Community Participation and Web Mapping with Open Source Technologies: An Approach to the Identification and Dissemination of Intangible Cultural Heritage: A Case Study of Analco, Mexico

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Abstract

The integration of web mapping with Intangible Cultural Heritage (ICH) can provide a powerful tool for the identification, documentation, preservation, and promotion of cultural manifestations in a given location. Web mapping enables the creation of interactive and accessible maps that dynamically and visually represent geographic and cultural information. As part of a doctoral research project, we designed and developed a web application to disseminate the ICH of the Analco neighborhood in Puebla, Mexico, a site included in the UNESCO World Heritage List. Through a community-based participatory process, supported by participatory mapping and the integration of other data sources, we implemented a pilot project for a web mapping tool using technologies such as JavaScript, CSS, HTML, and LeafletJS. The resulting project was deployed on a test server, the tool was presented to the community, which, in a free, informed, and collaborative manner, authorized the dissemination of their cultural information to other interested parties, leveraging the advantages of the internet to promote their heritage. The initial version was positively evaluated by the community in terms of design, functionality, and usability, though it was concluded that additional multimedia content generated by the community is needed. We found that web mapping, combined with community participation through participatory mapping, offers an innovative and effective approach to preserving and promoting cultural traditions. By leveraging open-source technologies and fostering active collaboration, communities can ensure that their cultural heritage is recognized, valued, and transmitted to future generations in a dynamic and interactive manner.

1. Introduction

The exponential growth of the internet has gone hand in hand with the progress of web mapping, understood as "the process of designing, implementing, generating, and delivering maps via the internet" (Shekhar & Xiong, 2009). This has allowed us to transition from paper maps to dynamic maps with multimedia content such as images, videos, audio, hyperlinks, and other web platforms that were difficult to imagine just a few years ago. These maps can be accessed from different locations and reach a wider audience, to the point that their use has become so commonplace that it may even seem simple to some extent.

In the field of cultural heritage—understood as both tangible and intangible—there are extensive studies that locate cultural elements in their material form due to the ease of representing physical objects based on their spatial location. However, a less explored area is the representation and dissemination of intangible cultural elements, as they seemingly lack a spatial component, making their identification and representation challenging. While mapping them was difficult some years ago, advances in technology and the advent of the internet have allowed us to capture intangible cultural manifestations and representations in various formats and interact with diverse applications and platforms.

This study sought to involve the community in identifying and representing their intangible cultural manifestations, defined as "the practices, representations, expressions, knowledge, and skills as well as the instruments, objects, artifacts, and cultural spaces associated therewith that communities, groups, and, in some cases, individuals recognize as part of their cultural heritage" (UNESCO, 2003a), acknowledging that it is difficult to separate them from their physical aspects.

The data were primarily obtained through a participatory mapping exercise conducted in 2023, where cultural manifestations were represented mainly in mental maps, combined with other sources of information such as memory cards and spatially referenced audio files provided by the community.

Following the paradigm shift introduced by UNESCO with the definition of Intangible Cultural Heritage (ICH) in the Convention for the Safeguarding of the Intangible Cultural Heritage (2003) and the manifestations it encompasses (UNESCO, 2022), a clear methodology for identifying and representing ICH remains ambiguous. Article 15 of this document mentions community participation in these processes: "Each State Party shall endeavor to ensure the widest possible participation of communities, groups and, where applicable, individuals that create, maintain, and transmit such heritage, and to involve them actively in its management" (UNESCO, 2003).

This new perspective presented an opportunity to integrate ICH with digital technologies, such as the creation of electronic inventories where online community participation enabled the development of platforms like ICHPEDIA for web-based inventories that store and display ICH manifestations (Artese & Gagliardi, 2022; Soon, 2014). Other collaborative platforms, such as the one presented by Mathioudakis et al. (2022), collect narratives on cards and then use web tools and augmented reality (AR). These digital ICH inventory approaches follow a bottom-up approach, where the community generates knowledge through their experiences, narratives, lived experiences, or inherited knowledge passed down through generations.

