A Scale-Aware Web GIS Architecture for Village-Level Exploratory Spatial Interaction: Design, Implementation and Scenario Evaluation

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Abstract

Following the COVID-19 pandemic, independent travel has become a tourism trend, and the use of digital tools to support exploratory spatial interaction in rural tourism has increased. While Web-Based Geographic Information Systems (Web GIS) have been widely applied in tourism research, most of these applications focus on visualization or promotion, with few examining the application of village-based exploratory spatial interaction tools. This research introduces DTExplorer, a scale-aware Web GIS application powered by curated spatial data. DTExplorer enables category- and radius-based exploration of curated Points of Interest (POIs), reflecting how independent travelers make decisions in rural destinations, where proximity, thematic relevance, and clustering of visits are the main spatial choice factors. The system was developed using a research and development (R&D) approach and implemented as a Web GIS application using Node.js, JavaScript, MySQL, Google Maps and an interactive mapping interface. DTExplorer has been tested and passed functional and scenario testing. These findings indicate that at the village level, the main focus of effective exploratory spatial interaction has not been based on analytical complexity and optimization-based models. Rather, the efficacy of exploratory interaction arises through the spatial scale congruence, user decision reasoning, and controlled POI data governance. Combining curated POI data with simple spatial operations such as proximity and category-based filtering, DTExplorer demonstrates the potential of simple GIS functions to be applied as meaningful exploratory spatial interaction in rural tourism situations. This study contributes to applied geoinformatics by redefining exploratory spatial interaction in rural tourism as a scale-aware, design-oriented process rather than an analytical one. This work advances theoretical knowledge on adapting Web GIS for small-scale destinations and demonstrates the strategic importance of curated spatial data in community-based tourism decision-making.

Keywords: Curated POI, Exploratory Spatial Interaction, Scale-aware Web GIS, Village-Scale Tourism, Web GIS

1. Introduction

The COVID-19 crisis has significantly changed tourism trends worldwide and increased the trend toward independent travel, smaller destinations, single-destination trips, and localized tourism experiences [1][2][3][4] and [5]. With the growing number of tourists avoiding congested urban areas, tourism villages have become an attractive substitute that provides open space, authenticity of culture, and community-based experiences [6][7][8][9] and [10]. Consequently, reliable and spatially explicit information is crucial for destination selection and travel planning, particularly for independent travelers [11][12][13] and [14]. As part of these behavioral changes, digital technologies have become increasingly integrated into tourism planning processes [15][16][17] and [18]. Digital tourism platforms are now widely used to support destination discovery, information search, pre-trip planning, and on-site navigation [19][20] and [21]. Developing tourism villages plays a strategic role in Indonesia's post-pandemic tourism recovery and sustainable local development [10] and [22]. Although digital tourism solutions have been increasingly developed, the majority of the current systems are mainly geared towards information delivery and destination promotion, and lack support for spatial reasoning and exploratory travel planning at small geographic scales [23] and [24].

Independent travel planning is inherently a spatial process [25]. Spatial proximity, accessibility, and spatial layout influence the choice of attractions to visit, the combination of two or more POIs, and the possibility of covering travel distances in a limited time [26]. In village tourism settings, tourists often make these decisions with limited prior spatial knowledge, with information sources that are not necessarily complete and with limited dedicated spatial interaction tools [24]. This frequently requires travelers to manually cross-reference information across multiple platforms, increasing their cognitive load and decreasing their efficiency in planning. GIS offers a potential solution to this data integration problem.

GIS offers proven tools for combining spatial and attribute data, and for conducting spatial analysis and queries [27][28][29] and [30]. These capabilities can be provided by Web GIS platforms that allow for interactive geographic exploration without the need for special software [31][32] and [33]. Although tourism research extensively employs Web GIS, existing applications focus primarily on destination visualization, information delivery and promotional functions [34][35][36] and [37]. Less attention has been paid to its use as an exploratory spatial interaction tool in rural tourism settings.

The spatial support strategies of tourism Web GIS applications are diverse in terms of context and purpose. Existing systems provide interactive map-based tourism information, accessibility assessment, proximity-based analysis, route-aware travel support, and structured POI organization [33][38] and [39]. However, limited attention has been given to scale-aware exploratory spatial interaction in village-scale tourism, where decision-making is strongly influenced by proximity, thematic relevance, and compact geographic settings. Unlike metropolitan or regional tourism systems [40] and [41], village-level travel is typically characterized by short distances, simple transportation modes, and attraction clustering rather than sophisticated optimization processes [42] and [43]. Consequently, complex analytical models may introduce unnecessary cognitive burden [44], highlighting the need for scale-aware spatial interaction tools that support intuitive exploratory planning in rural tourism destinations.

Another significant constraint of existing digital tourism platforms is related to data governance [45] and [46]. The majority of popular mapping services are based on crowdsourced POI databases, and visibility and popularity are more important than local relevance and destination development priorities. In village tourism contexts, this uncurated information can misrepresent local stories and undermine community-based tourism goals [47]. This suggests that the availability of spatial tools is not enough to enable meaningful exploratory spatial interaction; it is also important to provide stakeholder-curated POI data that are locally validated, contextually relevant, and in line with the destination management goals.

To address this gap, this study proposes DTExplorer, a Web GIS-based application that can be used to support exploratory spatial reasoning in the village-scale tourism destinations, by providing two types of POI exploration: category-based and radius-based. DTExplorer is not only a Web GIS application for providing information and marketing destinations such as conventional tourism applications, but it is also a Web GIS application that is based on the spatial logic of independent travel in small rural areas. The application is also enriched with POI data that is curated by stakeholders, thus the spatial information presented is relevant, locally validated and aligned with the characteristics of the village tourism destinations.

The primary contribution of this study lies in the design of a scale-aware Web GIS architecture that operationalizes village-level exploratory spatial interaction through proximity-based discovery, thematic exploration, and stakeholder-curated spatial information. Rather than emphasizing new spatial algorithms, routing models, or database technologies, the study demonstrates how geographic scale, user decision-making processes, and system design can be aligned to support context-sensitive travel decision support in rural tourism environments.

