Jurnal Kecerdasan Buatan dan Teknologi Informasi
Vol. 5, No. 2, May 2026, pp. 122-129
e-ISSN: 2964-2922, p-ISSN: 2963-6191
DOI : https://doi.org/10.69916/jkbti.v5i2.436

WEBGIS APPLICATION FOR SEARCHING THE NEAREST CAR AC REPAIR SERVICE IN METRO CITY USING THE VINCENTY ALGORITHM

Rayhan Prasetiyo

Informatics Engineering Study Program, Faculty of Business and Science Technology, Dharma Wacana University, Metro City, Indonesia
Email: rayhan.prasetiyo2@gmail.com

(Received: April 12, 2026; Revised: April 24, 2026; Published: May 2, 2026)

Abstract

The rapid increase in vehicle mobility in Metro City has led to a higher demand for specialized car AC maintenance services. The purpose of this study is to develop a WebGIS-based application designed to facilitate the search for the nearest car AC workshops by implementing the Vincenty Algorithm. Unlike standard digital maps that often use spherical models, this system utilizes the WGS-84 ellipsoid reference to ensure high precision in geodesic distance calculations. The software was developed using the Waterfall model, integrating PHP, MySQL, and the Leaflet.js library. System validation was conducted through Black Box Testing across seven core modules, achieving a 100% functional validity rate. The comparative analysis between manual Vincenty calculations and the system's actual driving distance showed a minimal margin of 0.13 KM or 1.8%, confirming the algorithm's reliability and accuracy for nearest-location ranking. In conclusion, this WebGIS serves as an efficient and highly accurate digital navigation tool to support vehicle maintenance for the community in Metro City.

Keywords: geographic information system; geodesic distance; black box testing; vincenty algorithm; precision accuracy.

1. INTRODUCTION

As one of the epicenters of economic growth in Lampung Province, Metro City has recorded a fairly massive increase in four-wheeled vehicle mobility. In tropical climate conditions that tend to be hot, the existence of a car air conditioning (AC) system becomes a vital instrument for the comfort as well as the safety of drivers. However, the distribution of information regarding the locations of workshops that specifically handle AC repairs in this region has not been managed in an integrated digital system. As a result, the public often faces obstacles when needing immediate technical assistance on the road [1].

The utilization of a web-based Geographic Information System (WebGIS) serves as a highly relevant solution instrument. Through this platform, spatial data can be presented dynamically and accessed in real-time without requiring users to install additional applications on their devices. One of the limitations in current general map applications is the lack of service category specifications that separate general mechanic workshops from AC specialists. In addition, distance calculations in most systems still rely on the Haversine formula, which simplifies the shape of the earth as a perfect sphere. In fact, to achieve more precise positional accuracy, an algorithmic approach that considers the earth's curvature as an ellipsoid (flattened at the poles) is required [2]. The importance of this accuracy is also aligned with studies on environmental factors that influence the stability of coordinate points on mobile devices [3]. Through the Vincenty algorithm, distance calculations are expected to be more accurate compared to conventional methods [4].

Several previous studies have examined the optimization of mapping public facilities. Saputra and Marlim (2020) applied the Dijkstra method for searching workshops [5], while Ashiddiqi (2020) focused on WebGIS to map motorcycle repair locations [6]. Furthermore, Farhan, Faizah, and Koryanto (2024) developed a GIS application for official workshops using Location-Based Services (LBS) [7], and Aldrian (2026) expanded this by implementing a WebGIS platform for general car repair shops to enhance urban navigation [8]. However, the reliability of such systems is highly dependent on algorithmic precision; a comparative analysis by Vats, Kumar, and Sinha (2025) emphasizes that the selection of geographical distance methods, specifically between the Vincenty and Haversine algorithms, is crucial for the accuracy of location-based services [9]. Consequently, studies by Fauzi (2025) [2]as well as Ritonga and Alda (2021) [4] assert that the Vincenty algorithm provides superior accuracy results for calculating geodetic distances compared to other methods by accounting for the earth's actual curvature. Referring to these research gaps specifically the absence of specialized digital mapping for car AC services in Metro City and the necessity for high-precision geodetic implementation this article proposes the development of a specific WebGIS application for car AC services by integrating the Vincenty algorithm based on the World Geodetic System 1984 (WGS-84) ellipsoid model [10].