Another type of collaborative methodology is participatory mapping, which is "a process in which community members

generally contribute their own experiences, relationships, information, and ideas about a place to create a map" (Cochrane & Corbett, 2018). Participatory mapping and other tools such as cultural mapping, counter-mapping, or community mapping share the common focus of involving communities and giving them a voice. These techniques, when applied to ICH—such as cultural mapping—allow the transformation of the intangible and invisible into tools for heritage management, education, and intercultural dialogue (Crawhall, 2010).

While these techniques are effective, they employ highly varied procedures, ranging from paper maps, models, mental maps, 3D models, and other analog formats (McCall & Larrain, 2023). With the emergence and evolution of web mapping and its diverse technologies, a new alternative for representing and disseminating ICH from the community's perspective arose.

Web mapping, defined as "the process of designing, implementing, generating, and delivering maps on the World Wide Web" (Shekhar & Xiong, 2009), gained momentum with platforms like Google Maps, OpenStreetMap (OSM), Microsoft, and Yahoo!, and later with the release of their APIs, which allowed users to map their own data and distribute it on the web (Rouse et al., 2007). Combined with rapid advancements in internet infrastructure, development technologies, and the exponential increase in mobile devices, web mapping became a powerful tool applied to many areas, including ICH.

The application of methodologies such as participatory mapping and the advent of web mapping have resulted in a remarkable integration—the former for identification and the latter for the dissemination of cultural heritage, where users can generate content and share it locally or on a broader scale. However, there are few initiatives applying web mapping with participatory approaches to ICH. Lai et al. (2012) designed a WebGIS based on ICH information using MSSQL Server 2008, .NET technology, and Google Earth. The Peruvian Ministry of Culture developed an audiovisual map of intangible heritage, where web mapping allows the representation of elements and manifestations through multimedia content (Ministry of Culture of Peru, 2025).

This integration of methodologies and techniques provides an opportunity for users to collectively generate content using web mapping tools supported by crowdsourcing, where ICH elements such as myths and legends can be represented and linked to their material aspects using applications like ArcGIS (Ziku et al., 2024), with the community actively participating in the process.

Another case study is that of Conejo-Arrabal et al. (2022), who employed an ICH mapping methodology based on community identification and recognition through participatory actions such as interviews, guided tours, and workshops, integrating the data into the WebGIS ARCHES (Arches Project Open Source Data Management Platform, 2015), enabling the analysis of connections between ICH and its territory.

In the area of integrating participatory methodologies and applying web mapping tools to ICH, there are few case studies according to the literature review, considering it is a relatively new field from both technological and epistemological perspectives—the latter concerning who validates heritage and its various social functions. These two approaches may seem difficult to reconcile.

2. Case study

Analco, one of the earliest foundational neighborhoods of Puebla City (designated a UNESCO World Heritage Site in 1987 (UNESCO World Heritage Centre, 1987)), is located in central Mexico. Characterized by its orthogonal street grid—a hallmark of 16th-century Spanish colonial urban planning—the neighborhood derives its name from the Nahuatl term meaning "on the other side of the river" (Siméon, 2007). While its exact origins remain unclear, archaeological and historical evidence suggests initial settlement by Indigenous groups from surrounding regions.

Situated southeast of Puebla’s Monument Zone (Fig. 1), Analco was historically separated from the city’s core by the now-covered San Francisco River. Like many colonial-era neighborhoods, it has experienced urban decay yet retains its original urban layout and a distinctive material and intangible heritage—even amidst modern urban pressures.

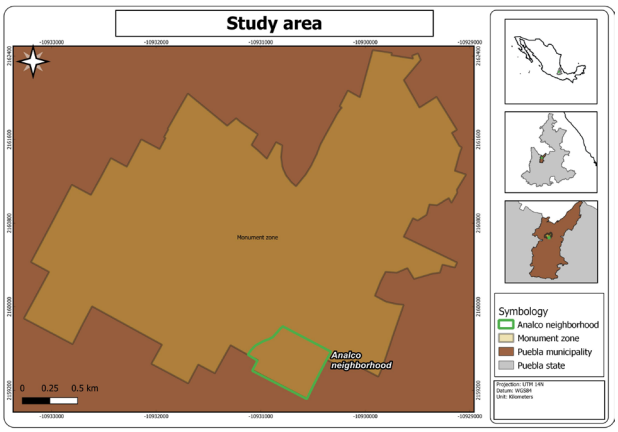

Figure 1. Location of the Analco neighborhood.

