Client-Side Geospatial Visualization for Tourism: Supporting a Leaflet-Based Web App

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Abstract

This paper presents the development and implementation of a lightweight, entirely client-side web mapping tool tailored for users of short-term rental platforms. By leveraging Leaflet.js, OpenStreetMap data, and custom GeoJSON layers, the application enables location-aware experiences without relying on server-side infrastructure. The approach demonstrates a scalable, replicable architecture for smart tourism applications that non-developers can deploy. The application features custom markers, multimedia popups, interactive tools (search, measurement, drawing), and contextual menus for emergency contacts and promotions. The map centers on the apartment location, offering a personalized, location-aware digital guide for short-term visitors. Initial deployment and user feedback demonstrate the system's usability, efficiency, and potential for improving local orientation and decision-making. While the current version requires developer intervention for updates, future improvements will focus on automating data input via a CSV-based metadata structure or a graphical user interface (GUI). This will enable property owners to manage their content independently, paving the way for a scalable, no-code geospatial solution for small-scale hospitality providers. The project highlights the potential of open-source web GIS tools in democratizing innovative tourism technology. Technically, the project demonstrates how an entirely client-side web mapping tool can deliver personalized, spatially anchored experiences without any backend infrastructure, using open-source technologies such as Leaflet and OpenStreetMap. This client-side architecture exemplifies a lightweight, no-backend web GIS solution that can be deployed in data-scarce environments or by users without programming knowledge.

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Introduction

In recent years, the rapid growth of short-term rental platforms such as Airbnb has transformed urban tourism and reshaped the way travelers interact with local environments. Unlike traditional hotel services, platform-based short-term lodging often lacks structured tourist guidance or concierge support, leaving guests dependent on commercial mapping services or fragmented recommendations. As a result, there is a growing demand for location-aware digital tools that provide hyperlocal, customized information tailored to the guest's immediate surroundings (Neuhofer et al., 2015; Xiang & Gretzel, 2010).

Web-based geospatial technologies, particularly those built using open-source tools, offer a powerful, scalable means of addressing this gap. Tools like Leaflet.js and GeoJSON enable developers to construct lightweight, mobile-friendly map applications that can visualize spatial data and support user interaction without requiring server-side infrastructure (Haklay & Weber, 2008; Brunsdon & Comber, 2015). These applications are well-suited for innovative tourism environments, where personalization, immediacy, and simplicity are key (Gretzel et al., 2015).

This paper presents a client-side interactive mapping platform. The application integrates multiple categories of Points of Interest (POIs), organized via structured GeoJSON files and rendered dynamically using Leaflet.js. The map is centered on the apartment location, with a focus on walkable access to local amenities, including traditional restaurants, nightlife venues, parks, and historical sites. Additional features include interactive pop-ups with images and links, emergency contact integration, and promotional messaging.

The goal of the project is twofold: first, to explore how web-based geospatial interfaces can improve the visitor experience at a micro-urban scale; and second, to propose a replicable, low-cost, and manageable framework even for non-technical users. The application has been successfully deployed in a real-world context, and this paper outlines the design methodology, results, and future directions, particularly a shift toward metadata-driven or GUI-based automation to increase the system's scalability and autonomy.

Literature Review

Smart Tourism and Digital Personalization

The rise of smart tourism has transformed the way destinations and local businesses engage with travelers. Smart tourism involves integrating information and communication technologies (ICTs) to create personalized, real-time, location-based experiences (Gretzel et al., 2015). These systems empower tourists to explore places based on their preferences and context while supporting local providers through better visibility and interaction. In the context of Airbnb and similar platforms, this personalization is often missing, as hosts typically provide static descriptions with limited spatial intelligence (Neuhofer, Buhalis, & Ladkin, 2015).

Digital tools that localize content and visualize surroundings, such as map-based applications, offer a compelling solution. Tourists increasingly seek location-aware services that go beyond basic navigation, preferring interfaces that highlight curated places of interest, display distances from their accommodation, and support planning decisions (Tussyadiah & Pesonen, 2016). Xiang et al. (2017) highlight the growing reliance on digital content, reviews, and personalized mapping platforms in shaping tourist behavior and decision-making.