2. RESEARCH METHODS

This research method was conducted systematically to ensure that the development of the WebGIS application for searching car AC workshops in Metro City proceeded according to target. The approach used is the Waterfall software development model combined with the implementation of the Vincenty algorithm for precise distance calculation.

2.1. Waterfall Development Method

This research adopts the Waterfall model as a sequential system development framework to ensure every phase runs in a structured manner [11], The stages carried out include:

1. Requirements Analysis: The initial stage focused on collecting primary data, namely the coordinate points of car AC service locations in the Metro City area, as well as mapping the technical specifications required by system users.
2. Implementation: In the construction phase, the application architecture was built using a combination of PHP and MySQL. For the map visualization aspect, the system utilizes the Leaflet.js library due to its efficiency in displaying interactive geographical data on the WebGIS platform without burdening the performance of the user's device [12].
3. Integration and Testing: All system modules were combined to undergo a series of evaluations through the black box testing method. This testing aims to ensure that interface functions operate accurately and that the implemented algorithms can provide relevant location recommendations for the community in Metro City [13].
4. Operation and Maintenance: The final step involves testing the application under real field conditions and conducting continuous optimization to resolve technical issues that arise after the system is implemented.

2.2. Implementation of Vincenty Algorithm

To achieve maximum accuracy in determining the nearest location, this research utilizes the Vincenty algorithm, which is based on the WGS-84 earth ellipsoid model, proven to be more precise than conventional spherical models [10]. The algorithm processing logic within the system is designed with the following flow:

1. Data Input: The device retrieves the user's latest coordinate data via the Location Based Service (LBS) feature and processes it alongside workshop coordinate data stored in the database [1].
2. WGS-84 Parameter Configuration: The system establishes physical earth constants based on the ellipsoid model, which include the values for the *semi-major axis* (a), *semi-minor axis* (b), and *flattening* (f) [10].
3. Iterative Calculation: Variables $U1, U2$, and λ are calculated iteratively until they reach a convergence value with a precision of $< 10^{-12}$ [4]. If the convergence threshold is not met, the system will repeat the calculation process on these iterative variables.
4. Geodetic Distance Calculation: Once the variable values reach convergence, a final calculation is performed to determine the geodetic distance (s) or straight-line distance over the earth's surface between the two coordinate points [10].
5. Result Output: The system performs an automatic sorting based on the shortest distance and displays a list of workshops on the WebGIS map as destination recommendations for the user [5].

3. RESULTS AND DISCUSSION

This section presents the results of the application interface implementation as well as the accuracy testing of the implemented algorithm.

3.1. User Interface Implementation

This WebGIS application is designed with a responsive interface to guarantee ease of access for users via both mobile devices and desktops . The complete visualization of the system interfaces is shown in Figure 1 through Figure 7.

Figure 1. Login Interface

The login interface (Figure 1) serves as the primary security gateway for the WebGIS system. Users are required to authenticate by inputting their registered email address and password. This authentication mechanism acts as a strict barrier to ensure that only authorized individuals can access the full spectrum of search services securely, thereby preventing unauthorized access and safeguarding personalized user interactions within the application.