3. Methodology

This research employed qualitative methods structured in two sequential phases:

Phase 1.- *Participatory Mapping Exercise*

The initial phase involved a participatory mapping approach to extract local spatial knowledge regarding the identification and recognition of ICH for example: oral traditions such as the legend of the stone cross, the black charro, social practices such as neighborhood patron saint festivals. Community-generated analog materials were subsequently digitized into geographic formats to facilitate spatial analysis and preservation.

Phase 2.-*Web Mapping Development*

The second phase focused on developing an interactive web mapping platform to represent traditionally challenging-to-map ICH elements. The implementation utilized:

- Core web technologies (HTML, CSS, JavaScript)
- Open-source frameworks (LeafletJS for dynamic cartographic visualization)
- OpenStreetMap (OSM) as the base mapping service

The platform was designed under a participatory framework where community members served as both data producers and primary end-users (Fig. 2). The methodological approach, conducted with Free, Prior, and Informed Consent (FPIC), enabled the community to collectively decide on external dissemination of their cultural knowledge through the web-based platform.

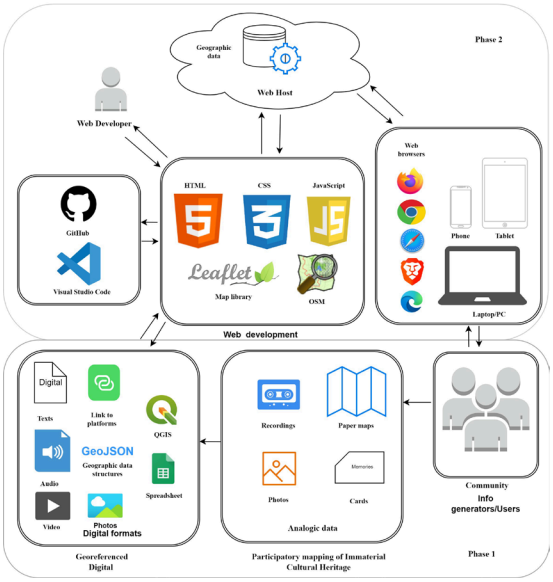

Figure 2. Methodological approach with 2 main phases.

3.1 Phase 1 – Participatory mapping exercise

The data presented in this study correspond to a participatory mapping exercise conducted in August 2023 (Fig. 3), obtained from the local spatial knowledge of 18 residents of the Analco neighborhood, aged between 37 and 88 years, who voluntarily shared their knowledge individually and collectively regarding the neighborhood's intangible cultural manifestations. These were classified according to Article 2 of the Convention for the Safeguarding of the ICH (UNESCO, 2003c).
This Article defines the manifestations as:
a) Oral traditions and expressions, including language as a vehicle of intangible cultural heritage;
b) Performing arts;
c) Social practices, rituals, and festive events;
d) Knowledge and practices concerning nature and the universe;
e) Traditional craftsmanship.
For this research, two additional types of knowledge were included: Facts and Values, both concepts defined by McCall & Larrain (2023, p. 29). The former is described as: *"Technical knowledge, similar to scientific knowledge in terms of characteristics, structure, purpose, and cognition, but which is only knowable by local people."* The latter is defined as: *"Spatial knowledge representing the diverse viewpoints, priorities, interests, and concerns of different local actors, which differ from the dominant 'official vision' and often also reflect internal distinctions."* (McCall & Larrain, 2023, p. 30).
Although participatory mapping encompasses a wide variety of methods, techniques, and tools—ranging from sophisticated 3D models to simple yet communicative mental maps (Larrain et al., 2022; McCall & Larrain, 2023)—the preliminary planning phase considered variables such as participants' age, time allocated for mapping, schedule availability, educational level, physical condition, and even weather conditions. Most importantly, we prioritized the community’s knowledge over technological tools, which, while useful for data collection (e.g., ODK - Collect Data Anywhere, 2025; KoboToolbox, 2025) and facilitating georeferencing in later stages, involve a learning curve. Instead, we opted for more basic yet efficient techniques, such as mental maps and audio recordings, ensuring participants felt comfortable and familiar with the process while emphasizing the community's extensive local spatial knowledge.
Participants were divided into two heterogeneous groups and shared their knowledge primarily through printed maps without street names, using only basic references such as the location of the neighborhood church. Blank cards were provided for them to record facts, values, and memories related to their ICH. Due to the age range, some participants preferred alternative communication methods and opted for audio recordings, all with signed consent.
This approach ensured that the methodology was accessible while effectively capturing the community's ICH.


