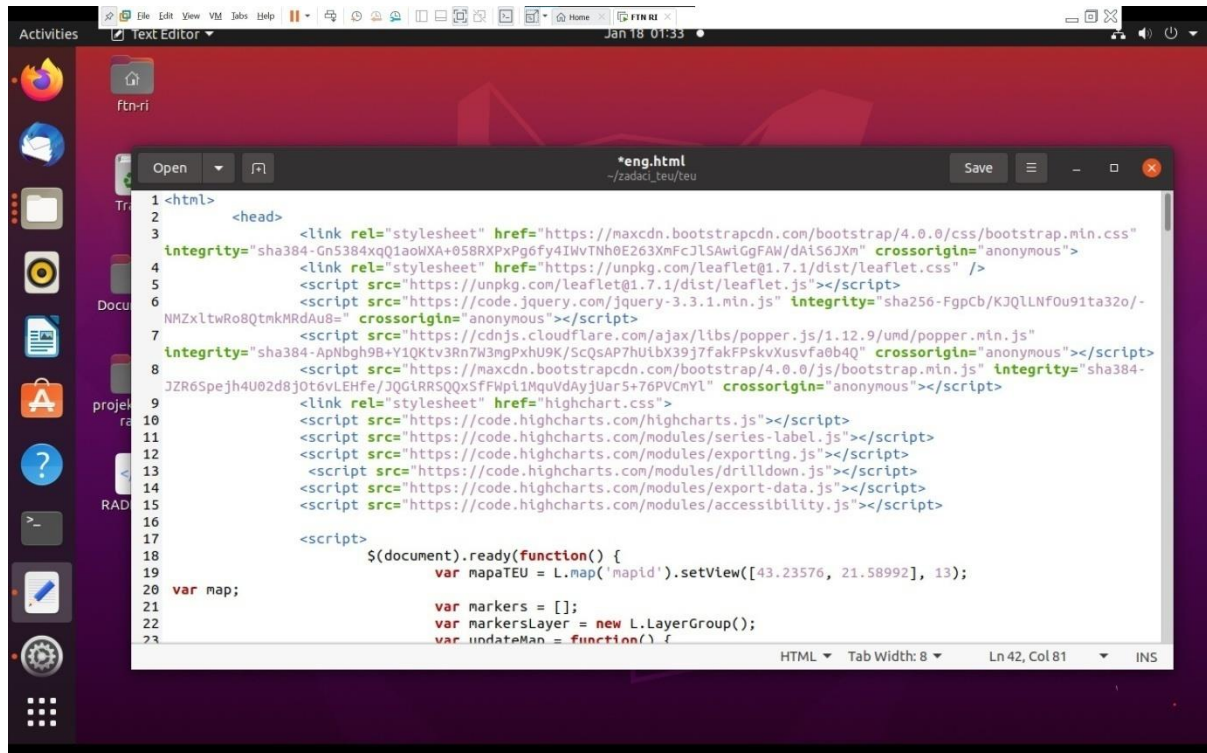


Fig. 1 Appearance of the operating system

At the very beginning of application development, key libraries are integrated to ensure successful operation. The included libraries, namely: Bootstrap for styling, Leaflet for interactive maps, jQuery for easy manipulation of JavaScript and Highcharts for creating dynamic graphs, contribute to improving the appearance and functionality of the website. These libraries are essential for efficient management of maps, styles, DOM manipulation, and graph data visualization.

In the continuation of the development of the application, the Leaflet library was used to create an interactive map that is focused on specific geographic coordinates. Emphasis is placed on creating markers, initializing an empty array and a layer that will serve to clearly mark museums and accurately display their location on the map. This functionality allows users to visually identify museums in the Republic of Serbia.

After placing the markers, we moved on to the implementation of pop-up windows, which provide detailed information about each museum, including the name, address, municipality and similar relevant data.

In the further process of developing the application, the focus was placed on the manipulation of cities. By selecting the HTML element with the ID "District", a dropdown list is implemented that allows users to select a specific city from the list. This interface, known as a drop-down menu, is used to easily select options from a list by clicking and dragging down.

The next step in the development of the application was working with the JSON file that contains data about museums. Specifying the directory and location of this JSON file was crucial, as it pointed to precise data retrieval. Each line of the JSON file was systematically reviewed, extracting information about the municipalities where the museums are located. After that, the procedure of sorting cities and dynamically adding options to the dropdown list for each individual district was carried out, which enabled users to easily search and select data according to their interests. This approach further improves the user experience when interacting with the application.

