

SIG Denúncia - Web GIS of Popular Participation in the Public administration

Henrique Pereira de Freitas Filho
Instituto Federal de Brasília
Campus Taguatinga
Brasília, Brasil
Email: henrique.filho@ifb.edu.br

Thiago Oliveira de Freitas, Johnny Evangelista
Figueiredo
Instituto Federal de Goiás
Campus Luziânia
Goiás, Brasil
Email: thiago.oliveira.f@outlook.com,
johnnyestudos@gmail.com

Abstract—The participation of the population in public management results in different solutions from those that can be obtained without their involvement, because it is the inhabitants who know the local problems and can present details that are not usually obtained from other sources. In order to receive and manage denunciations related to public services, focusing on the involvement of society, it is necessary to create systems capable of registering, organizing and presenting this information covering the geographic position of each occurrence. In this sense, a computational solution called SIG Denúncia was developed, which includes an Android application, a Web Geographic Information System (Web GIS) and a geographic database, which together allow the collection, visualization and storage of the alphanumeric and geographic data of each denunciation received regarding public services.

Index Terms—Web Geographic Information System (Web GIS); Geographic Database; SIG Denúncia; Public Services; Public Administration; Popular Participation.

I. INTRODUCTION

PUBLIC services are provided directly by a country's government or by affiliated entities with the aim of meeting the needs of the population and their habitat. Among the most important services are hospital care, police patrols, educational activities, public transportation, maintenance of recreational areas, environmental preservation, urban works, and others. These services, when delivered with quality, ensure the well-being of citizens and the preservation of urban spaces and nature. However, when these services are executed irregularly, they can negatively impact people's daily lives, resulting in serious social problems, particularly in Brazil, where the majority of individuals have low incomes and rely on these services daily [1].

The collection of data on complaints related to public services in Brazil is generally conducted through phone calls or in-person visits. A citizen calls or goes to the public agency responsible for overseeing the public activity to report their dissatisfaction. This process often leads to data loss and inconsistency, as the collected information is typically stored on paper, which can easily be misplaced or lost due to its

fragility. Consequently, this method does not provide a reliable and consistent database. The difficulty faced by the population in participating in public matters fosters public dissatisfaction and results in low data collection, which could be crucial for improving the services provided by each Brazilian municipality [2].

Public participation in the management of public services is mandated by Brazilian law to improve the quality of public administration [3]. The residents of each city are the ones who truly understand the local realities and issues and are able to provide details that are often not found in other sources [4].

With the digital transformation that has occurred in Brazil in recent years, citizens in many cities have gained a new means of reporting issues related to public services through the web systems of public agency ombudsman offices. While this innovation partially addresses the previously mentioned database issues and offers greater convenience and satisfaction to the population, challenges remain. For each area or type of complaint, citizens must access a specific system of a specific agency to file their report; there is no unified system for submitting all types of complaints. After a complaint is made, only the individual who submitted it receives feedback and has access to the status of the complaint. Other citizens are unaware of the complaints that have already been filed, resulting in a lack of transparency. Additionally, these ombudsman systems do not utilize georeferencing, making it difficult to pinpoint locations and have an overarching view of the issues presented in the complaints [5].

Despite the widespread availability of mobile and web technology in Brazil, public administration in several Brazilian cities still lacks the digitization of many of its work processes, including the collection and management of information on the quality of public services, particularly those involving public participation [6].

To address this issue, a computational system was developed, consisting of a mobile application, a Web Geographic Information System (Web GIS), and a geographic database. With the mobile application, citizens can register their com-

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plaints in text format and include a photo to verify the existence of the reported problem.

The Web GIS will provide visualization and management of the occurrences received by the system, ensuring that city administrators can respond to complaints received through the application, and allowing the population to view a map containing the data of each reported issue, thereby ensuring transparency of information for society.

The geographic database will be used by both the mobile and web applications to store and query the alphanumeric and geographic data of complaints related to health, safety, education, transportation, recreation, the environment, and urban development projects. This database can be extended to persist data from various other areas of public services.

The system was developed using modern software development technologies that allow for the maintenance of up-to-date information. It highlights the issues present in each environment within the municipal, state, and federal spheres, as well as the expectations of its users.