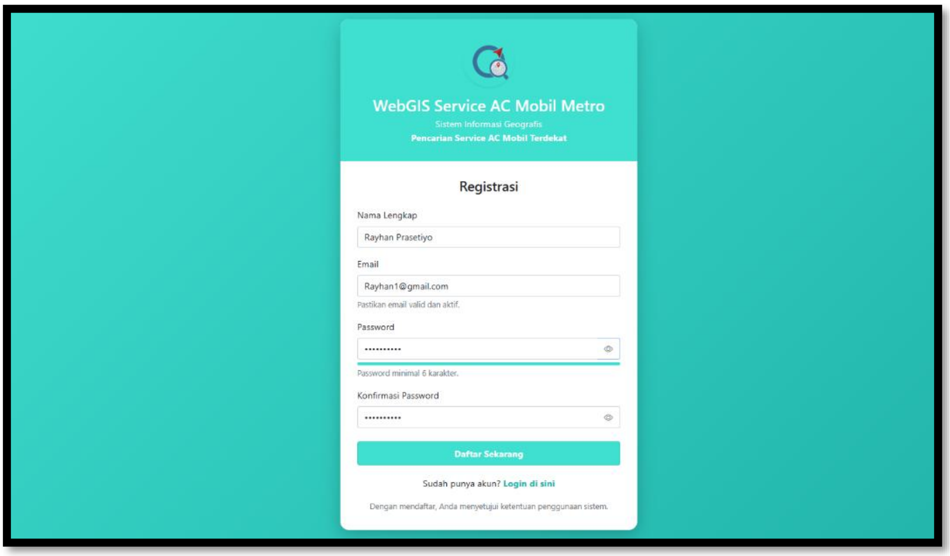

Figure 2. Registration Interface

The Registration interface (Figure 2) is specifically provided to facilitate the onboarding of new users. Individuals can register a new account by comprehensively filling out basic identity parameters, including their full name, a valid email address, and a secure password along with its confirmation. This inputted data is automatically processed and stored directly into the system's database, establishing a dedicated user profile that grants continuous and secure access to the application's spatial features.

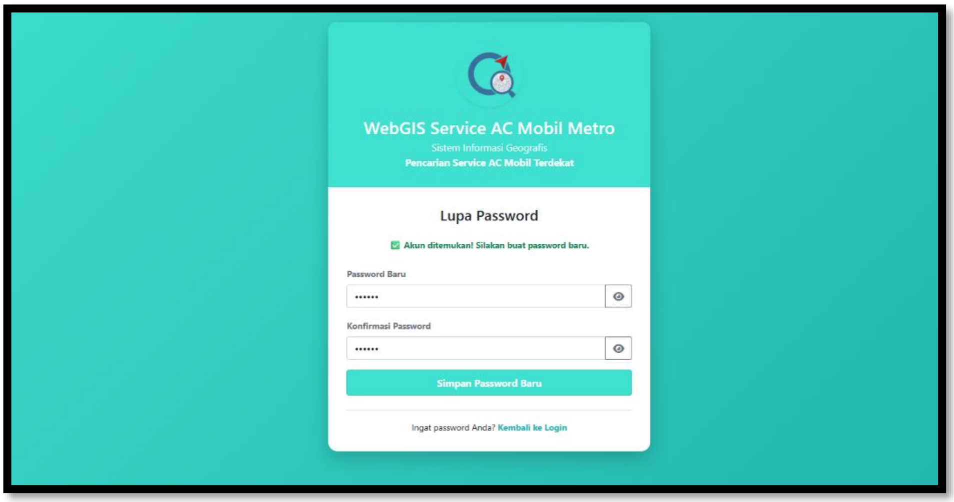

Figure 3. Forgot Password Interface

The Forgot Password interface (Figure 3) serves as a critical recovery tool utilized by users who encounter issues losing access to their accounts. This interface ensures continuous, independent use of the service by securely guiding users through a credential reset workflow. By allowing the creation of a new password, the system minimizes administrative intervention while maintaining a high level of account security and user autonomy.