In this study, exploratory spatial interaction refers to the process by which users discover, evaluate, and compare spatially relevant POIs through interactive engagement with spatial information. The concept emphasizes spatial reasoning during destination exploration rather than route optimization or advanced spatial analysis, reflecting the practical decision-making needs of independent travelers in village-scale tourism environments.

2. Materials and Methods

2.1 Study Area

The study was carried out in the village of Ulakan, Subdistrict of Ulakan Tapakis, Padang Pariaman Regency, West Sumatra Province, Indonesia (Figure 1).

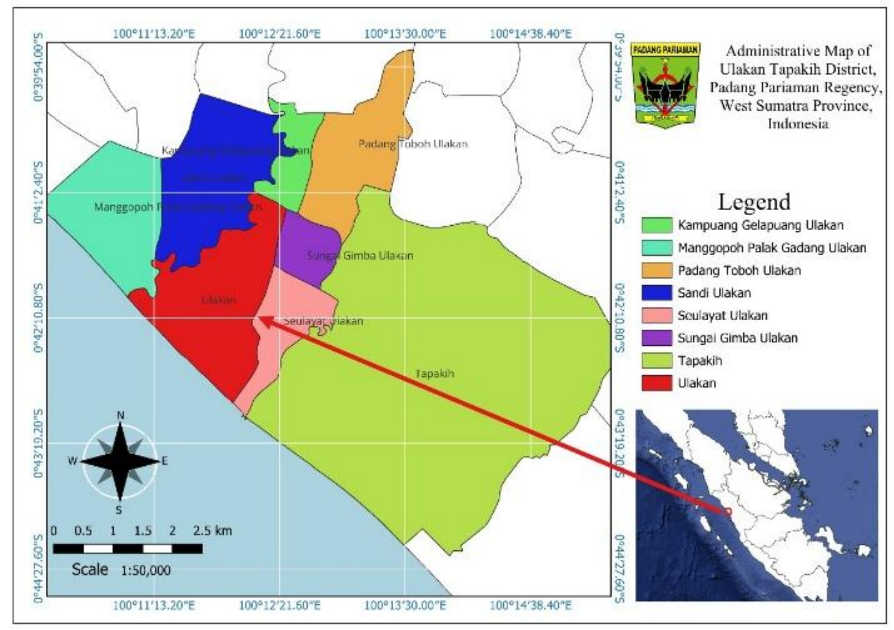

Figure 1: Location of the study area

Ulakan Village is one of the coastal tourism villages that is characterized by a blend of natural, cultural, and religious tourism resources. It is also home to one of the main attractions, the Green Talao Park, which is an ecotourism site where estuarine and mangrove ecosystems form the foundation of conservation and education-based tourism activities. In addition to natural attractions, Ulakan Village also has a religious tourist site in the form of the Tomb of Syekh Burhanuddin, along with accommodation facilities, culinary services, homestays, places of worship, and souvenir shops. Given its spatial heterogeneity and functional dispersion, Ulakan Village provides an ideal case study for developing and evaluating a village-level Web GIS POI exploration system. The small spatial size of the village further supports the investigation of proximity-oriented and exploratory spatial interaction, which applies to independent travelers.

2.2 Research Approach and Development Stages

This study adopts a research and development (R&D) methodology to create an operational digital product in the form of a Web GIS to aid in interactive spatial query and exploratory travel planning at the village level. The waterfall model was selected because system requirements were relatively stable and predictable, since the information structures of tourism, POI categories, and functionalities at the level of the village are comparatively stable. In rural tourism settings, the core tourism assets and service categories are likely to be stable in the short to medium-term, which means that the requirements of the system can be well-defined based on the literature review and initial field surveys. Under these conditions, a sequential development model is appropriate and helps in the clear recording of system design decisions.

The research phases include: (1) literature review, (2) data acquisition, (3) spatial data preparation, (4) scale-aware Web GIS design, (5) DTExplorer development, and (6) scenario-based evaluation (Figure 2). The study began by reviewing post-pandemic tourism behavior, independent travel, digital tourism platforms, and how GIS and Web GIS have been applied in tourism research. This review provided the conceptual and methodological background for the study and revealed a research gap associated with the underutilization of the Web GIS as an exploratory spatial interaction tool in the village tourism destinations, especially in the Indonesian context.

2.3 Data Acquisition and Spatial Data Preparation

The second and third phases comprised a field survey, system analysis, and data collection. The field survey was conducted to identify the major tourism attractions, supporting facilities, and service infrastructure in Ulakan Village. The findings of the survey revealed that the tourism structure in the village revolves around the Green Talao Park and the Tomb of Syekh Burhanuddin supported by secondary facilities and attractions such as Pulau Pieh access points, cottages, homestays, culinary services, places of worship, and souvenir shops.