Web GIS and Open Mapping Technologies

Open-source Web GIS platforms have made interactive mapping more accessible to non-governmental actors, small businesses, and individuals. Libraries like Leaflet.js, in combination with GeoJSON for spatial data structuring, provide the tools necessary to build rich, browser-based mapping interfaces without the need for backend servers. These frameworks are mobile-friendly, lightweight, and extensible, making them ideal for projects that focus on user-centric geospatial storytelling (Brunsdon & Comber, 2015).

Moreover, user-generated geospatial content is gaining traction as a reliable source of spatial information. Jokar Arsanjani et al. (2015) assessed the reliability of OpenStreetMap data and concluded that, with proper filtering and context, it can offer high-quality base data for urban applications. As Antoniou, Morley, and Haklay (2010) demonstrated in their assessment of Web 2.0 geotagged photos, applications built on volunteered geographic information (VGI) can provide accurate and meaningful spatial coverage, especially when curated and contextualized around specific user needs, such as urban tourism.

From Static Maps to Metadata-Driven Applications

While many custom mapping applications are technically sound, their long-term usability often depends on whether non-technical users (e.g., property owners or local hosts) can manage and update the data independently. This is where metadata-driven architectures and geoportals become relevant. Maguire and Longley (2005) highlight how geoportals and spatial data infrastructures (SDIs) rely on metadata records to organize and expose geographic content in a flexible, user-friendly way. By separating the user-facing interface from the underlying data source, systems can become dynamic, allowing real-time or self-managed updates.

The future of lightweight mapping tools for tourism likely lies in no-code or low-code systems that enable content updates via spreadsheet-like interfaces (e.g., CSV) or user-friendly graphical dashboards. In the Albanian context, Hysenaj and Barjamaj (2012) emphasized the need for Web GIS platforms that support local data dissemination and user interaction. Their vision for a regionally managed mapping infrastructure laid the groundwork for scalable, citizen-accessible tools such as the one proposed in this study. This aligns with Batty et al. (2010), who describe the rise of Web 2.0 map mashups as a democratizing force in geospatial development, enabling user-generated data integration and simpler deployment models. Such an approach would enable lodging providers, tour operators, and even municipalities to manage POIs and tourism content without modifying the application code.

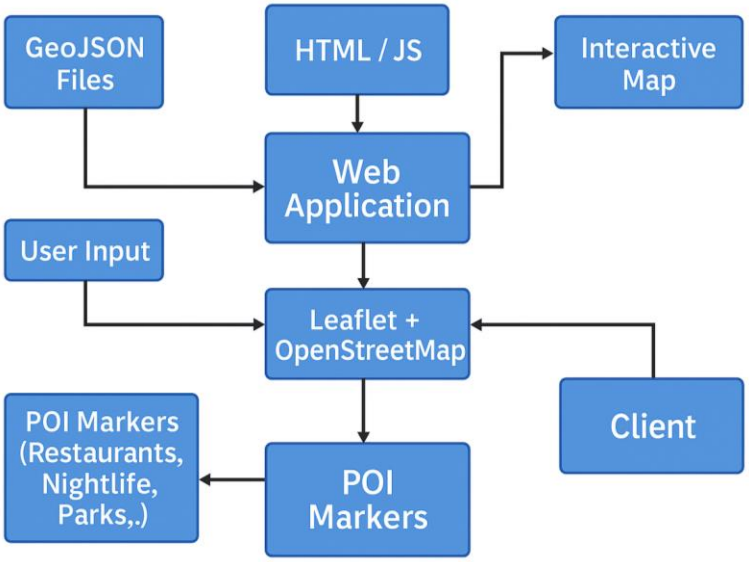
Methodology

Application Architecture and Technologies

The application was developed as an entirely client-side, web-based platform using HTML, CSS, and JavaScript. As Peterson (2014) notes, client-side web mapping approaches such as Leaflet represent a shift toward decentralized, scalable cartographic tools that can be deployed without server infrastructure. Its interactive mapping functionality is powered by Leaflet.js, a lightweight, widely adopted open-source framework for building mobile-friendly maps. To provide the base map, OpenStreetMap (OSM) tiles were used for their free, open access and global coverage. We adopt a set-theoretic approach to process multiple spatial datasets, as similarly formalized by Chyrun & Vysotska (2014).