Due to the limited scope of work, only part of the code for creating the application is presented, and the rest of the code includes manipulation of markers, adding markers by districts, connecting to the user interface, etc.

The visual representation of the map after opening the application is given in Fig. 2.

```

18 $(document).ready(function() {
19     var mapaTEU = L.map('mapid').setView([43.23576, 21.58992], 13);
20     var map;
21     var markers = [];
22     var markersLayer = new L.LayerGroup();
23     var updateMap = function() {
24         markersLayer.clearLayers()
25     };
26
27     L.tileLayer('https://api.mapbox.com/styles/v1/{id}/tiles/{z}/{x}/{y}?-
28     access_token={accessToken}', {
29         attribution: 'By <a href="http://www.ftn.pr.ac.rs">FTN KM</a>',
30         maxZoom: 18,
31         id: 'mapbox/streets-v11',
32         tileSize: 512,
33         zoomOffset: -1,
34         accessToken: 'pk.eyJ1IjoicG1pbGljIiw1YSI6ImNrbmQxd2FpOTI3Nmgybn54a3IzbGZlZ2E1fQ.-
35     2o_NoLcKBeCugwMvtLOYFQ'
36     }).addTo(mapaTEU);
37
38     var popup = L.popup();
39     var $district = $('#district');
40     $.getJSON('https://localhost/teu/data.json', function(data) {
41         var town = new Array();
42         $.each(data, function(index, element) {
43             town.push(data[index]['okrug']);
44         });
45         town = town.filter(function(itm, i, a) {
46             return i == town.indexOf(itm);
47         });
48         town = town.sort();
49         $.each(town, function(index, element) {
50             $district.append("<option />".val(element).text(element));
51         });
52     });

```

Fig. 2 View of part of the code for loading, filtering and sorting JSON data

IV. DISPLAY OF MAP LAYOUT AND RESULTING GRAPHS USING LIBRARIES

During the development of the application, the focus was on providing visuals available in two languages. In order to demonstrate the presented approach, a web application was created that visualizes open data about libraries in the Republic of Serbia. For this, a dataset available on the national open data portal of the Republic of Serbia was used, and JavaScript libraries Leaflet.js and HighChart.js were applied [11].

Application execution takes place on the client side and is created with the help of the following files: JSON file, HTML file and CSS file.

The JSON file includes information about each library available on the National Open Data Portal. This data is further processed in a .html file via JavaScript code, allowing it to be displayed on a map and graphs.

On Fig. 3 presents a part of the JSON file that was used to implement the application.

An HTML file plays a key role in the process of displaying data on a web page. Combining with JSON files enables dynamic formatting and aesthetically pleasing display of content, and using JavaScript code in the HTML file, data in JSON format is dynamically manipulated and updated. This combination provides a flexible and interactive display on web pages, making it a powerful tool for application development and data visualization.

The CSS file is implemented with the aim of improving the aesthetics of the application, thus contributing to the overall visual experience. This customization enriches the user experience and contributes to the overall attractive appearance of the application.

On Fig. 4 shows the layout of the application obtained by combining the previous three files.