II. POPULAR PARTICIPATION IN PUBLIC ADMINISTRATION

The concept of public administration has two meanings. One is objective, encompassing the idea of action, activity, and task, encapsulating the very function of administering. The other is subjective, as it refers to the universe of administrative sectors and the people who perform management work collectively, sharing the same function [1].

Popular participation refers to the involvement of citizens or their representatives from social groups in public management with the aim of seeking improvements within the administration of the State, implemented to favor the collective interest [7]. This term is used when a citizen or their social representative seeks the common good without pursuing personal interest. It conceptualizes the exercise of society's power over Brazilian politics and expresses the democracy mandated by law in the contemporary era [8] [9].

In Brazil, societal participation gained greater emphasis following the 1988 Brazilian Constitution, which granted a series of rights and duties to Brazilians, including the right to human dignity and citizenship [1]. Article 1 of the Constitution emphasizes that all power emanates from the people, who exercise it directly or through democratically elected representatives. Article 37 of the Constitution outlines the right of Brazilian citizens to participate directly or indirectly in public governance [10].

In recent decades, there has been enhancement in discussions and legislation addressing the participation of Brazilian society. However, the achieved outcome is not yet considered fully democratic due to low popular engagement, as the government has not managed to include the majority of the urban population, attributed to three main factors described below [7][9]:

- 1) Political apathy: occurs when the population lacks information about their rights and responsibilities, receives no feedback through public communication channels with government officials, does not

receive responses to their inquiries, or experiences excessive delays in response times, leading to low levels of popular participation;

- 2) Political abolition: becomes evident when citizens choose not to engage in public management due to their disbelief in being heard by the government and having their requests addressed;
- 3) Political acrycy: is the issue that arises when citizens' level of education is low and the participation tools provided by the government address complex terms and data, which hinders the involvement of individuals who lack sufficient education to engage in public management affairs.

According to [4], the Brazilian government still requires effective tools to ensure the rights established by laws for citizens, aiming to enhance the quality of popular participation. There remains a challenge in the daily lives of public service users to efficiently engage in matters related to their areas of life.

III. THE SIG DENÚNCIA

A. Architecture

The architecture of the SIG Denúncia solution shown in Figure 1 was designed following the thick client model.

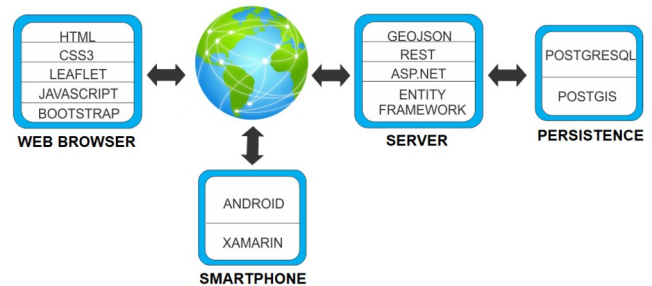


Fig 1. Architecture of the SIG Denúncia

The SIG Denúncia is a computational solution (system) that consists of two applications sharing the same geographic database:

- Mobile Application: The mobile application is responsible for collecting and submitting citizens' complaints to the server. The framework Xamarin was used for the development of this system. The communication between the application and the server is conducted using RESTful, with data transmitted in JSON format;
- Web GIS: It was built using HTML5, CSS3, JavaScript, Bootstrap, and Leaflet technologies. The web system is divided into two parts:
 - Map: This is the homepage of the web system, responsible for displaying georeferenced complaints from citizens. In this layer of the system, Leaflet was utilized as the primary component of the Web GIS. Leaflet is responsible

for generating and managing the map within the client's browser. Data communication between the server and Leaflet is performed using RESTful, with information transmitted in GeoJSON format;

- Administrative: The administrative area manages the system's forms, utilizing the Bootstrap framework to ensure a responsive interface. This allows the interface to adapt seamlessly to the client's browser screen size.

In the Server layer, technologies such as ASP.NET MVC, RESTful, GeoJSON, and Entity Framework were employed. ASP.NET manages the operations of the system's forms, while the RESTful communication layer returns responses in JSON and GeoJSON formats. ASP.NET utilizes Entity Framework for mapping, controlling, and accessing persistence.