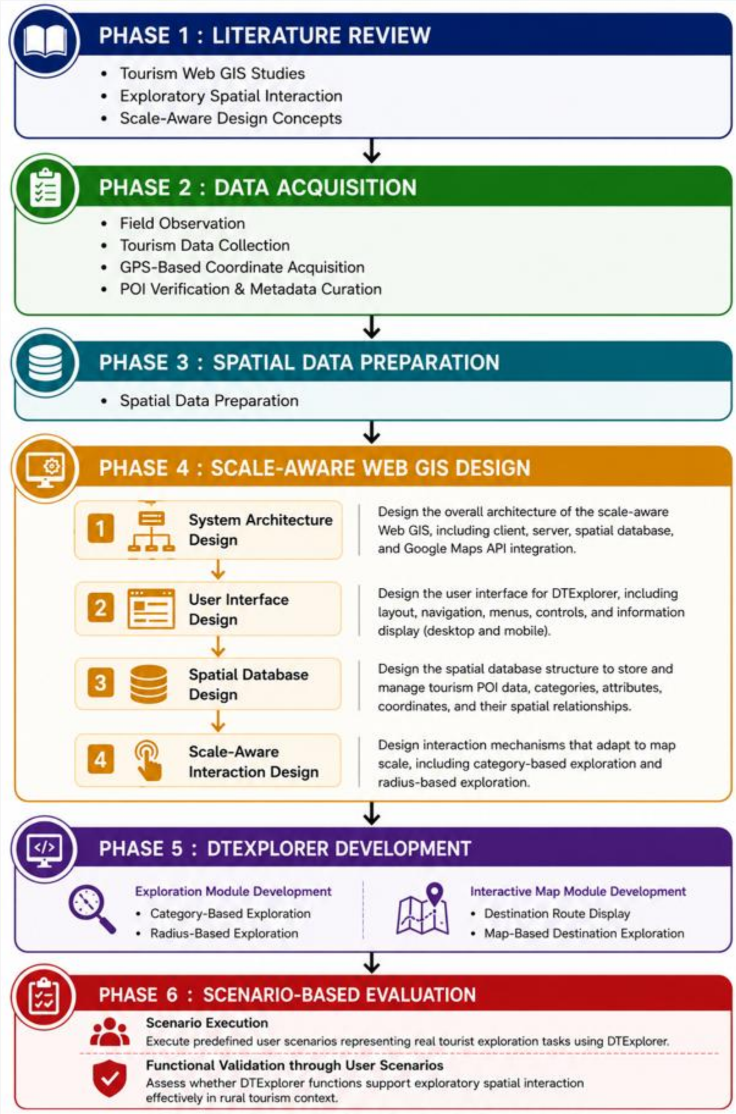

Figure 2: Flowchart of methodology

The collection of the tourism data included the spatial and attribute data of POIs. The field survey utilized GPS-enabled smartphones to capture spatial data in the form of geographical coordinates of the position of tourism-related features. These coordinates guided the on-screen digitization of POIs within a GIS environment, utilizing Google Maps as the baseline reference. Table 1 shows the categories and counts of POIs. Figure 3 shows the distribution of digitized POI data. Prior to system integration, all POI datasets were curated and validated by local tourism stakeholders. This curation process ensures that spatial information aligns with local development priorities, community-based tourism principles, and contextual relevance, rather than visibility driven by popularity or crowdsourcing. The data, both spatial and attribute, were stored in a MySQL database and used as the basis of visualization and interactive spatial query in the Web GIS application developed.

2.4. Scale-Aware Web GIS Design

The fourth phase was dedicated to system design, which included architecture, user interface, database, and scale-aware interaction design, and resulted in the three-tier Web GIS framework of DTExplorer shown in Figure 4. A user types in search parameters at the Presentation Layer, and the client sends an HTTP GET request to the server (Process A) that includes the coordinates and a radius to search. The Node.js Application Layer receives and processes these parameters, building the geospatial query using a Spatial Query Builder and a Scale-Aware Controller to manage scale-related query behavior (Process B).

Table 1: Number of POIs

POI	Number of POIs
Unique Attractions	3
Regular Attractions	5
Culinary specialties	23
Souvenirs	1
Worship Places	10
Homestays	1
Total	43

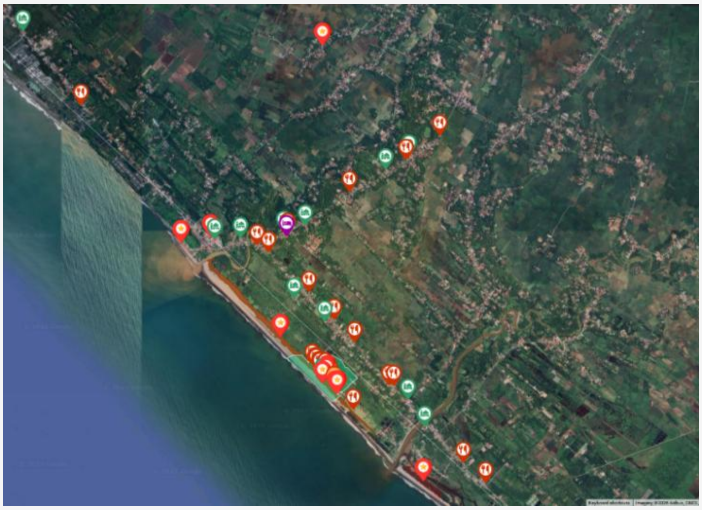

Figure 3: Spatial distribution of POIs in Ulakan Village

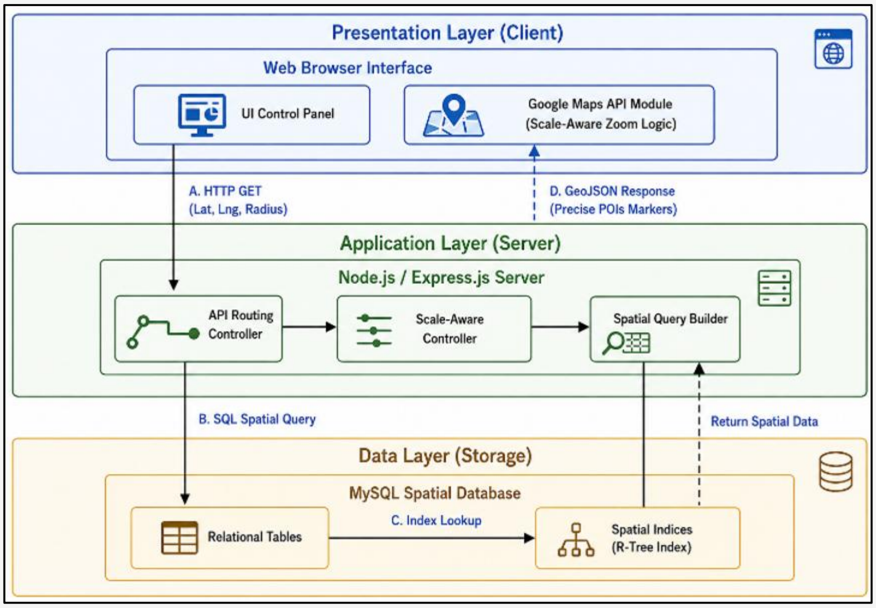

Figure 4: Three-Tier technical architecture of DTExplorer

This query is then passed to a MySQL 8.0 Spatial database, where the query is optimized by the use of R-tree spatial indices to improve query performance and provide support for complex geometric data (Process C). The server can execute native spatial operations, such as ST_Distance(), or filter the POI based on the Euclidean distance and then include an attribute filter to guarantee an efficient query execution. Lastly, the server returns this data to the client in a compressed GeoJSON format (Process D) and the Google Maps JavaScript API dynamically creates a POI marker for each point, resulting in a highly responsive and scalable user experience.