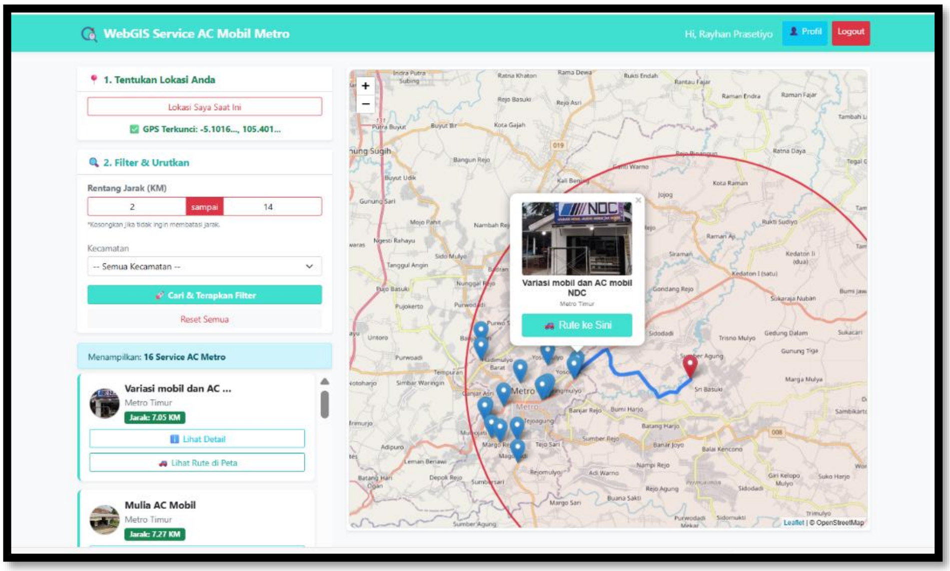

Figure 4. Main WebGIS Interface

The Main WebGIS interface (Figure 4) constitutes the core operational feature of this research. It seamlessly integrates a real-time Location-Based Service (LBS) that detects and locks the user's current GPS coordinates. Furthermore, it provides interactive filter instruments, including a specific distance radius input (in kilometers) and a district-based sorting dropdown. The Vincenty algorithm is actively applied within this module to guarantee high-precision geodetic distance calculations based on the WGS-84 ellipsoid model. The interface then visually plots the optimal routes, displaying interactive markers for both the user's location and the nearest recommended car AC service points on the digital map.