The Persistence layer is responsible for storing registration information. The PostgreSQL database management system with the PostGIS geographic extension was used to store geographic information.

B. Technologies Used

The following are the technologies used in the SIG Denúncia:

- ASP.NET MVC: Part of the .NET framework, ASP.NET MVC was designed for creating websites. Websites built with ASP.NET run on Internet Information Services (IIS) and can be developed using C#, F#, and VB.NET languages. ASP.NET MVC implements the Model-View-Controller (MVC) pattern, a software architecture pattern created to abstract the complexity of information systems by separating development into layers [11];
- C#: It is an interpreted, multi-paradigm programming language rooted in C and easily assimilated by developers familiar with C, C++, and Java [12]. C# is compiled and interpreted within the .NET framework;
- GeoJSON: It is a data interchange format for various geographical data structures based on the JSON format. GeoJSON supports geometric types such as Point, LineString, Polygon, MultiPoint, MultiLineString, MultiPolygon, and GeometryCollection [13];
- Leaflet: It is a robust open-source library developed in JavaScript with a simple design. It operates on all major browsers and mobile platforms, supporting CSS3 and HTML5 [14]. Developers need to connect Leaflet to a map server, which can be public like OpenStreetMap [15], private, or personal using a geographic database management system (GIS) such as PostgreSQL together with PostGIS. Georeferenced objects are added to the map through the GeoJSON layer. Thus, Leaflet can manage interactive layers;

- PostgreSQL: It is an open-source data storage system. PostgreSQL is a powerful framework for data management and processing, as it allows the use of multiple languages to execute functions and triggers, making it flexible. It features dynamic loading of user-defined functions, eliminating the need for recompiling the database, and includes automatic actions to update changed data in the database. The system is available for MacOS, Linux, and Windows operating systems [16];
- PostGIS: It is an open-source spatial extension for the PostgreSQL database management system (DBMS). This extension enables PostgreSQL to support spatial types such as Point, LineString, Polygon, Multipoint, MultiLineString, MultiPolygon, and GeometryCollection. PostGIS provides numerous functions for spatial queries, allowing geographic queries to be performed using SQL;
- Xamarin Community 2015: It is a framework used for developing cross-platform mobile applications. It allows developers to create native apps for iOS, Android, and Windows Phone using a single language, C#. This means a team of C# developers can produce an application for three different platforms without needing to learn a new language [17].

IV. SYSTEMS INTERFACE

The SIG Denúncia consists of a mobile application and a Web GIS. This section presents the interfaces of these systems.

A. Mobile App

This section demonstrates the interface of the mobile application and its functionalities. To make a complaint, users need to log into the system. Therefore, users must enter their email address and password. If they have not registered yet, they can click on "Register" on the home screen of the system.

The application has two main tabs: "Report" and "Complaint History". The "Report" tab consists of four sub-tabs (as shown in Figures 2 and 3), which represent the steps required to make a complaint, described as follows:

- Area: The citizen must choose the area where they will make the complaint;
- Type: After selecting the area, the user must choose the type of complaint. Each type of complaint is listed under categories; Figure 2 displays the categories within the "Infrastructure and Urbanization" area and the types of complaints that can be made under the "Lighting and Energy" category;
- Additional Information: The citizen must attach an image to their complaint by clicking "Attach a photo to your Complaint" and enter a comment in the field below;
- Submit: On this screen, all complaint details are displayed for the user to confirm. The user must

have the GPS location active on their Android device; if it is disabled, the app will request the user to activate it. The "Submit" button is only enabled after the device's location is determined. After submitting the complaint, the app returns to the "Area" tab.