Figure 3. Participatory Mapping Activity 1.

For this initial mapping exercise, support was provided by a team of seven members from “Casa Analco”, a university-led project aimed at enhancing social cohesion through heritage-related activities (Hernández Sánchez et al., 2021). The team consisted of cultural heritage specialists, anthropologists, and Geographic Information Systems (GIS) experts, who served solely as facilitators for the participants. Their role was to assist in the process without contributing their own knowledge, ensuring that community participation remained uninhibited.
Following the participatory mapping, the analog data was digitized through the transcription of cultural manifestations and elements depicted on the maps, as well as written memories on cards with their approximate locations converted into digital text files. Audio and video recordings were spatially referenced using geographic landmarks, similar to a geocoding process, to later plot them on a digital map. All collected data was compiled into spreadsheets with corresponding geographic references (coordinates) for subsequent mapping.
The identified cultural expressions were classified according to Article 2 of the Convention for the Safeguarding of the ICH (UNESCO, 2003d). However, only three categories (a, c, e) were recorded in this exercise, while no manifestations were identified for the remaining two (b, d)—meaning participants did not report cultural expressions in those classifications. Additionally, we incorporated the categories of Facts and Values, as illustrated in Table 1: Cultural Manifestations Identified in the Participatory Mapping.
This methodological approach ensured an accurate and participatory representation of the neighborhood’s ICH while maintaining the integrity of local knowledge.

Manifested	Audio	Text	Video	Images	Lines (movement)	Total
a) Oral traditions and expressions, including language as a vehicle of the intangible	4	19	0	0	0	23
b) Performing arts;	0	0	0	0	0	0
c) Social practices, rituals and festive events;	4	3	1	7	4	19
d) Knowledge and practices concerning nature and the universe;	0	0	0	0	0	0
e) Traditional craftsmanship.	1	31	0	0	0	32
Facts	8	33	0	30	0	71
Values	4	37	0	0	0	41
						186

Table 1: Cultural manifestations identified in the participatory mapping.

Once the information was categorized, it was stored in CSV (Comma Separated Values) format and subsequently processed using the geographic information system software QGIS (*Spatial without Compromise · QGIS Web Site, 2024*). The data was then converted into GeoJSON format (*GeoJSON, 2024*), a relatively recent standard implemented between 2015–2016 for encoding geospatial data. GeoJSON is widely adopted for representing geographic features—such as points, lines, and polygons—along with their associated attributes in a structured and interoperable manner.
This conversion facilitated efficient spatial analysis and visualization while ensuring compatibility with modern web-based mapping platforms.

