Leveraging Network Analyst In Geospatial Design For Advancing Islamic Boarding School Information Systems

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Abstract. This research presents the development of an interactive geospatial information system tailored for Al-Munawwir Krapyak Islamic Boarding School in Kabupaten Bantul, Daerah Istimewa Yogyakarta, Indonesia. The study involved comprehensive data collection, meticulous data processing, and functional and usability testing, creating an efficient system. Functional testing confirmed the system's ability to meet predefined success criteria, while usability testing yielded a high satisfaction index of 82.8%. The system's design prioritizes user-friendliness, featuring an intuitive landing page, clear menu options, a dynamic map, and real-time routing capabilities. Future enhancements, including dynamic route analysis and advanced features like live traffic updates, hold the potential to further elevate the system's utility, ensuring it remains a valuable tool for students, staff, and visitors to the Islamic Boarding School, facilitating easy navigation and access to essential information in an evolving technological landscape.

Keywords: Geospatial Information System, WebGIS Development, Routing and Navigation, Usability Evaluation, Location-Based Services.

1 Introduction

In today's digital age, the demand for precise and user-friendly navigation tools [1], including websites and mobile apps, is on the rise [2]. However, these tools often fail to meet diverse user needs due to limited datasets and overwhelming complexity [3]. The concept of geospatial design has emerged as a critical framework, recognizing the essential role of spatial aspects in our lives [4].

Al Munawwir Krapyak Islamic Boarding School, founded in 1911 in Yogyakarta, Indonesia, has evolved into one of the region's oldest Islamic boarding schools, facing the challenge of aiding students unfamiliar with the campus's layout [4], [5]. To address this, a prototype has been developed to enhance the school's location map, providing spatial comprehension and efficient route planning [6], [7].

This article explores the transformative potential of geospatial design within the Al Munawwir Krapyak Islamic Boarding School, focusing on streamlining user access to information and improving their understanding of the campus layout. A literature review, detailed methodology, results, and discussions offer insights into the relevance of geospatial design in today's dynamic landscape.

2 Literature Review

In today's world, geographical information is pivotal in decision-making at various scales [8]. Geographic Information Systems (GIS) are essential for inputting, storing, processing, querying, analyzing, and visualizing geospatial data [9], [10]. Within GIS, WebGIS is a tool that facilitates spatial and non-spatial data access [11].

WebGIS, a web-based mapping system, can acquire, store, manipulate, and present data without specialized geospatial software [12]. It transcends temporal and spatial boundaries, providing swift, accurate, and universally accessible information [7], [13]. Geography and information technology convergence has led to various geospatially enhanced information systems. These systems cater to a wide range of applications, manage spatio-temporal data, integrate datasets, and offer interactive interfaces, enhancing user understanding [14]–[16]

Usability in system development focuses on user-system interaction and can be assessed using various methodologies [17]. Prototyping is a tangible bridge between design and user expectations [18]. As Al Munawwir Krapyak Islamic Boarding School seeks to enhance its information system, these foundational concepts and methodologies provide a comprehensive framework. Integrating geospatial design and network analyst methodologies promises to elevate information accessibility and usability, bridging the gap between information and its spatial context.

3 Method

The study's methodology involves data collection, processing, website development, user testing, usability evaluation, and deployment, resulting in a custom geospatial information system for Al Munawwir Krapyak Islamic Boarding School.

3.1 Data Collection

The foundation of our geospatial information system for Al Munawwir Krapyak Islamic Boarding School relied on robust data collection [19]. This comprehensive approach included high-resolution aerial photographs from 2021 for spatial context and valuable data extraction from the prototype website. This ensured our user-centric geospatial information system's accuracy, functionality, and comprehensiveness.

3.2 Data Proessing

In the data processing phase, we transformed raw data into a dynamic and interactive geospatial information system [20], [21]. This involved georeferencing aerial photographs using QGIS to establish a geospatial framework, meticulously scrutinizing building data for accuracy, developing real-time routing scripts in HTML, PHP, JavaScript, and CSS, and integrating Mapbox's API for dynamic mapping and route calculations. After rigorous local testing, the system was hosted online via Domainesia, ensuring data accuracy, functional effectiveness, and a user-friendly interface while enabling real-time routing and dynamic interactions.

