THE TEMPORAL EVOLUTION, DYNAMICS AND CURRENT STATUS OF PHARMACIES IN SIBIU COUNTY USING FREE GIS RESOURCES

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Abstract: *A Brief Summary of the Process of Creating an Interactive Web Map GIS is an essential technology for managing and analyzing spatial data, with vast applications in many fields. A Geographic Information System (GIS) is a technology for managing and analyzing spatial and geographic data. It combines hardware, software, and data to capture, store, analyze, manage, and present information related to locations on the Earth's surface. Using GIS, users can visualize, understand, and interpret spatial data in various ways, revealing relationships, patterns, and trends in the form of maps, reports, and charts.*
The present article attempts a straightforward graphical representation within a GIS environment of a database derived from various sources. The database in question originates from official websites and consists of multiple use of .xls files. The data contained therein are considered sufficient for graphical representation, as this database maintains records from multiple data series of pharmacies in Sibiu from 2017 to 2022, including numerous metadata related to each pharmacy, the most important being the address. In addition to the graphical representation of the database, the creation of a digital and interactive map (in HTML format) is also aimed for, which will be accessible via a web browser.

Keywords*: GIS; QGIS; geocoding; data visualization; webmap*

1. Introduction

In the age of big data, the ability to transform vast datasets into compelling, interactive visualizations has become a game-changer in data analysis. Geographic Information Systems (GIS) stand at the forefront of this revolution, offering powerful tools to turn static information into dynamic, spatially aware maps that unlock new perspectives. Inspired by the challenge of finding a unique project, I embarked on a journey to bridge complex data with user-friendly visualization.

After navigating countless web pages, I discovered a chunk of public datasets on data.gov.ro, some of them focusing on pharmacies in Sibiu County organized as time phased data. The rich metadata, including geographical locations, opened the door to a deeper exploration of spatial relationships of visual and text-based data through GIS technology.

This paper delves into the creation of an interactive digital map that transforms these datasets into real-time analysis tools. By leveraging GIS, I not only represent the data visually but also make it accessible and meaningful in a way that static charts or tables are not able to do. Through this project, I will show how GIS can turn complex databases into living maps, each one telling its own story.

2. Materials and Methods

The software used for creating this application is QGIS (Quantum Geographic Information System), which is a free, open-source software that allows users to create, edit, visualize, analyze, and publish geospatial information. [1]
QGIS can be downloaded and installed at no cost from the following address: https://www.qgis.org/en/site/.

The version employed is 3.28.10 LTR, which may be significant as several plugins are used in the development of the application, and these may vary across different versions of QGIS.

The first step involves creating a new project, which can easily be done from the *Project* menu by selecting the *New* option. After creating a new project, it is essential to select the coordinate system that will be used throughout the project. Since platforms like Google Maps or OpenStreetMap use coordinates based on the WGS84 system, it is important to choose this system in the QGIS project as well. Also, the user needs to be careful when choosing the WGS84 system, as there are several versions of it.

As a next step, we consider preparing the data and representing it on a basemap. This step involves preparing the database and representing it within the newly created project. To achieve this, an external QGIS plugin called MMQGIS [2] will be required to perform a geocoding process. This step involves the use of two new elements: a basemap and the geocoding process. These two terms will be explained below.

A basemap is a foundational layer on a map that is the basis of GIS visual and geographic context. A basemap may include background reference information such as landforms, roads, landmarks, and administrative boundaries. It displays below any other layers and is typically excluded from the legend. A basemap is used for locational or spatial data reference. [3].

Geocoding is the process of determining geographic coordinates for place names, street addresses, and codes (e.g., zip codes). Geocoding is typically preceded by the data cleaning step of preprocessing and standardizing the format of the data you will be geocoding. Related tasks include batch geocoding (geocoding multiple addresses, place names or codes at one time) and reverse geocoding (determining the nearest street address for a given point location specified as a latitude and longitude). [4]

The geocoding process is used because our database does not contain geographic coordinates directly, but only text-based addresses, which need geographic coordinates to be graphically represented. Although another plugin, GeoCoding, is available for this task, it is unable to batch-process multiple addresses simultaneously. In order to use MMQGIS, our database must be in a format readable by the plugin. The required format is .csv (Comma Separated Values), which can be obtained directly from an Excel .xls file by selecting the "Save As" option and choosing the CSV format.