A modular structure was adopted to keep code maintainable and scalable. The HTML file serves as the main entry point, responsible for importing all relevant scripts and stylesheets, initializing the map canvas, and managing user interface components. JavaScript functions handle map interaction logic, layer toggling, custom popup rendering, and user-triggered events. The app does not rely on a back-end server, allowing it to be hosted locally or embedded within other platforms, such as lodging providers' property pages (Figure 1).

Figure 1
Data flow and system architecture of the lodging providers mapping application, showing the interaction between static data sources (GeoJSON), the web application logic, Leaflet-based rendering, and user interface controls.



Source: Author's illustration

Data Management and Integration

Points of Interest (POIs) are organized into multiple GeoJSON files, with each file representing a different category of attraction, such as restaurants, bars, nightlife, historical sites, parks, and miscellaneous venues. A separate GeoJSON file defines the site's location, which serves as the anchor point for the map experience. Each GeoJSON entry includes properties such as name, address, distance, image_url, and link, which are later parsed into interactive map elements.

These datasets are loaded asynchronously into the application and rendered as dynamic vector layers. Each layer is styled with a unique icon, helping users visually distinguish between POI categories. The separation of content (GeoJSON) from application logic (JavaScript) ensures that future updates or expansions can be handled easily by editing or replacing metadata files without modifying the core codebase.

User Interaction and Visualization Features

The application emphasizes ease of use and flexibility. Upon initialization, the map centers on the apartment's location, marked with a custom icon. Users can interact with the map through various controls, including zoom, search, and category toggles. A custom sidebar allows filtering by POI type, while the map interface includes

optional tools such as a ruler for distance measurement, drawing capabilities for annotations, and live coordinate tracking.

To enhance the application's usability and spatial awareness, several advanced features were integrated into the client-side interface. Users can switch between base maps and activate thematic layers, such as streets and buildings, rendered from preprocessed OpenStreetMap (OSM) GeoJSON data (Figure 2). A custom search functionality enables users to locate specific street names interactively, utilizing indexed OSM-derived attributes (e.g., name, type, maxspeed). In addition, a legend widget provides semantic clarity by categorizing Points of Interest (POIs) using intuitive icons and color codes. These enhancements allow the web application to simulate key functionalities of a full-fledged GIS platform, while remaining fully browser-based and accessible without server-side dependencies.

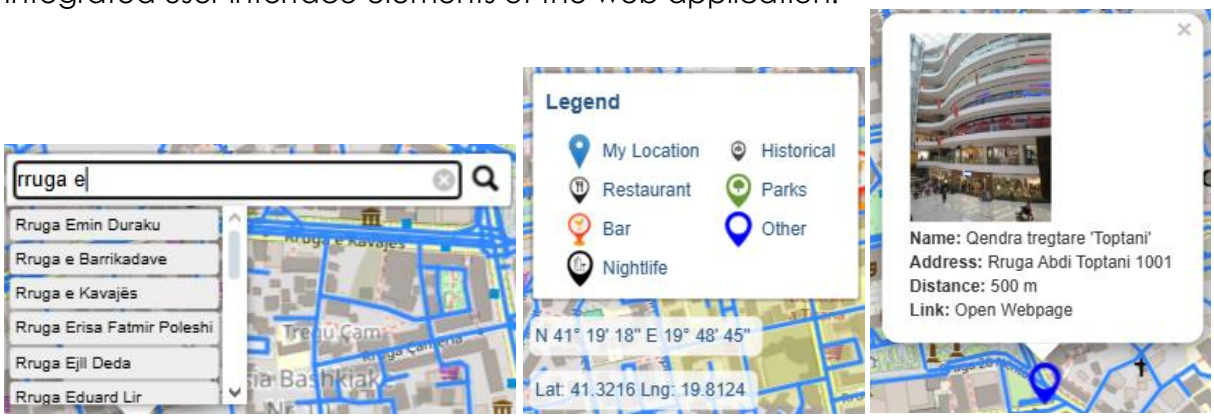
Figure 2

The interactive map interface displays Points of Interest (POIs) by type, with custom icons and filters in the right sidebar.

