Ceddi Journal of Information System and Technology (JST)
Vol. 2 No. 1 April (2023)
https://doi.org/10.56134/jst.v2i1.32

ISSN: 2829-808X (print)
ISSN: 2829-6575 (online)

Development of a Web-based Geographic Information System for Locating Medical Practices

Andryanto Aman[1*], Wisda[2], Suryadi Syamsu[3], Khaidir Rahman Nasir[4], Tatik Maslihatin[5] & Magfirah Nur Iqlimah[6]

[1]*Department of Informatics Engineering, Universitas Teknologi Akba Makassar, Makassar, Indonesia*
[2-6]*Department of Information Systems, Universitas Teknologi Akba Makassar, Makassar, Indonesia*

Abstract

This study aims to develop a web-based Geographic Information System (GIS) for searching medical practices. The system is designed to provide the public with easy access to information on the location of medical practices in the city. The Haversine method is used to calculate the distance between the user's location and the medical practice locations, and the system displays the nearest locations on the map. The system was developed using the PHP programming language, MySQL database management system, and Google Maps API. The user interface was designed to be simple and user-friendly, with a search bar and filters for narrowing down search results. The system's feasibility was evaluated through a questionnaire answered by 20 respondents with seven questions. The average score was 84.42%, indicating that the system is highly feasible for use. The developed system is expected to facilitate the public's access to medical practices and provide a more efficient way to find the nearest doctor.

Keywords: General Practitioner; Haversine; Nearest Distance; Geographic Information.

Received: 15 February 2023 Revised: 29 March 2023 Accepted: 27 April 2023

Introduction

Health is one of the indicators of a country's successful development. Technology is rapidly developing every year, including in the field of health (Bhutta et al., 2005; Organization & Others, 2002). With technology, all activities can be done at home because nowadays various developments of smartphones and computers/laptops can various developments of smartphones and computers/laptops can be carried everywhere (Bicen & Arnavut, 2015). In the combination of health and technology, it becomes easier for someone to find the information they need.

Health is one of the indicators of a country's development success. Currently, technology is rapidly developing from year to year, including in the field of health (Cohen, 2006; Ullah et al., 2021). With the help of technology, we can perform various activities at home as the era is supported by various developments in smartphones and computers/laptops that can be taken everywhere. The combination of health and technology makes it easier for people to find what they need (Boulos & Wheeler, 2007). Private doctor practices, including general practitioners, dentists, and specialists, are called Doctor practices (Zwack & Schweitzer, 2013). However, a lack of information about the location of doctors practices can hinder patients who need medical attention, thus requiring an information system that shows the location of health facilities. Due to the absence of a system that can provide information in the form of digital maps, most people experience difficulties in finding the nearest health services when experiencing health problems such as illness, accidents, and others (Al-Shorbaji, 2021; Jia et al., 2020). Geographic Information System (GIS) technology, which has developed rapidly, can be the answer to overcoming these problems and fulfilling the need for basic information about the location of doctor practices that can be easily accessed via computers, laptops, or smartphones using an internet connection (Davenhall & Kinabrew, 2022; Lü et al., 2019). A Geographic Information System is an information system that presents information in a graphical form about an object or phenomenon related to a map and uses a map as an interface (Chique et al., 2019; Sebillo et al., 2020).

The availability of numerous doctors' practices in various areas of Makassar City makes it difficult for the public to choose the closest location. As a result, the public has many options in seeking optimal health care services.

*Corresponding author.
E-mail address: andryantoaman@akba.ac.id (Andryanto Aman)

The program to be developed will use web-based GIS technology with the Haversine algorithm. This algorithm can be used to determine the distance between two points based on their latitude and longitude coordinates on Google Maps. The calculation using the Haversine Formula method will show the distance between the two points, which can be displayed on a map using the Leaflet JS software. This application not only helps users find the location of a doctor's practice, but also provides information such as the doctor's name, practice address, and working hours. With this GIS-based location search application, the public will find it easier to locate the nearest doctor's practice and avoid any inconvenience caused by a closed practice.

In this study, we conducted a literature review of several related studies. Some of the studies reviewed in our study included previous research by (Şahin et al., 2019) which was conducted to select the best location for a hospital in Muğla, Turkey, using an Analytic Hierarchy Process (AHP) decision support model. The results showed that demand is the most important factor in determining the appropriate location for a hospital, followed by accessibility, competitors, government, related industries, and environmental conditions. Based on these findings, Bodrum was chosen as the best location to establish a new hospital. This study provides a reference for hospital managers and investors in selecting hospital locations using AHP.

Research conducted by (Jo et al., 2021) identified and compared access to dental and general practices and investigated whether there is a socioeconomic distribution of both types of practices among older adults. The research method used included mapping 13,007 dental practices and 13,759 general practices using GIS software. Furthermore, the location data of the practices was supplemented with population data of the elderly and poverty rates in health areas in England. The results showed that there is an imbalance in spatial accessibility to dental and general practices in the UK. In addition, both types of practices are socioeconomically distributed among older adults in England, Wales, and Northern Ireland, but not in Scotland.