Before utilizing the geocoding function, a base map will also be required. To insert this base map into our project, there are several options available. However, for convenience, we will use specific plugins, depending on the desired base map, whether it is sourced from Google Maps, Google Earth, OSM, or others. To achieve this, we will use the HCMGIS [5] plugin.

After inserting a base map, which will appear as a layer on the left side, the data from the CSV files will be imported using MMQGIS. When using MMQGIS, certain adjustments to the reporting settings will be necessary, the most important of which is the selection of the provider responsible for geocoding the addresses. For this purpose, we will use a Geocoding API [6], which can be the free and open-source service provided by OSM, or the geocoding

service offered by Google Cloud. In the case of the latter, an API key, obtainable from the Google Cloud platform, will be required, which necessitates a Google account. Additionally, the service provided by Google is not entirely free and imposes certain limits under its free tier.

In the present project, I used the service provided by Google Cloud, as it offers much greater accuracy and ensures the location of all pharmacies in the database. When using the Google service, out of 176 pharmacies, it successfully geocoded 174, whereas the OSM service was only able to report 56 out of the 176 pharmacies.

An optional, but recommended step to follow, is modifying the properties of the reported data. The geocoded data with MMQGIS will appear as a single layer, with each geocoded CSV file having its own corresponding layer. By selecting a layer and choosing the "Properties" option, any desired attributes can be modified. In this case, we will adjust the size of the symbol used to represent each pharmacy, change its color to differentiate pharmacies from different years, and label each pharmacy by attaching its corresponding name.

Creating an interactive HTML interface for the map is quite a straightforward an easy process. Once the GIS map is completed, using another plugin called qgis2web, it is possible to easily create an HTML site containing all the necessary elements for navigating the GIS map directly from a browser such as Google Chrome. [7]

Creating a map in HTML format is particularly valuable, as with the functionality provided by GitHub, specifically GitHub Pages, the map can be quickly and freely hosted, allowing it to be accessed from anywhere, including mobile devices. For this, a GitHub account will be required. Furthermore, the webmap can easily be hosted from a personal computer using a custom domain.

The qgis2web plugin is installed in the same manner as the other plugins. After installation, the "Create Web Map" function will be selected. In the window that appears, the desired modifications can be made, with the option to preview the changes on the right side of the window.

An important setting is selecting the "Cluster" option, which dynamically groups the pharmacies, represented as colored points, based on the map's zoom level. This allows for easy visualization of the total number of pharmacies in a given area, enabling comparisons between different regions and observing the increase or decrease in the total number of pharmacies across the years in the observed areas.

After adjusting the settings, the "Export" function will be chosen, using the export option as a folder.

The last step needed to finish this project is to publish the map using various means. Using GitHub Pages, this step involves creating a GitHub account and establishing a new repository, which will be made public, with the GitHub Pages option activated. The data exported from qgis2web will be uploaded to the repository. After completing the aforementioned steps, the link provided by GitHub will be accessible, allowing users to interact with the map.

All the aformentioned steps can easily be recreated using a simple workflow chart as shown in Figure 1.