3.3 Website Development

During the website development phase, the static prototype was transformed into a dynamic geospatial information system [22]. This involved designing a user-friendly interface for easy navigation and visual appeal, integrating Mapbox's API for dynamic mapping with color-coded building markers, and implementing real-time routing using Mapbox's Directions API scripts. These enhancements made the system a powerful tool for users to explore Al Munawwir Krapyak Islamic Boarding School.

3.4 User Testing and Usability Evaluation

User testing and usability evaluation [23] were essential to validate the system, uncover issues, and measure user satisfaction. This included functional testing, covering critical scenarios like displaying the home page, accessing the building layout, showing building names on hover and generating real-time routes. Additionally, usability evaluation with 19 respondents assessed learnability, efficiency, memorability, error prevention, and user satisfaction based on Nielsen's Attributes of Usability. These phases confirmed the system's robust functionality and user-friendliness.

3.5 Deployment and Accessibility

The deployment phase transformed the geospatial design into a real-world online platform [24], ensuring its accessibility to a broader user base [25]. This involved web hosting on almunawwir.cloud via Domainesia for enhanced accessibility on desktop and mobile devices. Mapbox's API integration added interactive mapping features and real-time user location displays. Ongoing testing and maintenance maintained system reliability, ensuring a dependable and immersive experience at Al Munawwir Krapyak Islamic Boarding School.

4 Results and Discussion

Having meticulously outlined the methodology and processes involved in enhancing the geospatial design capabilities of Al Munawwir Krapyak Islamic Boarding School, we now turn our attention to the pivotal outcomes of this endeavor.
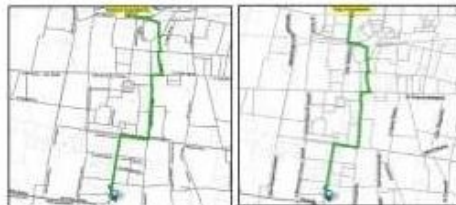

Fig. 1. Static route map featured in the pre-existing system.

4.1 Data Collection Process

The research began with a comprehensive examination of available data within the initial system prototype of the Islamic Boarding School. This data included georeferenced aerial photographs taken in 2021, forming the base map for digitizing the buildings on the school premises. The digitization process resulted in shapefile-format spatial data for the school's structures. In addition, we extracted scripts from the static prototype website and transformed them into a dynamic website layout. The data also included essential information from the prototype, such as the total number of buildings and their categories: male dormitories (29 buildings), female dormitories (17 buildings), and ordinary buildings (7 buildings). Each building had attribute information, including name, function, contact details, etc. Unfortunately, the existing route information remained static (Figure 1). Our efforts aimed to convert these routes into dynamic and real-time information through network analysis methods, which required a Map API with road network data.
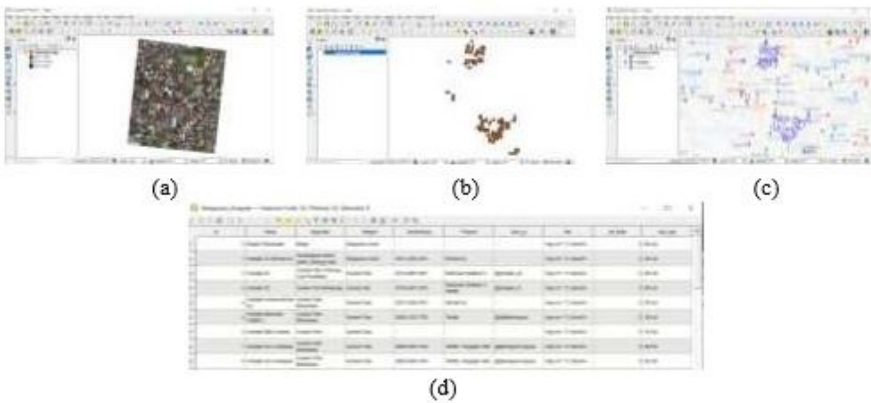
4.2 Data Processing Results

Fig. 2. QGIS Preprocessing Steps: (a) georeferencing aerial photos for digitization, (b) validating building shapefiles for geodetic compatibility, (c) verifying building locations against online base maps, (d) inspecting building attributes for data validation.