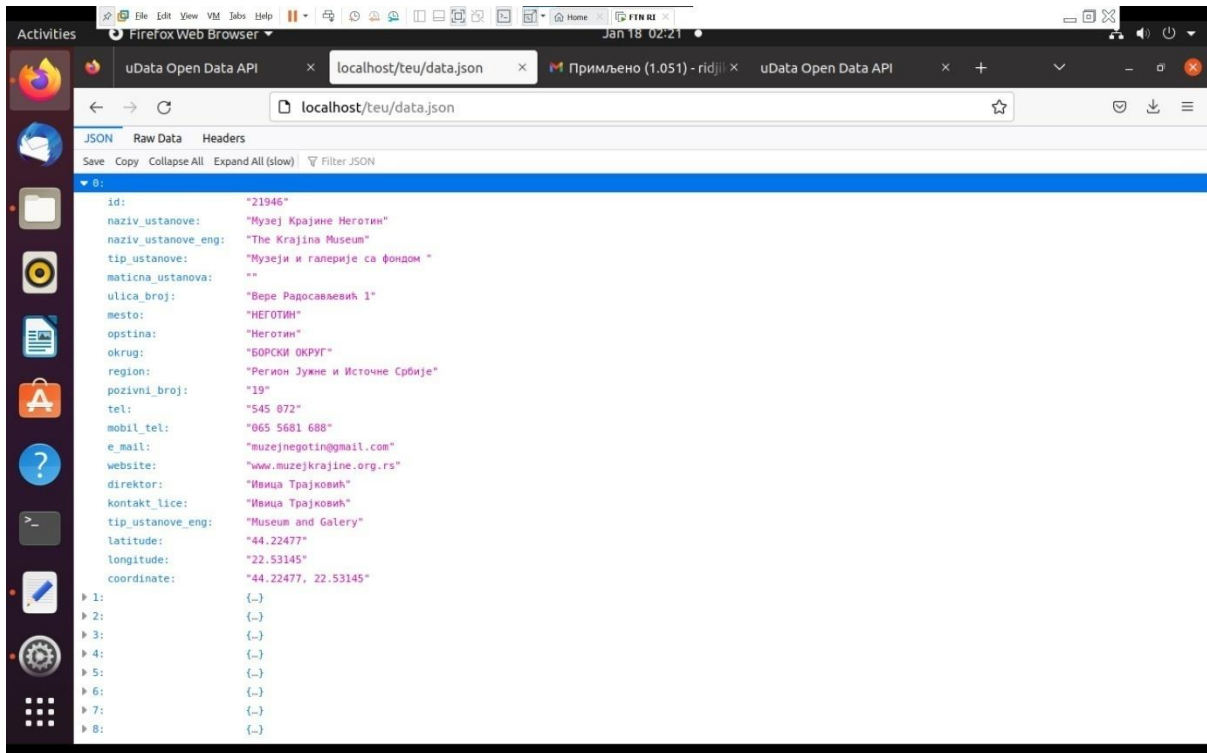


Fig. 3 JSON files

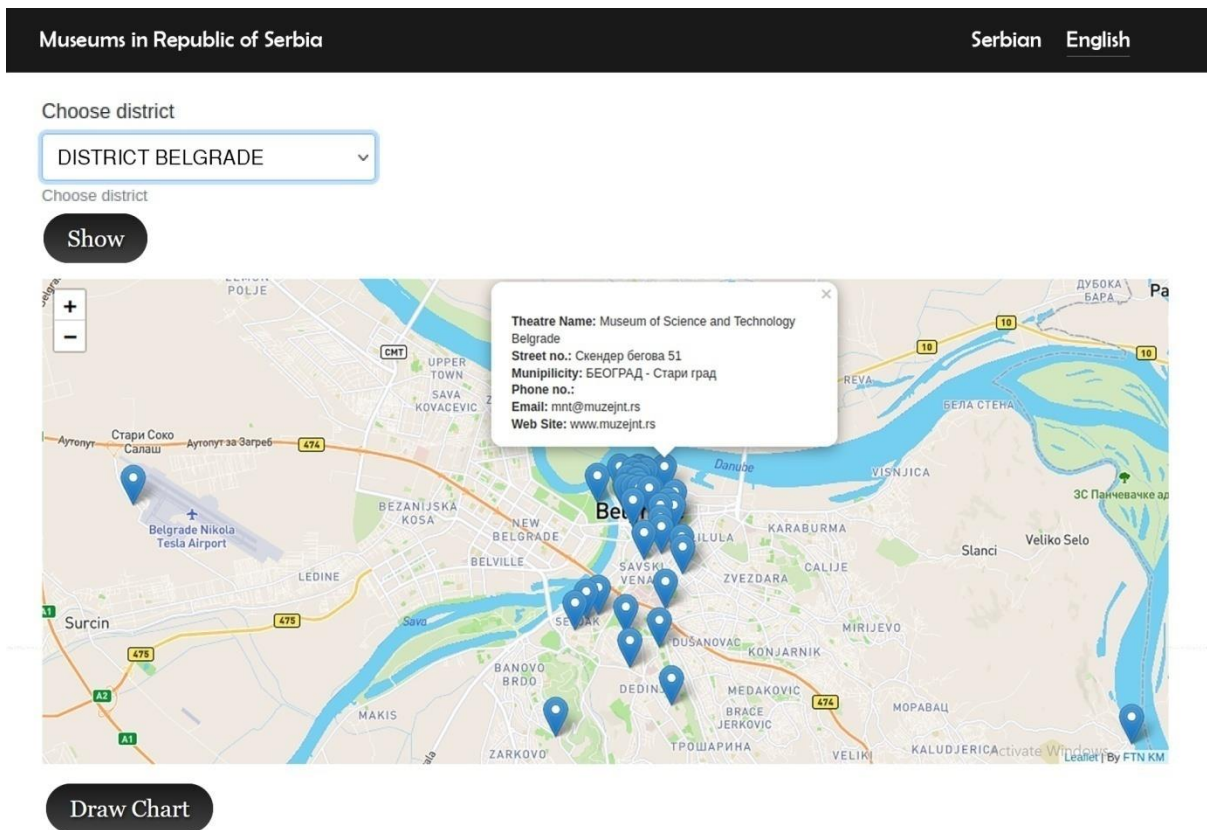


Fig. 4 Design view of the museum search application

The menu line, located in the upper right corner of the page, plays a key role in facilitating navigation through the application for end users, i.e. tourists. It gives them the option of choosing the English language, which makes it significantly easier to search and find specific museums. This functionality is of particular importance for tourists, allowing them intuitive and efficient access to information, which further improves the user experience.