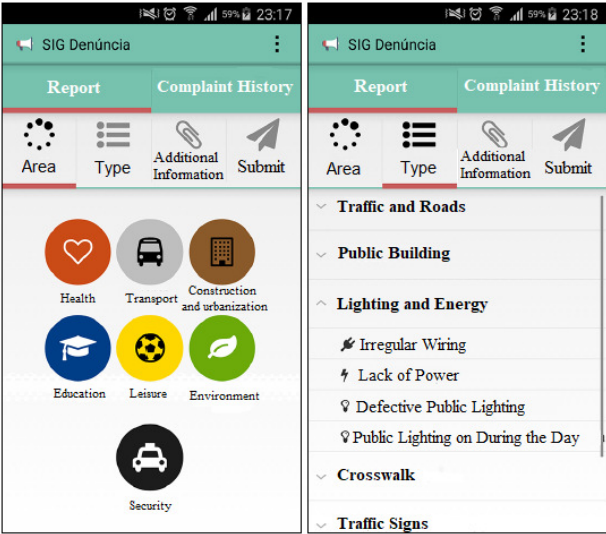


Fig 2. Screens of the "Report" tab - Part 1

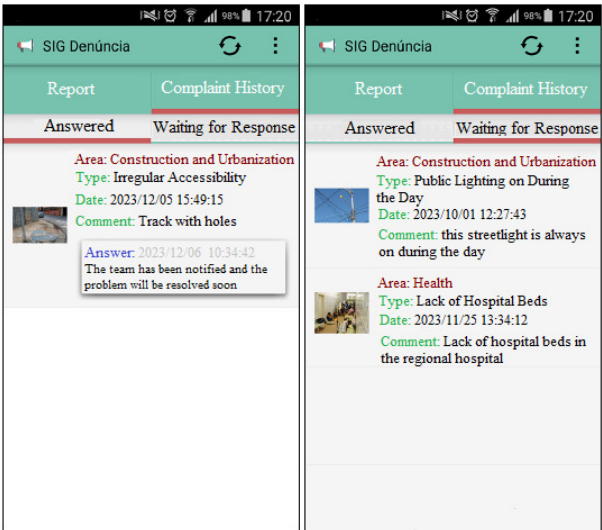


Fig 3. Screens of the "Report" tab - Part 2

The "Complaint History" tab displays the complaints submitted by the user regarding public services and the responses provided by public agencies, as shown in Figure 4.

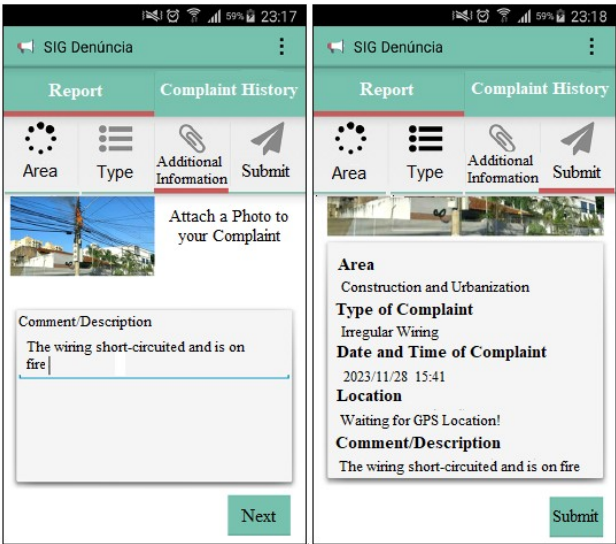


Fig 4. Screens of the "Complaint History" tab

B. SIG Web

The Web GIS has two main areas: the map area (georeferenced) and the administrative area. In the map area, all complaints are displayed at their respective locations. Figure 5 depicts the initial screen of the Web GIS.

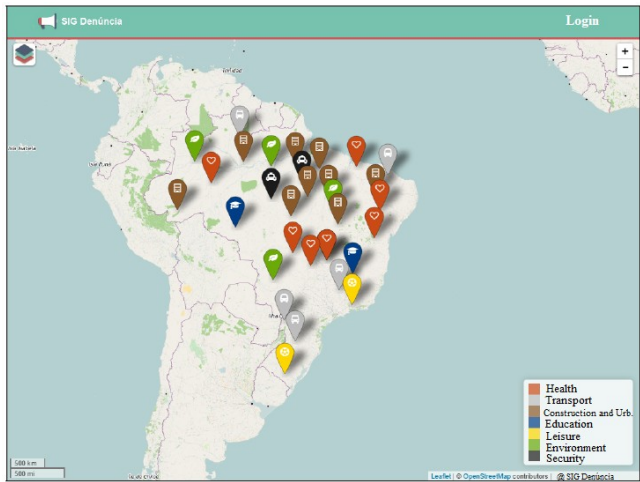


Fig 5. Screens of the Web GIS - Part 1

Clicking on a complaint icon displays a tooltip containing information about the complaint, such as the citizen's name who submitted the complaint, type, category, city name, comment, date, latitude, longitude, and the image uploaded by the citizen, as shown in Figure 6.