3.2 Phase 2 – Web-mapping development.

For the development phase, Visual Studio Code (*Visual Studio Code - Code Editing. Redefined, 2024*) was used as the primary code editor, optimized for web and cloud-based application development. GitHub was employed for version control and code management. The project utilized JavaScript (*JavaScript | Oracle Developer, 2024*) for creating interactive web applications, along with HTML5—the latest standard markup language for webpage structure, featuring significant multimedia enhancements—and CSS for styling elements such as fonts, colors, and visual effects.
With this foundational web development triad (HTML, CSS, JavaScript), which is supported by most web browsers, the next step was selecting a mapping library. Among available options—including ArcGIS Maps SDK, Google Maps API, and LeafletJS—each with distinct advantages and disadvantages tailored to specific project needs (*Solpieva, 2023*), LeafletJS (*Agafonkin, 2024*) was chosen for its modularity, extensive documentation, and adaptability to project requirements. According to Crickard III (2014), while lightweight, LeafletJS incorporates nearly all essential mapping functions, with additional functionalities available through plugins.
For map services, OpenStreetMap (OSM) (*OpenStreetMap, 2024*) was selected as the primary provider due to its community-driven, frequently updated, and open-access nature. Secondary basemaps included ESRI’s World Imagery (*Imagery with Metadata - Overview, 2024*) and Stadia Maps (*Stadia Maps, 2024*), the latter under a basic access-tier plan, providing three basemap options.
With geospatial data converted to GeoJSON, web development proceeded with a focus on responsiveness—ensuring compatibility across various screen sizes and devices. The platform includes in this first versión:

- Default zoom-in/zoom-out controls
- Scale bar and minimap
- Geolocation (real-time user positioning within the study area, without data storage)
- Layer (category) toggle buttons, mimicking traditional GIS software functionality
- A "Show" button listing participatory mapping contributors
- A "Return to Analco" button to recenter the map on the study area
- A button linking to a page describing data collection methodology
- A return-to-map button
- A welcome pop-up with a brief description (*Fig. 4*)

This design ensures an intuitive, accessible, and informative user interface for exploring the neighborhood’s ICH.

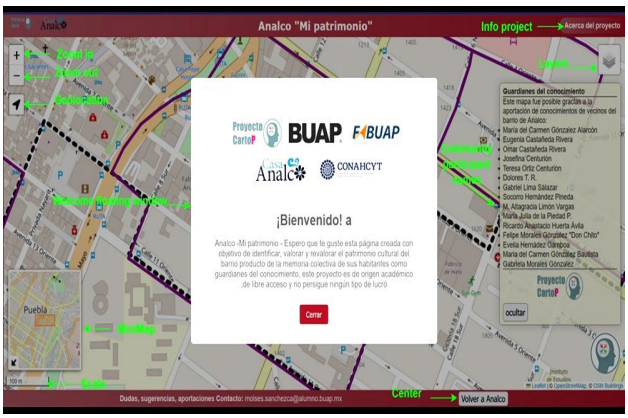

Figure 4: Analco “Mi patrimonio” platform home window.

The first version of the platform features a responsive web design, ensuring optimal display across diverse devices with varying screen sizes—from mobile phones to large desktop monitors. To track engagement, Google Analytics (Google Analytics, 2024) was integrated for visit monitoring and analysis.
Hosted on a dedicated domain, the platform was presented to community members in December 2023, offering two access methods:
1.-QR code (Quick Response), a widely adopted access technique
2.-Direct entry via http://mipatrimoniocultural.com/ (Fig. 5)

The research team provided guidance during initial access, ensuring the community—whose knowledge formed the platform’s core content—were the first to interact with the published results. This participatory approach reinforced transparency and local ownership of the digital outcomes.

https://mipatrimoniocultural.com/

Conoce el patrimonio cultural del barrio de Analco
desde la visión de la comunidad.

Figure 5. Brochure delivered to the community to access the platform.