By selecting the district from the drop-down menu in Fig. 4, the focus of the map is automatically changed, pointing to the coordinates of the selected district and displaying the location markers of the museum within that district. Additionally, by clicking on these markers on the map, users are given access to all relevant information about the museums, including name, address, phone number, e-mail, etc. This functionality provides users with easy and quick access to detailed information about museums.

On Fig. 5 graphically shows the museums distributed by district.

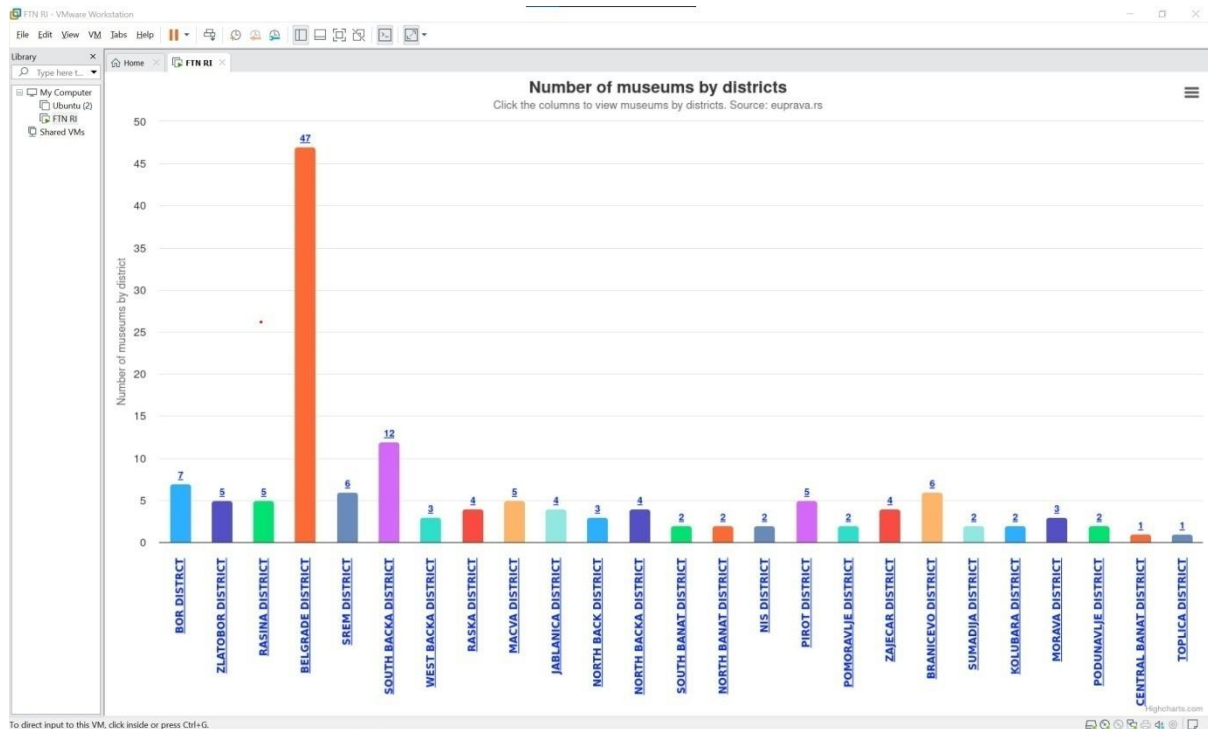


Fig. 5 Graphic representation of museums distributed by district

The "Draw Chart" button is also necessary because it signals the need to draw a chart showing the number of museums by county.