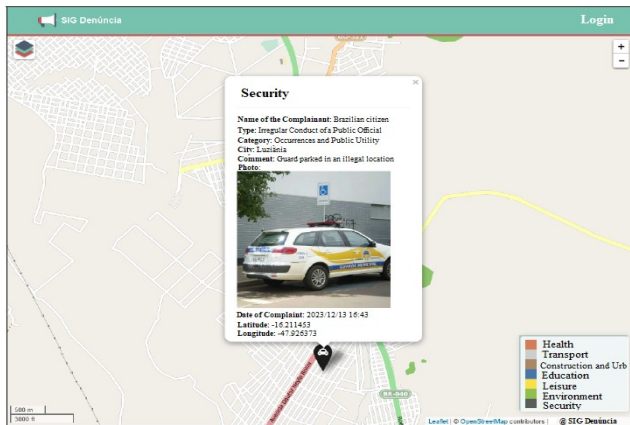


Fig 6. Screens of the Web GIS - Part 2

In the administrative area, the administrator user has functionalities to respond to complaints, as well as to add, edit, and delete areas and users. Figures 7 and 8 depict some screens from the administrative area.

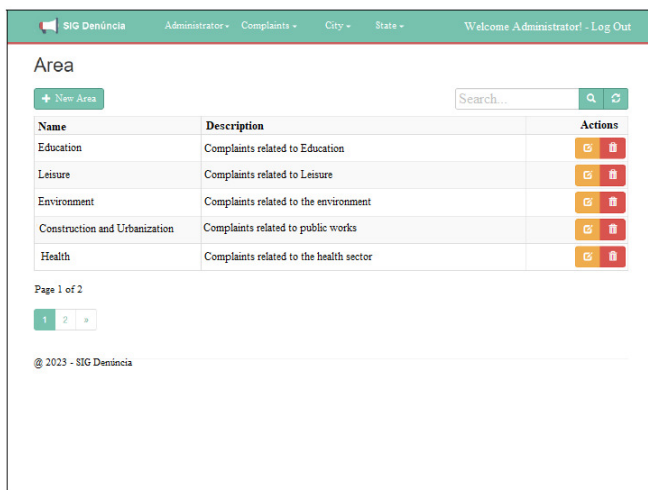


Fig 7. Screens of the administrative area of the Web GIS - Part 1

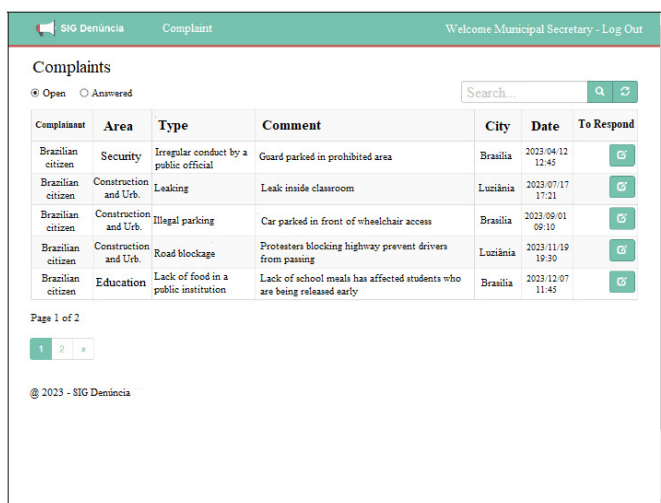


Fig 8. Screens of the administrative area of the Web GIS - Part 2

V. RELATED WORK

Similar works to the SIG Denúncia solution also encompass the issue of public participation in public services.

A. Colab.re

Colab.re is a digital platform that provides government services to citizens through a web interface and a free mobile application available for Android and iOS devices. Its primary objective is to improve Brazilian cities by fostering collaboration between the population and public authorities. The platform enables users to report urban issues, submit evaluations, and suggest solutions, with complaints being forwarded to the appropriate government agencies. While it offers functionalities such as photo submission, idea sharing, and public discussion, Colab.re does not incorporate georeferencing features to locate reports, which limits the spatial accuracy of the submitted information [18].