Source: Author's illustration

As shown in Figure 3, the web application provides a responsive search bar with indexed street data and a legend to interpret POI categories on the map. Each POI is rendered with a clickable marker. When selected, the marker displays a pop-up with an image, distance, and an external link (Figure 3).

Figure 3
Integrated user interface elements of the web application.



Each POI is represented by a clickable marker that opens a rich popup containing an image, address, and a hyperlink to external sources (e.g., Google Maps or social media). These features enhance tourist decision-making by offering both spatial and contextual information in a concise, visually attractive format. In addition, the system includes a collapsible legend and categorized layer control using the L.Control.The PanelLayers plugin allows users to show or hide layers as desired.

Spatial Logic and Personalization

The concept of spatial anchoring was applied by positioning the site's location as the central node of the entire interface. All distances within the GeoJSON data are expressed relative to this location, allowing users to assess how far each attraction is from their accommodation. This approach makes the map inherently personal and practical, particularly for tourists unfamiliar with the city layout.

To support safety and communication, additional features were integrated into the user interface, including collapsible menus with emergency service contacts, apartment support phone numbers, and promotional offers. These sections are conditionally displayed based on user interaction, further enhancing the tool's personalization and utility. An overview of the complete system architecture, including data loading, marker rendering, user interface logic, and external interactions, is illustrated in Figure 1, which provides a flowchart of the core components and their relationships within the application.

Results

During the initial deployment of the application, the platform was made available to guests through a web link accessible from their booking confirmation or QR code within the property. Informal feedback collected from early users was encouraging: guests appreciated the ability to quickly identify nearby places of interest, assess walking distances, and visually explore recommended locations. The inclusion of preview images and direct links to external web pages enhanced usability and trust. The application performed consistently across devices (desktop and mobile), with no server dependency, ensuring high availability and low maintenance costs. Users found the map intuitive, and the average interaction time suggested strong engagement with the content.

Discussion

The project demonstrates how modern web technologies, specifically Leaflet, GeoJSON, and client-side scripting, can empower small accommodations to deliver personalized, map-based guidance without the need for complex infrastructure. The structuring and monitoring of geospatial data in our system parallel the information resource processing methods proposed by Chyrun et al. (2016), which used unified models to streamline content architecture in web-based environments. By organizing data in a modular format and embedding it into an interactive map interface, the application creates a hyper-localized digital guidebook tailored to a single address and its surroundings.

However, while the tool provides significant value, it currently depends on developer involvement to update or modify the POI data. Adding new restaurants, changing contact details, or updating promotional offers requires direct editing of the GeoJSON or JavaScript files. This limits the tool's scalability, particularly for hosts with limited technical knowledge or multiple locations to manage.

To overcome this limitation, a future version of the platform should incorporate an automated, metadata-driven backend that allows the host to manage their own content. This can be achieved either through:

- A structured CSV file that feeds directly into the application via a parser, or
- A simple graphical user interface (GUI) that allows users to add, edit, or remove POIs without modifying code.

Such features would transform the system into a low-code or no-code platform, increasing accessibility and enabling broader adoption by non-technical users in the hospitality sector. As emphasized by Batty et al. (2010), the democratization of GIS through Web 2.0 technologies enables new paradigms of participatory and scalable mapping. The current system aligns with this trend, demonstrating that even non-technical stakeholders can benefit from geospatial integration when supported by modular and open standards.

Conclusion

This study presents a client-side, lightweight, and fully interactive map application designed for lodging providers' guests seeking localized guidance. By combining open-source tools and structured geographic data, the application delivers a visually engaging, user-friendly experience that helps travelers navigate urban environments, discover local businesses, and make informed decisions.