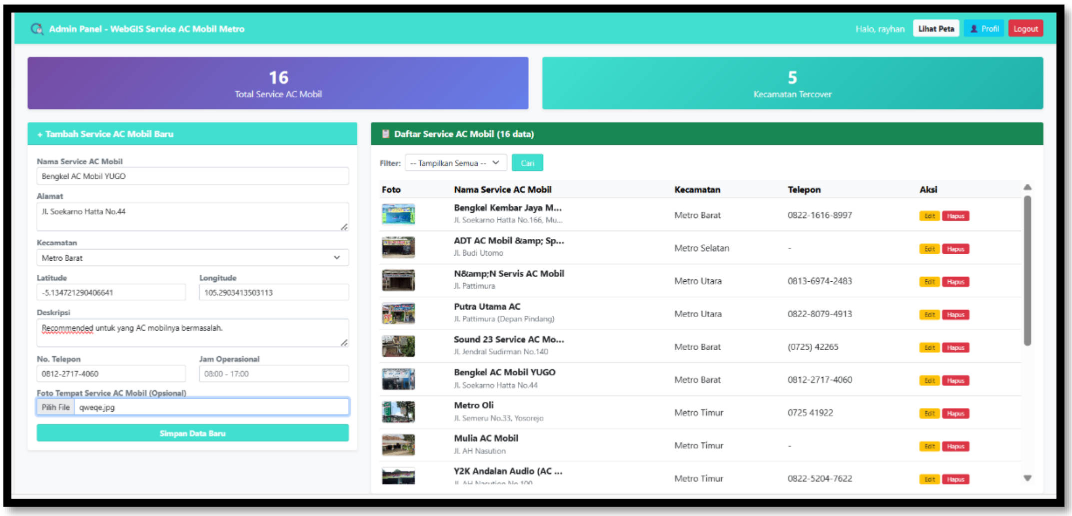

Figure 5. Admin Panel Interface – Add Data

In the Admin Panel interface – Add Data (Figure 5), system administrators are granted exclusive access to input detailed spatial and descriptive information regarding newly established car AC services. The required parameters include the workshop's precise geodetic coordinates (latitude and longitude)—which are heavily vital for the Vincenty algorithm's accuracy—alongside the workshop name, specific address, district category, operational hours, contact number, detailed descriptions, and location photographs to provide a comprehensive visual reference for the end-users.

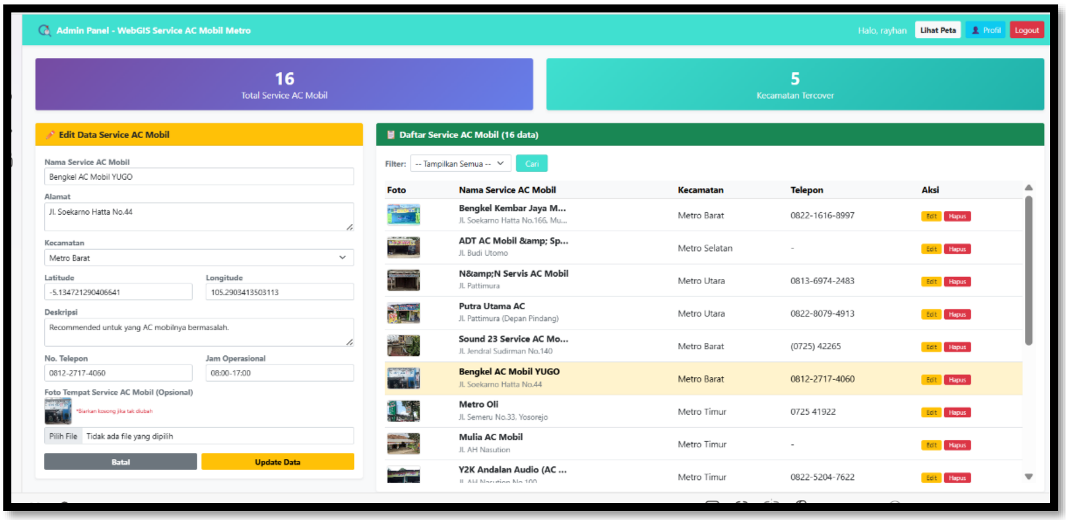

Figure 6. Admin Panel Interface - Edit and Delete Data

The Admin Panel interface - Edit and Delete Data (Figure 6) functions as a dynamic data management dashboard. It displays a comprehensive tabular list of all registered workshops and is utilized routinely by administrators to modify existing records or remove outdated information. This continuous data maintenance ensures that all workshop attributes and geographical coordinates displayed on the user's map remain highly relevant, strictly accurate, and consistently up to date with the latest field conditions in Metro City.