By clicking on a specific district or on the segments of the chart colored in different colors from Fig. 5, a subgraph with the cities belonging to that district opens, as shown in Fig. 6.

This functionality provides users with quick and intuitive access to detailed information about museums in the selected district. The main goal of the graphic displays is to enable users to easily deduce the total number of museums in the current city based on them. Also, graphic displays contribute to the visualization of all museums in the immediate environment, providing users with a clear insight into the wealth of museum offerings not only in the city itself but also in its immediate surroundings. In addition, this graphic display makes it easier for users to plan visits to museums and explore cultural content in a certain area.

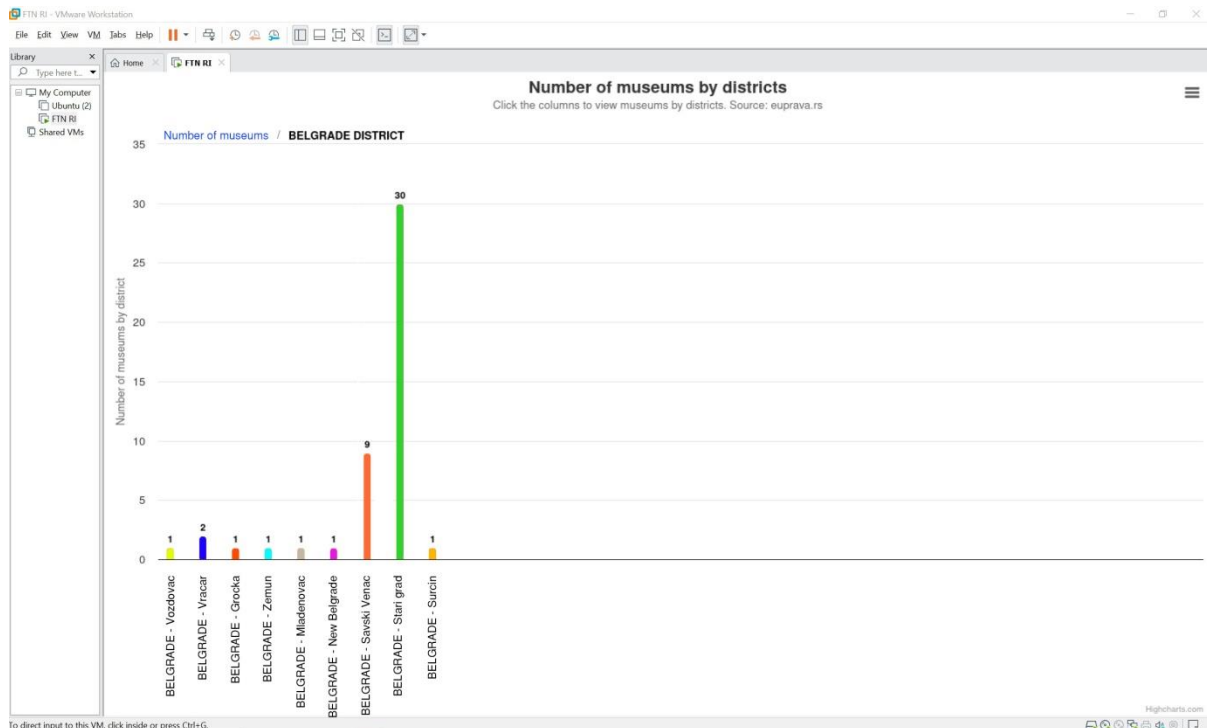


Fig. 6 Graphic representation of museums by cities in the district

V. CONCLUSION

The paper presents the possibilities of visualization and graphical interpretation of data about museums in the Republic of Serbia. The focus was on the use of open data, especially from the national open data portal of the Republic of Serbia, in order to create an application that enables users to easily access information about museums. Digitization of the public sector and the application of modern technologies are key factors in creating a more efficient society and improving the tourist experience.

The application for displaying information about museums, developed with the use of open data and the e-government portal of the Republic of Serbia, is an effective way of informing end users. This form of data visualization allows users to quickly and easily access information about museums throughout the Republic of Serbia. The implementation of the application also included language support, allowing users to access information in two languages. Also, the emphasis was on facilitating the search and overview of the museum, which was achieved by dynamic data display, drop-down menu for city selection, and interactive graphic displays.

The museum search application is a concrete example of how technology can contribute to the promotion of cultural heritage and facilitate users' access to relevant information.

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