Future work will focus on extending the system to allow dynamic data entry through metadata files or a built-in form interface. By empowering hosts to independently manage content without requiring technical expertise, the solution can evolve into a scalable framework suitable for widespread deployment across rental properties, hostels, and boutique hotels. Additional improvements may include multilingual support, real-time event overlays, and integration with booking platforms or QR-based user onboarding.

This project contributes not only to digital tourism experiences but also offers a replicable model for lightweight, client-side GIS applications. By avoiding server dependencies and using modular data structures, the application architecture is ideal for small-scale deployment by non-experts. Future developments will focus on automating configuration via metadata files or graphical interfaces, enabling end users to manage their own content without programming knowledge. Technically, the application reinforces the viability of zero-backend GIS systems by combining

open mapping data and modular client-side architecture a model that can be replicated across other tourism scenarios.

References

1. Antoniou, V., Morley, J., & Haklay, M. (2010). Web 2.0 geotagged photos: Assessing the spatial dimension of the phenomenon. *Geomatica, 64*(1), 99–110. https://doi.org/10.5623/geomat-2010-0009
2. Batty, M., Hudson-Smith, A., Milton, R., & Crooks, A. (2010). Map mashups, Web 2.0 and the GIS revolution. *Annals of GIS, 16*(1), 1–13. https://doi.org/10.1080/19475681003700831
3. Brunsdon, C., & Comber, L. (2015). *An introduction to R for spatial analysis and mapping*. SAGE Publications.
4. Chyrun, L., & Vysotska, V. (2014). Set-theoretic models and unified methods of information resources processing in e-business systems. *Applied Computer Science, 10*(3), 5–22.
5. Chyrun, L., Vysotska, V., & Laba, R. (2016). Information resources analysis in electronic content commerce systems. *Applied Computer Science, 12*(1), 48–66.
6. Gretzel, U., Sigala, M., Xiang, Z., & Koo, C. (2015). Smart tourism: Foundations and developments. *Electronic Markets, 25*(3), 179–188. https://doi.org/10.1007/s12525-015-0196-8
7. Haklay, M., & Weber, P. (2008). OpenStreetMap: User-generated street maps. *IEEE Pervasive Computing, 7*(4), 12–18. https://doi.org/10.1109/MPRV.2008.80
8. Hysenaj, M., & Barjamaj, R. (2012). Web GIS Albania platform, an informative technology for the Albanian territory. *Informatica, 36,* 431–439.
9. Jokar Arsanjani, J., Mooney, P., Zipf, A., & Schauss, A. (2015). Quality assessment of OpenStreetMap data using analytical methods. In *OpenStreetMap in GIScience* (pp. 113–132). Springer. https://doi.org/10.1007/978-3-319-14280-7_6
10. Maguire, D. J., & Longley, P. A. (2005). The emergence of geoportals and their role in spatial data infrastructures. *Computers, Environment and Urban Systems, 29*(1), 3–14. https://doi.org/10.1016/j.compenvurbsys.2004.05.012
11. Neuhofer, B., Buhalis, D., & Ladkin, A. (2015). Smart technologies for personalized experiences: A case study in the hospitality domain. *Electronic Markets, 25*(3), 243–254. https://doi.org/10.1007/s12525-015-0182-1
12. Peterson, M. P. (2014). *Mapping in the cloud.* Guilford Press.
13. Tussyadiah, I. P., & Pesonen, J. (2016). Impacts of peer-to-peer accommodation use on travel patterns. *Journal of Travel Research, 55*(8), 1022–1040. https://doi.org/10.1177/0047287515608505
14. Xiang, Z., & Gretzel, U. (2010). Role of social media in online travel information search. *Tourism Management, 31*(2), 179–188. https://doi.org/10.1016/j.tourman.2009.02.016
15. Xiang, Z., Du, Q., Ma, Y., & Fan, W. (2017). A comparative analysis of major online review platforms: Implications for social media analytics in hospitality and tourism. *Tourism Management, 58,* 51–65. https://doi.org/10.1016/j.tourman.2016.10.001

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