The DTExplorer user interface was created to enable independent travelers to explore through progressive information disclosure, promoting simplicity and intuitive interaction with the system. The client-side UI design is as displayed in Figure 5. The interface features a central map container that uses the Google Maps JavaScript API, a scale-aware parameter for selecting categories and setting the search radius. A dashed spatial buffer circle is used to visually represent the active query boundary, and a structured taxonomy checkbox menu is used for thematic filtering, with an interactive radius slider. Adjusting this slider dynamically captures user inputs to trigger optimized backend spatial queries, which immediately update the rendered POIs and informational windows within the defined geographic threshold. Road routes to selected destinations are displayed using the Google Routes & Directions API.

The database was designed to store both spatial and attribute data for multiple POI categories to facilitate its easy retrieval and filtering based on thematic and spatial attributes. Six main tables were created, namely unique attractions, regular attractions, culinary specialties, souvenirs, places of worship, and homestays. All tables contain at least the following attributes: Id (the primary key), name, contact person, description, and the geom (Figure 6). The geom attribute contains spatial data in the form of coordinates. Spatial querying and filtering are supported through the geom attribute stored in each table. Figures 7 and 8 should be read together to give a complete picture of DTExplorer, and are intended to be complementary views of the proposed scale-aware Web GIS. The conceptual layered architecture of the system is shown in Figure 7, in which the curated spatial data, spatial processing functions, user interaction components and scale-parameter alignment are integrated into a coherent system that enables exploratory spatial interaction at the village scale. Figure 8, on the other hand, illustrates the operational structure of scale-aware exploration, highlighting the impact of explicit scale parameterization on spatial filtering, result production, user assessment, and iterative parameter tuning throughout the exploration process.

Taken together, these figures show that scale-awareness in DTExplorer is not just a computational capability, but is integrated in the structural design and operational behavior of the Web GIS. Figure 7 illustrates the integration of scale-awareness into the system architecture, whereas Figure 8 illustrates the dynamic interaction cycle, in which users explore, evaluate, and refine spatial information within the context of village-scale tourism.

Main processes of the system are: (1) display of the general information about tourism villages, (2) route visualization between the position of the user and the tourism village, (3) the possibility to explore POIs by categories and by radius. Spatial geometries were stored using MySQL POINT data types. The system implements radius-based filtering using ST_Distance()/Euclidean distance (Figure 9), while category filtering was executed using SQL attribute queries. These processes were specifically intended to support location-based exploratory travel planning at the village level, where the role of spatial proximity and clustering of visits is predominant.

Figure 5: User interface design for POI search in tourist villages

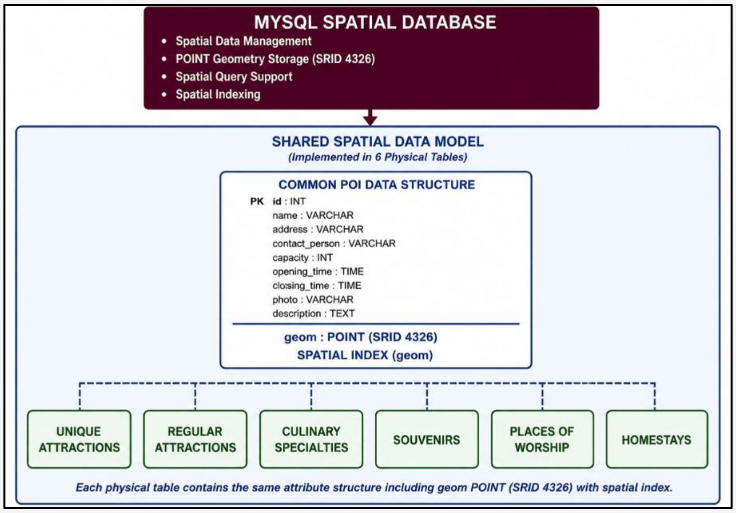

Figure 6: Conceptual spatial database model of DTExplorer showing six category-specific POI tables and shared spatial attributes

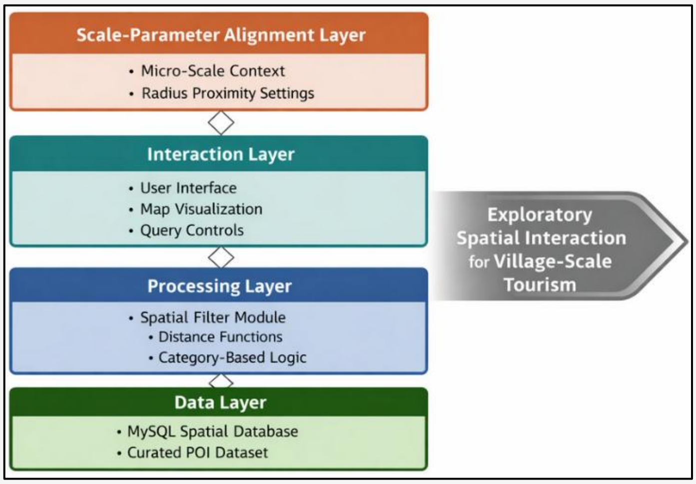

Figure 7: Conceptual architecture of the scale-aware Web GIS integrating spatial data, processing, interaction, and scale alignment