B. SP156

SP156 is a public service platform developed by the São Paulo City Hall to encourage citizen participation in municipal management. Similar to Colab.re, its primary focus is the provision of public services to citizens through a web portal, a mobile application, and a telephone service center (accessible via 156). Although the systematic collection of complaints is not its core objective, the system allows users to register and track requests related to urban issues, such as waste management or street lighting. However, SP156 does not utilize georeferencing to locate reported occurrences, which limits the spatial accuracy of the information and reduces its potential for territorial analysis [19].

C. The Differentiator of SIG Denúncia

SIG Denúncia stands out from other similar platforms by being specifically designed for the management of urban complaints, with a strong emphasis on the spatialization and georeferenced monitoring of reported occurrences. While many existing solutions prioritize the provision of public services or the simple forwarding of individual requests, SIG Denúncia distinguishes itself by integrating georeferencing capabilities, which add substantial value to the decision-making processes of public administration.

The use of spatially referenced data enables precise visualization of the territorial distribution of citizen demands, facilitating the identification of patterns, critical areas, and recurring problems. This approach supports more efficient urban planning, strategic resource allocation, and the development of public policies grounded in territorial evidence. Furthermore, it allows municipal authorities to adopt a more proactive and coordinated approach, guided by the geographic context of reported issues.

Additionally, the system is characterized by its configurational flexibility, enabling administrators to easily define new categories of reports and designate specific geographic areas of interest. This versatility ensures that the platform can be adapted to the particular needs of diverse urban settings, ranging from large metropolitan centers to small mu-

municipalities. In this way, SIG Denúncia establishes itself as a robust, scalable, and effective tool for strengthening participatory governance and integrated territorial management in cities.

VI. CONCLUSION AND FUTURE WORK

Currently, in several cities across Brazil, for a citizen to file a complaint or express dissatisfaction to the government, they must physically visit the responsible public agency or make a phone call. However, even after going through this process, their reports may get lost because they are stored on paper, which is prone to misplacement or loss due to its fragility. Therefore, it is evident that individuals face difficulties in presenting local issues to public administration and tracking their submitted requests.

To address this issue and improve public participation in governance matters, the development of a computational solution called "SIG Denúncia" has been proposed. This solution comprises a mobile application, a Web GIS (Geographic Information System), and a geographic database. Together, these components enable better interaction between public service users and city administrators for tracking incidents and potential resolutions.

Unlike other similar systems, which often focus primarily on the provision of public services and are developed for specific contexts, SIG Denúncia was designed with an emphasis on the structured management of urban complaints, enabling the registration, consultation, and systematic monitoring of reported occurrences. One of the main distinguishing features of the solution is the integration of georeferencing capabilities, which allow for the spatial mapping of complaints and significantly enhance the system's potential to support decision-making processes within public administration. The spatial analysis of data facilitates the identification of critical areas, the detection of recurring patterns, and the strategic prioritization of interventions based on evidence. Moreover, SIG Denúncia offers a high degree of configurability, allowing for customization across different categories of complaints and geographic areas, making it suitable for a wide range of urban contexts—from large metropolitan centers to small municipalities.

The mobile and web applications were developed in strict accordance with the proposed architecture, fully fulfilling their intended role as integral components of a Web Geographic Information System (Web GIS) designed to promote Popular Participation. Although the system has not yet been deployed in an operational environment, its design and implementation demonstrate substantial potential to significantly enhance the interaction between citizens and public administration. By fostering greater transparency, facilitating more efficient responses from public agencies, and encouraging active citizen engagement, these functionalities contribute meaningfully to the strengthening of participatory urban governance.

As part of future work, several enhancements are planned, including the addition of features such as audio and video

messaging, data caching to enable offline functionality, and mechanisms for information synchronization when an internet connection becomes available. The system is also intended to be deployed in a Brazilian city, with a subsequent evaluation of the outcomes to complete and validate the research. Additionally, tools and dashboards may be developed to provide strategic insights to public administrators, following the principles of Business Intelligence (BI).

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