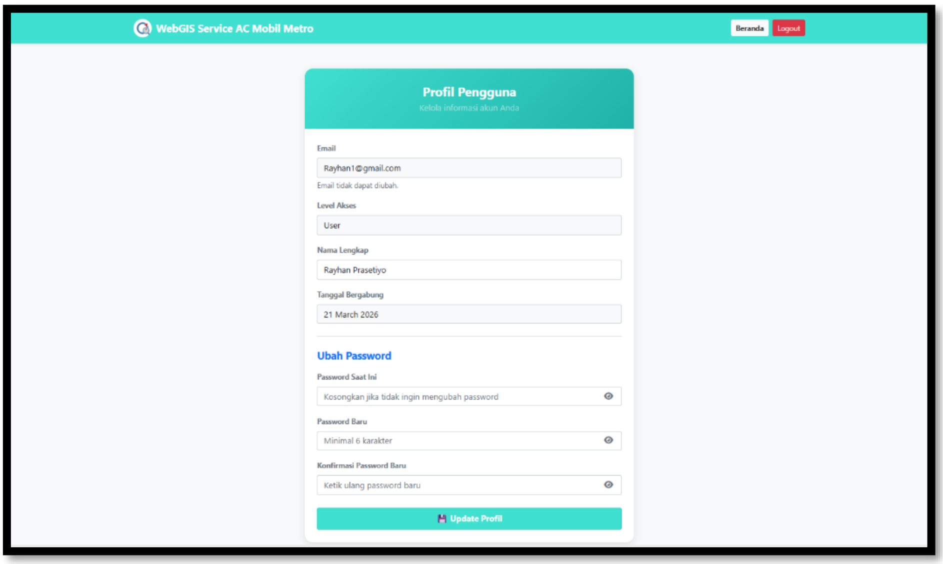

Figure 7. User Profile Interface

The user profile interface (Figure 7) is provided as a dedicated personal management space where users can clearly view their static account information, such as their registered email, access level, and join date. Moreover, it includes a functional form allowing users to change their passwords periodically. This feature empowers users to proactively maintain their system access security and overall data integrity without relying on external administrative support.

3.2. Mathematical Validation of Vincenty Algorithm

Validation was conducted to test the system's precision in calculating the geodesic distance between the user's location and a workshop (sample: Variasi Mobil NDC) using the WGS-84 ellipsoid model.

a. Parameter Data and Input Coordinates

Earth constants were established as $a = 6378137.0$ m, $b = 6356752.314245$ m, and $f = 1/298.257223563$. The test points used were :

1. Point 1 (User): $\emptyset_1 = -5.1016°$, $L_1 = 105.4010°$
2. Point 2 (Workshop): $\emptyset_2 = -5.09868°$, $L_2 = 105.33843°$

b. Step 1: Reduced Latitude (U) and Longitude Difference (L)

Coordinates were converted to radians, followed by the calculation of the reduced latitude (U) and longitude difference (L):

$$\tan U = (1 - f) \times \tan \emptyset \qquad (1)$$

1. $U_1 = -0.088741$ rad
2. $U_2 = -0.088690$ rad
3. $L = L_2 - L_1 = -0.001092$ rad (2)

c. Step 2: Vincenty Iteration

The iteration begins with $\lambda = L$ to determine the angular distance (σ) via spherical trigonometry equations:

$$\sin\sigma = \sqrt{(\cos U_2 \sin\lambda)^2 + (\cos U_1 \sin U_2 - \sin U_1 \cos U_2 \cos\lambda)^2} = 0.001088 \qquad (3)$$
$$\cos\sigma = \sin U_1 \sin U_2 + \cos U_1 \cos U_2 \cos\lambda = 0.999993$$
$$\sigma = \arctan(\sin\sigma / \cos\sigma) = 0.001088 \text{ rad}$$

Next, the correction coefficients $\cos^2\alpha = 0.009178$ and $\cos(2\sigma_m) = -0.710321$ are calculated. Iteration continues until the λ converges at the system's precision limit.

d. Step 3: Final Distance Calculation (s)

The earth's curvature correction variable is calculated based on the u^2 value:

$$u^2 = \cos^2 \alpha \times \left(\frac{a^2-b^2}{b^2}\right) = 0.000061 \quad (4)$$
$$A = 1.000015, \quad B = 0.000015$$

The shortest ellipsoid distance (s) is obtained via the formula:

$$s = b \times A \times (\sigma - \Delta\sigma) \quad (5)$$
$$s = 6356752.314245 \times 1.000015 \times (0.001088 - 0.0000001)$$
$$s = 6917.45 \text{ meters}$$

e. Conclusion of Manual Calculation

The implementation of the Vincenty Algorithm in the system yielded a geodesic distance of 6917.45 meters (6.92 KM). When compared with the road route visualization on the WebGIS interface, which shows a distance of 7.05 KM, there is a difference of 0.13 KM or 1.8%. This variance is a reasonable occurrence because the Vincenty Algorithm calculates the pure straight-line (geodetic) distance based on the WGS-84 ellipsoid to prioritize identifying the absolute nearest workshop geographically. Meanwhile, the 7.05 KM figure displayed on the system reflects the actual driving distance, which must follow the real-world geometry of the road networks and routes in Metro City. With a level of manual calculation precision consistent with the system, this algorithm is declared valid for use as a reliable workshop location search engine within the application.