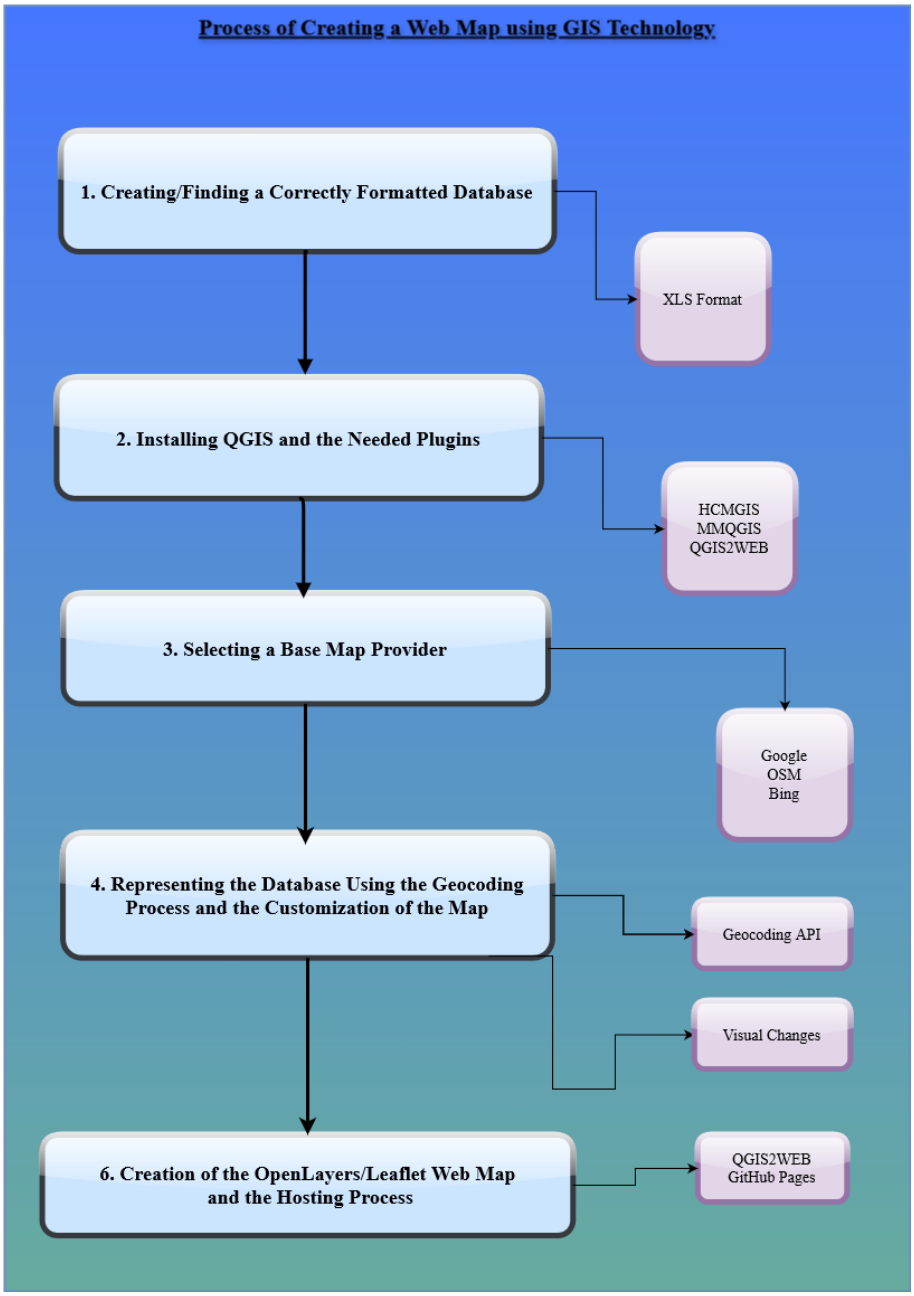

Figure 1 A simple wrkflow chart showcasing the whole process

3. Results and Discussion

The present application is a GIS application, as it is based on a relatively large dataset in tabular form, represented textually in Excel. By converting the Excel files into CSV format, these data can be represented against a reference map, such as those provided by Google Maps or OSM. This facilitates easier visualization of the data, allows for statistical analysis, and enables the creation of easily interpretable graphs. This graphical representation of a database within a GIS application is both impressive and useful, especially when conducting specialized studies.

With the help of this application, studies can be conducted on the dynamics of the pharmaceutical industry in Sibiu County, enabling an overview of various regions over

multiple years while simultaneously displaying additional information about each pharmacy, such as name, address, chief pharmacist, whether it is located in a rural or urban environment, establishment date, and more. Furthermore, it allows for advanced searches based on multiple criteria for different pharmacies. In addition to the market studies that can be performed using this GIS application, it also facilitates the simple search for a pharmacy in the user's vicinity based on distance, time, pharmacy chain, etc.

As mentioned before, the webmap created through this project can be seen in Figure 2 and used accessing the following GitHub Page: https://kiningston.github.io/QGIS-Map/