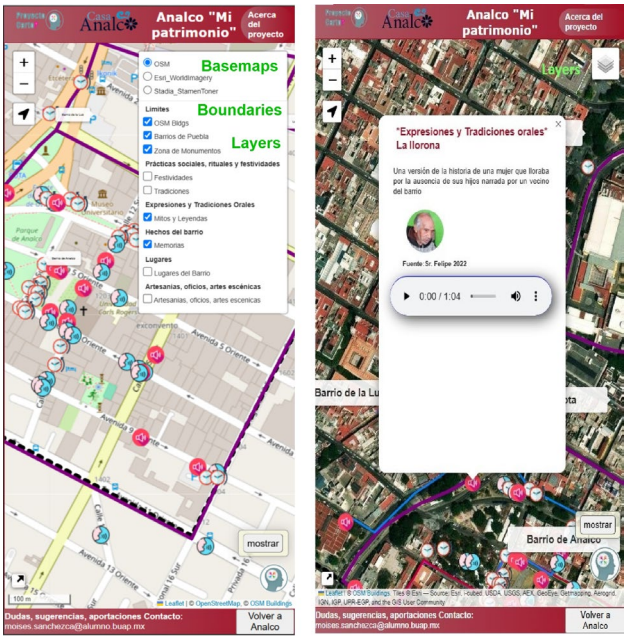

Figure 6. Left image shows the organization of the platform's content by layers. Right image shows an example of multimedia content viewed from a mobile phone.

The platform's layer system is structured into the following components:

1. Basemaps: Multiple base layer options including OSM and ESRI World Imagery
2. Boundary layers:
    - Historic neighborhood boundaries (including Analco)
    - Monument zones
3. 3D Building Service (*OSM Buildings, 2024*): Currently disabled in this development version due to performance limitations during initial mobile testing, particularly regarding load times and data consumption
4. Cultural manifestation layers:
    - Social practices, rituals, and festive events
    - Oral traditions and expressions
    - Neighborhood facts
    - Significant places
    - Traditional crafts, trades, and performing arts

The layer organization is visually presented in *Figure 6 (Left): Platform content structure*.

As previously noted, LeafletJS was selected in part for its responsive design capabilities. The interface dynamically adapts to mobile devices while handling multimedia content, though rendering may vary slightly depending on:

- Browser type
- Mobile operating system
- Screen dimensions

These variations are illustrated in *Figure 6 (Right): Responsive design demonstration across devices*.

3.3 Platform Dissemination and Community Feedback

The final project phase focused on platform dissemination and community feedback, employing the two previously described access methods to enhance accessibility for primary contributors (predominantly aged 50+). Outreach sessions were conducted using tablets and smartphones, supplemented with headphones for improved user experience (*Figs. 9-10*). This enabled the community to visualize and interact with their participatory mapping results in digital format.

Specialized support was provided to elderly participants, including:

1. Technical guidance on platform access
2. Navigation assistance through content
3. Post-interaction evaluation via structured surveys assessing:
    - Content accuracy
    - Functional performance
    - Interface design
    - Usability metrics
    - Improvement suggestions

Community feedback was gathered via a survey to evaluate the first version of the tool. The survey was administered to participants of the initial mapping process, as they were the primary data contributors and the central focus of the study. Due to mobility limitations, some surveys were conducted in participants' homes using mobile devices**.** The questions focused on content, interface design, functionality performance, and improvements for a future version.

In the content section, 100% of respondents indicated that they liked the application's content, as well as its functional performance. Regarding interface design, participants selected the (cherry color) as representative of the neighborhood. According to the survey, 94% responded that they liked the design (Fig. 7), finding the buttons intuitive and well-adapted to devices such as tablets and mobile phones.

In terms of usability (Fig. 8), respondents reported that the tool was very easy to use for 39%, easy to use for 50%, and difficult to use for 11%.

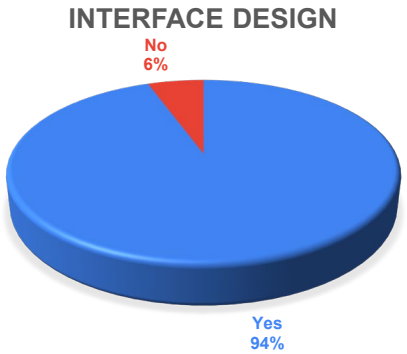

Figure 7: Interface design survey chart.