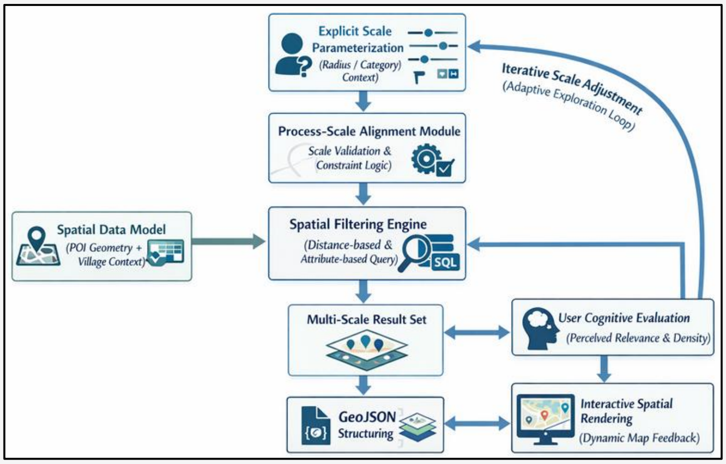

Figure 8: Operational framework of scale-aware exploratory spatial interaction illustrating the iterative relationship between scale parameterization, spatial filtering, and user exploration

```
// 1. Handler / Controller Layer (Handling Client Request)
FUNCTION listCulinaryByRadiusHandler(clientRequest):
   TRY
      EXTRACT lat, lng, radius FROM clientRequest.query
      culinaryList = CALL listCulinaryByRadius(lat, lng, radius)
      RETURN response(status: 'success', data: culinaryList)

   CATCH error
      PRINT error to system log
      RETURN response(status: 'error', message: error)
   END TRY
END FUNCTION

// 2. Data / Model Layer (Executing Spatial Query to MySQL 8)
FUNCTION listCulinaryByRadius(lat, lng, radiusInMeters):
   radiusLimitKm = radiusInMeters / 1000
   distanceFormula = "(ST_Distance(POINT(lng, lat), geom) * 111.32) AS distance"
   dataColumns = "id, name, address, contact_person, open, close, capacity, description, status"
   coordsColumns = "ST_Y(geom) AS lat, ST_X(geom) AS lng"
   sqlQuery = "SELECT " + dataColumns + ", " + coordsColumns + ", " + distanceFormula +
           " FROM culinary_place" +
           " HAVING distance <= " + radiusLimitKm
   queryResultRows = EXECUTE_QUERY(sqlQuery)
   RETURN queryResultRows
END FUNCTION
```

Figure 9: Use of the spatial function ST Distance for Radius-based filtering

Figure 9 shows the pseudocode for a radius based spatial filtering mechanism in DTExplorer. Among the spatial functions available in MySQL, ST_Distance() was adopted in this implementation. This function computes straight-line Euclidean distance between two geometric points. This approach was chosen because of the efficiency requirements of the Web GIS architecture. The spatial query processing is performed directly in the database engine, instead of sending a distance calculation query to the client. As a result, only the records for POIs within the specified radius are sent to the UI, which helps avoid unnecessary bandwidth usage and enhances overall responsiveness. This computational approach allows the DTExplorer architecture to remain lightweight, responsive and reliable in the presence of live and interactive tourist engagement.

The choice of Euclidean distance as the main measure of spatial proximity was based on the relatively small scale of the village environment studied and the short travel distances typically expected for tourists. Previous research has consistently reported that the difference between Euclidean and network-based measures of distance becomes reduced at finer geographical scales, especially in regions with extensive local road networks. In this context, Euclidean distance is a good and defensible estimate of spatial proximity, but with a negligible computational cost [48] and [49]. The differences between these two distance measures are not significant enough to have a significant impact on the analytical results of DTExplorer, where the main functions are determining the nearest points of interest and categorising them by themes.

2.5 DTExplorer Implementation

The fifth phase was the implementation of the system. The system logic and interaction were developed with Node.js and JavaScript, the spatial and attribute data were stored in MySQL 8.0 and the base mapping system was provided by Google Maps. Google Maps JavaScript API was used to implement interactive map functionalities, such as google.maps.Map(), google.maps.Marker(), google.maps.Circle(), google.maps.InfoWindow(), google.maps.Data(), google.maps.LatLng(), and google.maps.LatLngBounds(). Route visualization between the user and destination locations was supported through google.maps.DirectionsService() and google.maps.DirectionsRenderer(). The adoption of a widely used base map enabled the user to be oriented and to understand the spatial context, which enabled the study to concentrate on the design and evaluation of scale-aware Web GIS interactions, instead of developing custom cartographic components.

2.6 System Evaluation

The last step was the system evaluation, which consisted of functional validation and scenario-based evaluation. The analysis focused on the mechanisms of interactive spatial query that were being implemented and their ability to support typical exploratory travel planning scenarios faced by independent tourists. The evaluation method was design-oriented, emphasizing the alignment between user tasks and system functionality rather than measuring user performance or behavior. The effectiveness of category-based and radius-based interactive spatial queries to support decision-making in the presence of time constraints, preference-driven exploration, and limited prior spatial knowledge was evaluated using scenario-based evaluation.

This evaluation was not technical, meaning that it did not focus on server load times or network responsiveness, which are more dependent on hardware, hosting environments, and network conditions than functional validity. Instead, the assessment focused on the ability of the architecture to support the intended spatial interactions in simulated scenarios. All scenarios successfully produced the expected outputs for category-based exploration, radius-based exploration, route visualization, and POI retrieval, demonstrating the operational feasibility of the proposed architecture. Technical performance testing and extensive user behavior studies are therefore left for future research.

3. Results and Discussion

3.1 System Implementation as a Scale-Aware Web GIS

DTExplorer is a web-based GIS application that combines spatial and non-spatial contextual data, followed by exploration of spatial information. Based on the system design, the landing page serves as a first-level orientation layer where users can obtain an initial overview of the tourism village and then continue with map-based village exploration (Figure 10). This presentation of information is based on the assumption that independent travelers have little or no spatial knowledge of the destinations they visit. Therefore, DTExplorer presents a landing page as a transitional stage from contextual awareness to spatial reasoning. This design aligns with the scale-aware perspective guiding this research, where clarity and ease of understanding are valued over analytical complexity.

From a Web GIS perspective, DTExplorer is oriented to the exploration of spatial interaction as opposed to complex analytical processing. At the village level, where the travel distances are short and the decision-making process is mainly dictated by proximity and topicality, the system demonstrates that simple spatial operations can effectively explore spatial decisions when incorporated into an intuitively designed interface.

3.2 Operationalization of Core Web GIS Functionalities

As expected in the functional architecture given in Section 2.4, DTExplorer realizes exploratory spatial interaction as three fundamental Web GIS functions. The platform first displays general tourism village information via the landing page (Figure 10). This component, although not spatial in nature, plays a critical role in framing subsequent spatial exploration by providing thematic and destination context. This helps in early travel planning reasoning among the independent travelers who normally use fragmented channels of information before traveling.