Data processing began with georeferencing the aerial photographs using QGIS for precise digitization (Figure 2). A meticulous review of the spatial data related to the school's buildings was conducted, ensuring compatibility with geodetic coordinate systems. We also verified the attribute data to integrate it into the information system. The digitized building locations were cross-referenced with real-world conditions using online base maps to ensure spatial accuracy. A total of 53 school buildings were digitized, each with ten attributes. Subsequently, we created scripts for the website using HTML, PHP, JavaScript, and CSS, enhancing the user interface with Bootstrap (Figure 3).

Fig. 3. Website Development: (a) user-friendly landing page with real-time features, (b) script for real-time routing and MapAPI integration, (c) coding and MapAPI integration for enhanced user experience.

We also integrated Mapbox's map API to provide real-time mapping capabilities, which allowed us to display maps with dynamic features and calculate real-time routes. After rigorous local testing, the website was hosted online through Domainesia, and black-box testing was conducted successfully. Usability testing covered learnability, efficiency, memorability, error prevention, and user satisfaction.

4.3 Information System Result

The information system features a user-centric interface comprising a landing page with a user-friendly design, dynamic mapping capabilities, and real-time route generation. Using Mapbox and other technologies empowers users with up-to-the-minute information and interactive mapping. Users can effortlessly access the system through almunawwir.cloud, which hosts the website. The system color-codes buildings based on their functions, enhancing user orientation and offering real-time tracking of user locations. Users can select a specific building, and the system will generate a real-time route, significantly improving the practicality of the information system for navigation within the Islamic Boarding School.

5 Discussion

The data collection process was crucial, utilizing georeferenced aerial photos to establish a reliable base map. Spatial data and attributes were rigorously validated for real-world accuracy. Dynamic real-time routing, facilitated by the Map API (Mapbox), significantly improved the system's utility. Functional testing confirmed the successful implementation of both static and dynamic functionalities.

Usability assessment, aligned with Nielsen's Attributes of Usability (Table 1), provided insights into user satisfaction and ease of use. Users found the website comfortable (82.8% satisfaction) and easy to remember (80.0% memorability). However, the error handling category (37.6%) highlighted the need to identify and rectify issues for a smoother user experience. The system's design prioritizes essential information for user-friendliness. Completing the data processing phase for dynamic route analysis and incorporating advanced features, like live traffic updates, could enhance utility.

Table 1. Usability Assessment Results and Index Calculation.

Category	Likert Scale Score	Learnability	Efficiency	Memorability	Error	Satisfaction
Strongly Disagree	1	0%	0%	0%	13.00%	0%
Disagree	2	0%	0%	0%	6.00%	2%
Neutral	3	9.00%	9.00%	15.00%	6.00%	9.00%
Agree	4	24.00%	28.00%	28.00%	4.00%	12.00%
Strongly Agree	5	50.00%	45.00%	35.00%	0.00%	70.00%
Total Score	-	83.00%	82.00%	78.00%	29.50%	87.40%
Average Score	-	4.37	4.32	4.11	1.55	4.32

In summary, the development of the Al-Munawwir Islamic Boarding School information system successfully provides accurate and dynamic information. Functional and usability testing shows it to be effective and user-friendly. Future refinements will further improve functionality and user experience as technology evolves.

6 Conclusion

This study successfully developed a geospatial information system for Al-Munawwir Islamic Boarding School in Kabupaten Bantul, Daerah Istimewa Yogyakarta. The system provides real-time, precise location information for the school's buildings and undergoes structured data collection, processing, and testing processes. It passed functional testing criteria, ensuring efficient access and interaction. Usability testing reflected high user satisfaction (82.8%), with room for error-handling improvements (37.6%). The system prioritizes userfriendliness and simplicity, but further enhancements, such as real-time route analysis and live traffic updates, are possible. Overall, it is a valuable tool for the school's community, with ongoing refinements to adapt to evolving technology.

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