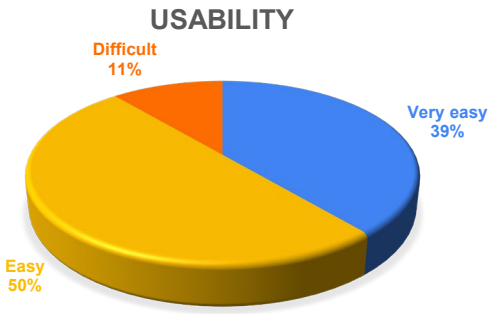

Figure 8. Usability graph.

The final part of the survey consisted of an open-ended question regarding improvements that the participating community would like to see in a second version. The responses were diverse due to the nature of the question, but 70% agreed on aspects related to content and enriching the tool with more multimedia material.

This feedback mechanism ensures iterative refinement for future versions while maintaining community-centered design principles.

Figure 9. Neighbour who participated in the participatory mapping by browsing the platform.

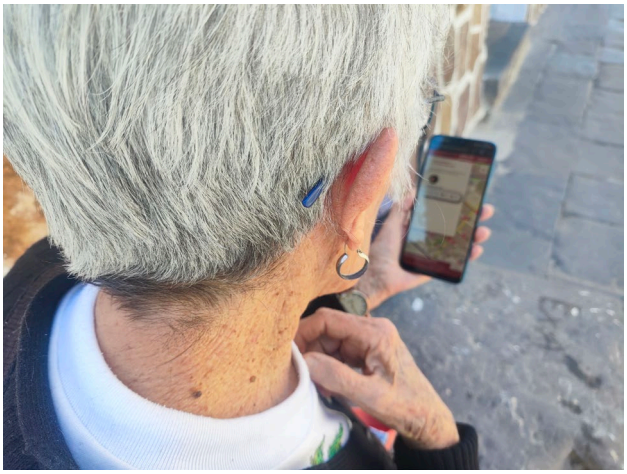

Figure 10. Access the Analco "Mi patrimonio " platform from your mobile phone.

4.Conclusions

The development of web-mapping solutions using open-source technologies, combined with participatory methodologies, represents an innovative strategy for safeguarding Intangible Cultural Heritage (ICH). This project successfully designed, developed, and implemented an open-access web-mapping platform that integrates community-generated data with open-source geospatial technologies to document and disseminate the cultural heritage of Analco.

The exponential growth of web-mapping technologies, driven by mobile device proliferation and improved digital infrastructure, has enabled new forms of participatory heritage documentation. By integrating participatory mapping with open-source geospatial tools, communities gain agency in representing their heritage, fostering greater project acceptance and reinforcing cultural ownership.

Advances in low-cost geospatial technologies and participatory mapping now facilitate the spatial documentation of ICH including social practices, rituals, festive events, oral traditions, and performing arts, which historically resisted cartographic representation. This methodology offers place-based contextualization, anchoring cultural practices within their physical and historical landscapes. A central contribution of this work is to strengthen the epistemological legitimacy of local/Indigenous knowledge systems regarding their cultural heritage. Geospatial visualization tools, particularly web-based cartographic platforms enable the systematic documentation and standardized scientific classification of culturally significant sites, material artifacts, and intangible heritage elements.

Involving participants from planning to dissemination instilled a sense of ownership, directly contributing to platform acceptance. Elderly participants (50+), often excluded from digital projects, engaged meaningfully through tailored outreach sessions.

Current implementation at local scale requires testing for expansion to neighboring districts. GeoJSON storage limitations may necessitate migration to spatial databases (e.g., PostGIS) for larger datasets. 3D building layers were disabled due to mobile performance constraints but remain a target for future optimization.

Temporary hosting underscores the requirement for institutional support—both financial and technical—to ensure long-term viability. Planned dissemination includes public workshops, school engagements, and government outreach, contingent on community consent.

This research provides a methodological framework for Participatory ICH identification through inclusive mapping, Open-source web-mapping as a decolonized representation tool, allowing communities to control heritage visibility (private/shared).
The study demonstrates how participatory geospatial technologies can democratize heritage preservation while respecting local autonomy—a model applicable to global contexts facing similar cultural safeguarding challenges.

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