3.3. System Testing (Black Box Testing)

Evaluation of application functionality was carried out using the Black Box Testing method to ensure that each module operates according to expected business logic. The focus of this testing is on interface functionality without examining the internal code structure, with test results summarized in Table 1. Black Box Testing.

Table 1. Black Box Testing

No	**Testing Scenario**	**Test Scenario (Input)**	**Expected Result**	**Test Result**	**Conclusion**
1	Login Function	Entering a valid and registered email and password.	The system accepts access and redirects the user to the main WebGIS page. .	As expected.	Valid
		Entering incorrect/empty email or password .	The system denies access and displays an error warning message.	As expected.	Valid
2	Registration Function	Completing the entire registration form (Name, Email, Password).	Data is saved to the database and the system shows a success message/redirects to the login page.	As expected.	Valid
3	Forgot Password Function	Entering a new password to reset the account.	The old password is overwritten by the new password in the database.	As expected.	Valid
4	Map Filter & Vincenty Algorithm	Entering a specific distance range (e.g., 2 - 14 KM) or selecting a specific sub-district.	The system calculates the distance using the Vincenty formula and only displays workshops that meet the filter criteria.	As expected.	Valid
5	Workshop Data Management (Admin)	Inputting new AC service data (including location coordinates and photos).	New workshop data is saved in the database and a new marker appears on the main map.	As expected.	Valid
		Editing information or deleting existing workshop data.	Data in the database and the map is updated or deleted according to admin instructions.	As expected.	Valid
6	User Profile Function	Entering a new password in the change password field on the profile page.	The system updates the account password for subsequent login purposes.	As expected.	Valid

The test results in Table 1 confirm that all primary modules, specifically comprising the seven core components of the application, have been accurately verified and achieved a 100% functional validity rate. Based on these data, it can be concluded that synchronization between user input and system response functions optimally without any errors, leading to the conclusion that this WebGIS platform is highly viable for implementation in Metro City.

4. CONCLUSION

Based on the design and implementation results gathered, it can be concluded that the WebGIS application for searching car AC workshops in Metro City has been successfully developed in accordance with the research objectives. The implementation of the Vincenty Algorithm has proven to provide optimal accuracy in calculating geodetic distances based on the WGS-84 ellipsoid earth model. This is supported by comparative test results showing a mathematically logical difference of only 0.13 KM (1.8%) between the Vincenty geodesic calculation (6.92 KM) and the actual driving distance on the map (7.05 KM). Furthermore, evaluations through the Black Box Testing method confirmed that all seven core functional modules operate validly with a 100% success rate, proving optimal synchronization between user input and system response. The integration of the systematic Waterfall development method ensures that this platform boasts sound data management and is fully prepared to be deployed as a reliable digital navigation solution for vehicle owners in Metro City.

REFERENCES

[1] M. G. Perrina, "Literature Review Sistem Informasi Geografis (SIG)," *J. Inf. Technol. Comput. Sci. JOINTECOMS*, vol. 10, no. 10, hlm. 1–4, 2021.

[2] M. Fauzi, "Analisis Perbandingan Formula Haversine dan Formula Vincenty dalam Perhitungan Jarak Destinasi Wisata Kabupaten Pacitan," PhD Thesis, UNIVERSITAS TEKNOLOGI DIGITAL INDONESIA (UTDI), 2025. Diakses: 30 Januari 2026. [Daring]. Tersedia pada: https://eprints.utdi.ac.id/10817/

[3] M. A. Asis, M. A. Mude, dan R. Astiani, "Analisis Akurasi Geolokasi Smartphone di Ruang Terbuka dan Tertutup," *G-Tech J. Teknol. Terap.*, vol. 8, no. 1, hlm. 286–294, 2024.