The second feature provides route visualization between the present position of the user and the tourism village region (Figure 11). This option allows users to evaluate accessibility and travel feasibility and proceed to on-site exploration in a more detailed fashion. By integrating route visualization, DTExplorer minimizes reliance on external navigation tools, preserving interaction continuity during spatial exploration.

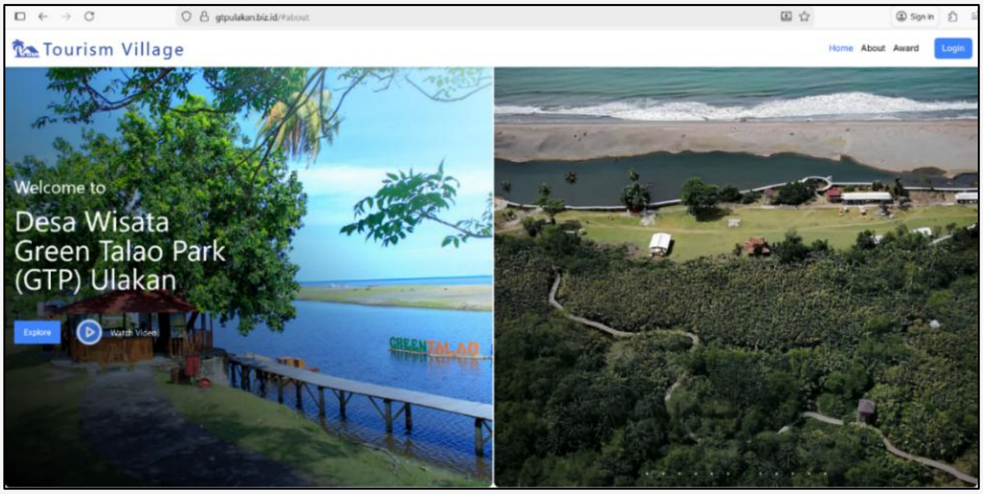

Figure 10: DTExplorer landing page that provides initial information to assist exploratory travel planning in the early stages of the journey at the village level

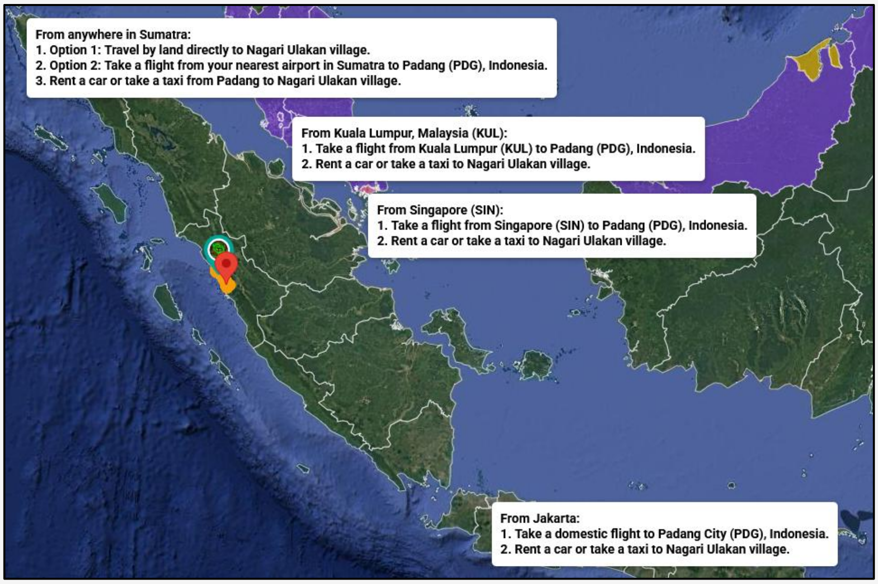

Figure 11: User-oriented route visualization to the village tourism site, which enables spatial awareness of the accessibility in advance before exploring the location

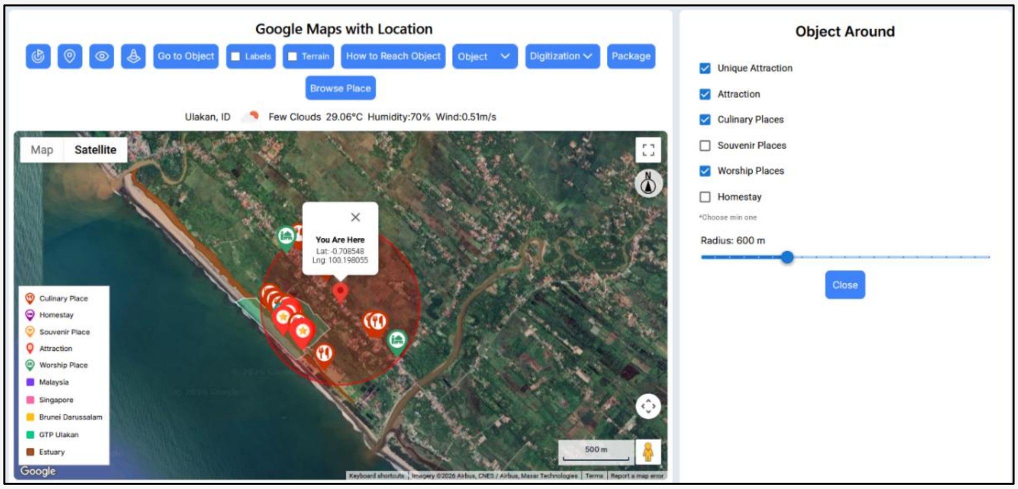

Figure 12: Radius-based POI exploration that depicts spatial proximity and possible clustering of attractions and service facilities within a set distance requirement

The third feature is POI exploration based on category and radius filtering. Users can search for POIs based on thematic categories, such as tourist attractions, accommodations, culinary facilities, and support services. Users can also refine their search based on spatial distance. This dual filtering process directly reflects the spatial logic of rural travel, where the decision to visit a POI is based on distance from the user's current location and the POI's category. This mechanism transforms complex GIS queries into intuitive exploration models. Users can quickly assess spatial alternatives without having to manually calculate distances or synthesize data from multiple platforms.