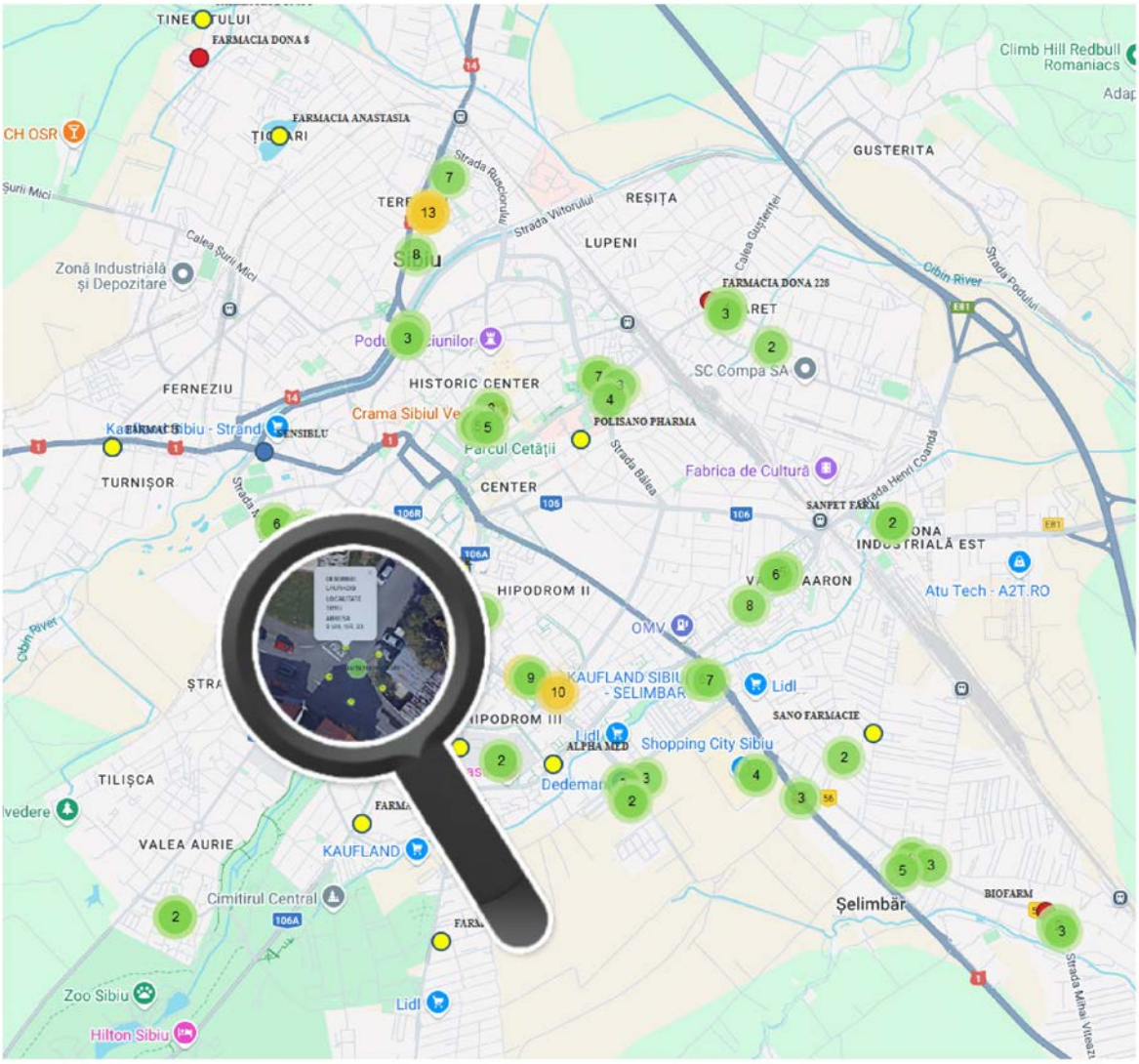

Figure 2 The generated webmap

4. Conclusions

The development of this application involved researching various important QGIS functions and extensions that may be necessary and applicable in many other GIS applications.

The creation of this interactive GIS map represents a significant advancement in the visualization and analysis of spatial data related to the pharmaceutical industry in Sibiu County. Among the most notable achievements of this application are the successful

integration of a substantial dataset converted from Excel to CSV format, allowing for efficient geocoding and representation on a base map. Another aspect that was discovered creating this map was the greatly improved performance of the Google Geocoding API over the one provided by OSM.

Also, the application’s use of the MMQGIS plugin facilitated the dynamic clustering of pharmacies, enhancing the user’s ability to observe trends over time. Furthermore, the incorporation of an HTML interface via the qgis2web plugin enables seamless access and interaction with the map through web browsers, making the data easily accessible to a broader audience. This interactive platform not only supports in-depth market studies but also provides essential information about individual pharmacies, thereby serving as a valuable tool for researchers, policymakers, and the general public interested in the dynamics of the pharmaceutical sector.

5. References

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