[4] S. H. Ritonga dan M. Alda, "Perbandingan Algoritma Vincenty Dan Hubeny Dalam Menentukan Jarak Terpendek Pada Fasilitas Kesehatan di Asahan Berbasis Mobile," *Decode J. Pendidik. Teknol. Inf.*, vol. 5, no. 2, hlm. 601–611, 2025.

[5] F. Saputra dan Y. N. Marlim, "Sistem Informasi Pencarian Service Ac Mobil Menggunakan Algoritma Dijkstra," *J. Mhs. Apl. Teknol. Komput. Dan Inf. JMApTeKsi*, vol. 1, no. 3, hlm. 135–140, 2020.

[6] N. Ashiddiqi, "PERANCANGAN APLIKASI SISTEM INFORMASI GEOGRAFIS LOKASI BENGKEL MOTOR DI KOTA PAYAKUMBUH BERBASIS WEBGIS," PhD Thesis, UNIVERSITAS PUTRA INDONESIA YPTK PADANG, 2020. Diakses: 29 Januari 2026. [Daring]. Tersedia pada: http://repository.upiyptk.ac.id/id/eprint/7887

[7] N. M. Faizah dan L. Koryanto, "Rancang Bangun Aplikasi Sistem Informasi Geografis untuk Pencarian Bengkel Resmi Honda di Kota Depok Berbasis Android dengan Metode Location-Based Service (LBS)," *Des. J.*, vol. 2, no. 2, hlm. 79–88, 2024.

[8] A. Aldrian, "Geographic Information System (GIS) Titik Lokasi Bengkel Mobil," *Kanzun J. Ilm. Multidisiplin*, vol. 3, no. 1, hlm. 1–13, 2026.

[9] T. Vats, S. Kumar, U. K. Sinha, dan S. Sahoo, "Comparative Analysis of Geographical Distance Methods: Haversine, Spherical Law of Cosines, Vincenty, Karney, and Great Elliptic Distance," dalam *2025 IEEE 4th World Conference on Applied Intelligence and Computing (AIC)*, IEEE, 2025, hlm. 311–316. Diakses: 24 April 2026. [Daring]. Tersedia pada: https://ieeexplore.ieee.org/abstract/document/11211926/

[10] T. Vincenty, "DIRECT AND INVERSE SOLUTIONS OF GEODESICS ON THE ELLIPSOID WITH APPLICATION OF NESTED EQUATIONS," *Surv. Rev.*, vol. 23, no. 176, hlm. 88–93, Apr 1975, doi: 10.1179/sre.1975.23.176.88.

[11] A. A. Wahid, "Analisis metode waterfall untuk pengembangan sistem informasi," *J Ilmu-Ilmu Inf. Dan Manaj STMIK No Novemb.*, vol. 1, no. 1, hlm. 1–5, 2020.

[12] M. Mardalius dan F. Dristyan, "Pemanfaatan Library Leaflet Pada GIS Sekolah Di Dinas Pendidikan Kabupaten Asahan Menggunakan Framework Codeigniter 4," *J. Teknol. Sist. Inf. Dan Sist. Komput. TGD*, vol. 6, no. 1, hlm. 157–163, 2023.

[13] R. Angel, W. Agustina, N. Nurhasanah, A. C. Mauluddin, dan R. N. Handayani, "Pengembangan platform e-commerce UMKM berbasis Laravel dengan blackbox testing dan metode Waterfall," *J. Pendidik.*, vol. 5, no. 2, 2025, Diakses: 12 April 2026. [Daring]. Tersedia pada: https://elibrary.ru/item.asp?id=81475587