3.3 Scenario-Based Evaluation of Exploratory Spatial Interaction

Following the evaluation strategy outlined in Section 2.6, DTExplorer was evaluated by functional testing and scenario-based testing. The strategy emphasizes task-system relevance and functional soundness as opposed to user behaviour quantification or usability performance indicators. When travel time is constrained, radius-based POI exploration enables users to locate attractions and supporting facilities that are within a set distance range (Figure 12). This visualization contributes to compressing the itinerary because it is able to focus on potential visit combinations that do not require the spatial movement that is most critical in a small village tourism context. In preference-based exploration cases, category-based POI filtering helps users display particular types of tourism services, while keeping the awareness of the spatial distribution (Figure 13). This facilitates thematic spatial choice without removing users from the geographic context of the village and maintains spatial coherence in the course of exploration.

For users with limited spatial knowledge, unified map visualization and POI data provide immediate contextual awareness, eliminating the need to cross-reference multiple platforms. Integrating spatial and descriptive information within a single interface (Figure 14) helps reduce cognitive load, thereby facilitating more informed exploratory decisions, and is a benefit of using DTExplorer. All of these situations illustrate that, even comparatively straightforward spatial operations, when paired with user decision logic and geographic scale, can prove useful as spatial exploratory interaction in village-scale tourism.

3.4 Role of Curated POI Data in Contextual Exploratory Support

One of the unique attributes of DTExplorer is the use of curated POI information maintained by the local tourism stakeholders, as indicated in Section 2.3. Unlike crowdsourced mapping platforms, which mostly rely on popularity or the visibility of the user, curated POIs reflect local development priorities, ideals of community-based tourism, and destination management objectives. Each POI's information panel includes detailed information and a map of the POI's location (Figure 15).

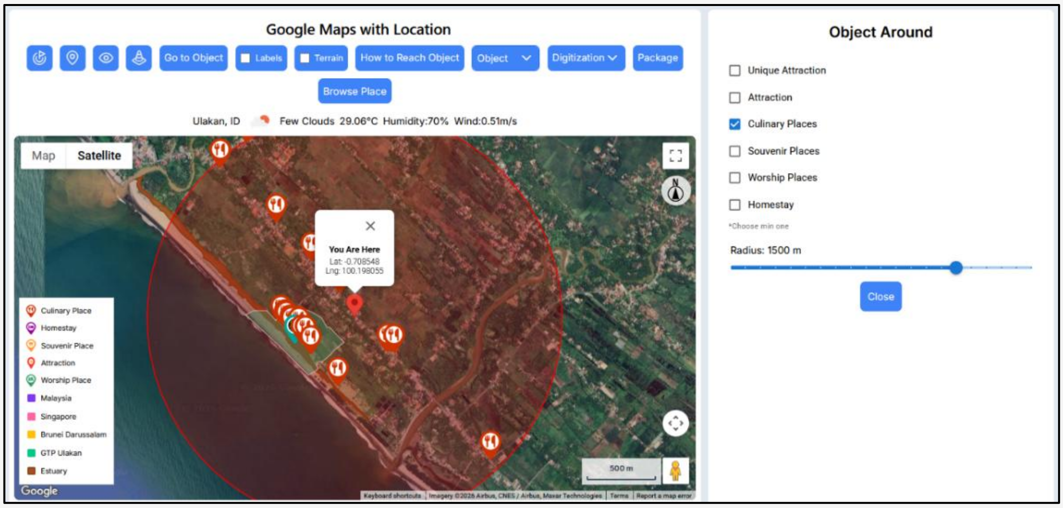

Figure 13: POI filtering using categories to distinguish among the locations of thematically related tourism facilities to aid in exploration based on preference

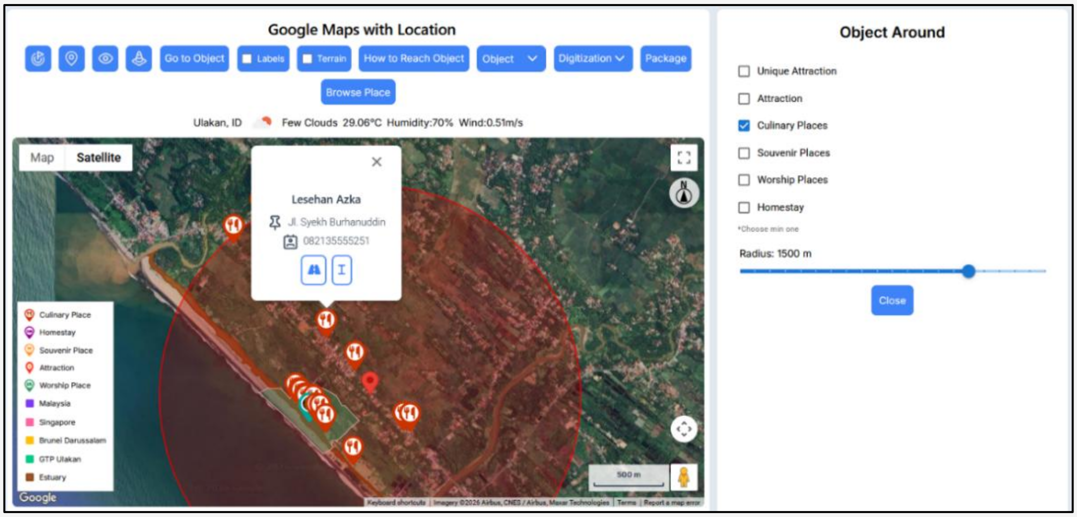

Figure 14: Spatial and descriptive data in one interface that helps reduce the cognitive load of tourists

Figure 15: Full POI information panel that displays contextual characteristics to enable a comparative analysis of other visit options

This integration allows users to compare alternative visit options within a geographically bounded area to facilitate spatially aware decision-making. At the village scale, where uncurated raw data can induce cognitive overload, filtered spatial information enhances contextual relevance over data volume. From a geoinformatics perspective, these results highlight that the processes of spatial data governance and selection can be as important as technical system design in enabling effective exploratory spatial interaction in rural tourism destinations

3.5 Implications for Scale-Aware Web GIS Design

In this study, the findings support the significance of the scale-aware GIS design in tourism applications at the village level. At the village scale, effective Web GIS systems focus more on spatial clarity, proximity-based exploration, and thematic relevancy than on analytical sophistication or optimization-based models. The base map of Google Maps is another pragmatic implementation option that makes the system easier to use and navigate on a spatial level without reducing the conceptual value of the work. The key innovation of DTExplorer lies not in cartography, but in the operationalization of spatial reasoning logic that aligns with the travel behavior in small-scale tourism destinations.

In general, the system implementation and scenario-based analysis show that DTExplorer can operationalize exploratory spatial interaction using straightforward but contextually relevant GIS functionality. DTExplorer, by combining proximity visualization, thematic filtering, and curated spatial data with a coherent exploratory interface, shows how scale-aware Web GIS design can be successfully used to support independent travel decision-making at the village-scale tourism destination.

3.6 Comparative Positioning of DTExplorer within Tourism Web GIS Systems

To contextualize the value of this study, we compare DTExplorer with three Web GIS tourism system typologies: generic mapping systems, optimization-based tourism systems, and traditional inventory-based tourism Web GIS systems (Table 2). This comparison is not intended to demonstrate technical superiority, but rather to highlight differences in spatial scale orientation, decision logic, and spatial data governance. The discussion underscores the operationalization of scale-aware design in DTExplorer as a structural attribute, but not an analytical feature.

As indicated in Table 2, DTExplorer prioritizes scale-aware exploratory support rather than algorithmic optimization. Rather, it restructures exploratory spatial interaction around the principle of geographic scale congruence. Whereas optimization-based systems seek to reduce the computational costs of travel inefficiencies, DTExplorer reduces the cognitive effort required to interpret spatial information by aligning interface design and spatial filtering functionality with the small-scale morphology of the village-scale destination.

In contrast to other generic mapping websites that use global aggregated POI databases and popularity to select the top map features, DTExplorer presents local-level control of the proposed spatial information through curated data structures that are controlled by local stakeholders. This governance model helps ensure contextual relevance and alignment with community-based tourism priorities, which are typically underrepresented within crowdsourced systems. From a geoinformatics perspective, the value lies not in developing new spatial algorithms but rather in the reparameterization of spatial interaction based on spatial limitations at the micro-scale.

Table 2: Comparative analysis of tourism WebGIS systems and DTExplorer

Dimension	Generic Mapping Platforms	Optimization-Based Tourism Systems	Conventional Tourism Web GIS	DTExplorer (Proposed System)
Primary Objective	Navigation & global POI discovery	Itinerary optimization	Destination visualization	Exploratory spatial interaction at the village scale
Spatial Scale Orientation	Global/urban	Regional / multi-destination	Urban/district	Micro-scale (village-level)
Scale Parameterization	Implicit	Explicit (time/distance constraints)	Rarely defined	Explicitly aligned with compact rural spatial structure
Decision Logic	Popularity-driven	Algorithmic optimization	Descriptive browsing	Proximity + thematic clustering logic
Spatial Filtering	Keyword & ranking	Constraint-based filtering	Category filtering	Category-based + radius-based filtering
Distance Model	Network-based	Network-based	Limited implementation	Euclidean proximity (scale-aware)
Cognitive Load Strategy	User-integrated	Automated optimization	Manual browsing	Progressive revelation & simplified spatial interaction
POI Data Governance	Crowdsourced	Mixed	Administrator-managed	Stakeholder-curated POIs
Alignment with Community-Based Tourism	Low	Medium	Medium	High
Analytical Complexity	Moderate	High	Low	Intentionally low, scale-congruent
Core Design Philosophy	Universal coverage	Efficiency maximization	Information delivery	Scale congruence & contextual relevance

Table 3: Comparison with existing tourism WebGIS studies

Feature	Ref. [39]	Ref. [38]	Ref. [36]	DTExplorer
Web GIS	Yes	Yes	Partial	Yes
POI Database	Yes	Yes	Yes	Yes
Tourism Planning	Yes	Yes	Yes	Yes
Radius Exploration	No	Yes (Buffer 500m)	No	Yes
Real-time Filtering	No	No	No	Yes
User-centric Exploration	No	Partial	Partial	Yes

The system shows that at small rural scales, exploratory spatial interaction can be better supported through spatial congruence, proximity-based filtering, and thematic filtering strategies than through multi-criteria optimization frameworks. This positioning supports the argument that scale-aware Web GIS architecture represents a distinct design paradigm for rural tourism applications.

3.7 Comparison of DTExplorer with Existing Tourism Web GIS Studies

Table 3 presents a comparison between DTExplorer and several tourism Web GIS studies. Similar to [36] [38] and [39], DTExplorer utilizes Web GIS and POI data to support tourism information delivery and planning activities. These studies demonstrate the growing role of geospatial technologies in improving access to tourism resources and supporting destination management.

However, differences can be observed in the way tourism information is explored and delivered to users. [39] focused on visitor monitoring and POI management, while [38] and [36] emphasized tourism analysis and planning. In contrast, DTExplorer is designed to support destination discovery through radius-based exploration and real-time filtering, enabling users to locate attractions and supporting facilities more efficiently. As shown in Table 3, DTExplorer combines POI management, radius exploration, real-time filtering, and user-oriented destination discovery within a single Web GIS platform. These features provide a practical approach for exploring tourism information while complementing the planning and management functions reported in previous studies.

4. Conclusion

This study developed DTExplorer, a Web GIS application to support exploratory spatial interaction in a village tourism destination. The system combines category-based filtering, radius-based exploration, and stakeholder-curated POI data to help independent travelers discover nearby attractions and supporting facilities. The findings demonstrate the feasibility of supporting exploratory spatial interaction and travel planning at the village scale through simple spatial functions that are aligned with local spatial characteristics, user decision-making needs, and relevant tourism information.

The results of implementation and evaluation further suggest that successful exploratory spatial interaction at the village level depends not only on users' ability to interpret spatial information, but also on how well the system design reflects destination scale, supports decision-making, and provides reliable spatial data. These findings highlight the importance of scale-aware Web GIS design for rural tourism destinations and contribute a scale-aware perspective to the broader development of tourism Web GIS applications.

Future research should extend validation through empirical usability and user behavior studies, network-based accessibility measures, and comparisons between Euclidean and network distance models. Technical performance evaluation remains an avenue for future investigation.

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