Then, researchers (Diyasa et al., 2022) developed an Android application using the Haversine formula to create a GIS for smart backpacker travel recommendations in Bali. The application aims to assist budget-conscious travellers in exploring tourist attractions independently by providing recommendations based on the distance between their location and the attractions. The Haversine formula is used to determine the distance between backpacker locations and tourist attractions, which was found to have an accuracy of up to 88% compared to the Google Maps API. This application covers all aspects of travel, including registration and tour guides, and is intended to help revive tourism in Bali impacted by the Covid-19 pandemic.

Furthermore, research (Candra et al., 2021) developed a GIS-based system that can assist public transportation users in finding the nearest bus stop with the best route based on the user's location. In this study, the Haversine method was used to find the nearest bus stop from the user's location and the Tabu Search method was used to find the best route from the user's location to the nearest bus stop. The test results showed that the Haversine method provides the closest distance of the bus stop to the user's location, while the Tabu Search algorithm generates the best route with an average running time of 0.526 milliseconds.

Based on the above problem, the author chooses the title "Design and Development of Web-Based Geographic Information System for Finding General Practitioners" to help people who have difficulty finding nearby general practitioners from their location, so that patients can be treated quickly.

Method

The stages involved in solving the problem are as follows: 1. Data Collection, 2. Analysis, 3. Algorithm 3. Design, 4. Implementation, 5. System Feasibility Testing using a questionnaire.

1. Data Collection

To obtain more accurate and appropriate data to be entered into the system that will be created, several data collection methods were used. The methods used by the researchers are a.) Observation: Finding data by directly coming to the object of the study, which is the doctor's practice. This method will provide data about the image to be entered into the application and also the location points of the doctor's practice object. b.) Literature Study: a data collection technique relevant to research on the development of a geographic information system for searching for web-based doctor practices from scientific articles or other scientific sources.

2. Analysis

In this stage, a needs analysis is required to build the system among 1.) hardware requirements such as a computer/laptop with recommended specifications of 8GB RAM and a minimum of 4GB for SSD/Hard disk storage space. 2.) Software requirements such as Xampp, Leaflet Js, and Visual Studio Code. Furthermore, user requirements have 2 actors: Admin and User. The Admin can log into the system, manage data and input doctor practice data, and can add, edit, and delete data contained in the database. Meanwhile, the User in this case is the public who can search for doctor practices, access the nearest distance search, and view a list of doctor practices.

3. The Haversine Algorithm

The Haversine method is a technique used in navigation systems where it calculates the distance between two points on the earth's surface based on their longitude and latitude coordinates. The Haversine method is a way of determining the distance between two points based on their position on the Earth's surface (Azdy & Darnis, 2020). In modern applications, it uses Latitude and Longitude on Google Maps. The result of the calculation using the Haversine formula is the distance between the two points which can be displayed on a map using the API or Application Programming Interface on Google Maps. The Haversine pattern is shown in Figure 1.

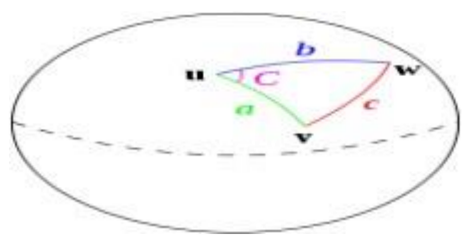

Figure. 1. Haversine pattern

The image shown in Figure 1 represents the Haversine formula pattern, which is depicted in the form of spherical trigonometry. This equation is crucial in navigation systems as it calculates the shortest distance between two points. Originally, the Haversine formula was used to solve main problems in nautical astronomy and to determine the distance between stars. It was first used by Josef de Mendoza y Rios and later discovered by James Andrew in 1805 (Dauni et al., 2019). The term "Haversine" was coined in 1835 by Professor James Inman (Vinod, 2022). Assuming that the Earth is a perfect sphere with a radius of 6,371 km and that the locations of the two points in the spherical coordinates (latitude and longitude) are lon1, lat1, and lon2, lat2, the Haversine formula can be expressed as follows:

$$X = (lon2 - lon1) * cos((lat1 + lat2)/2) \quad (1)$$

$$y = (lat2 - lat1) \quad (2)$$

$$d = sqrt(x * x + y * y) * R \quad (3)$$

Where:
Lat1 = User's latitude (in degrees)
Lon1 = User's longitude (in degrees)
Lat2 = Doctor's practice location latitude (in degrees)
Lon2 = Doctor's practice location longitude (in degrees)
x = Longitude (in degrees)
y = Latitude (in degrees)
d = Distance (in kilometres)
1 degree = 0.0174532925 radians
R = 6,371 km (radius of the Earth in kilometres)

The goal of system design is to meet the needs of system users and provide a clear overview and comprehensive design to programmers and experts involved in the project. One of the system designs that can be used is the Use Case Diagram. The Use Case Diagram can display a graphical representation of the system's functionality, viewed from the actor's perspective, actor goals, and related use cases (Kasmi et al., 2022). Figure 1 shows the Use Case Diagram of the system to be designed.

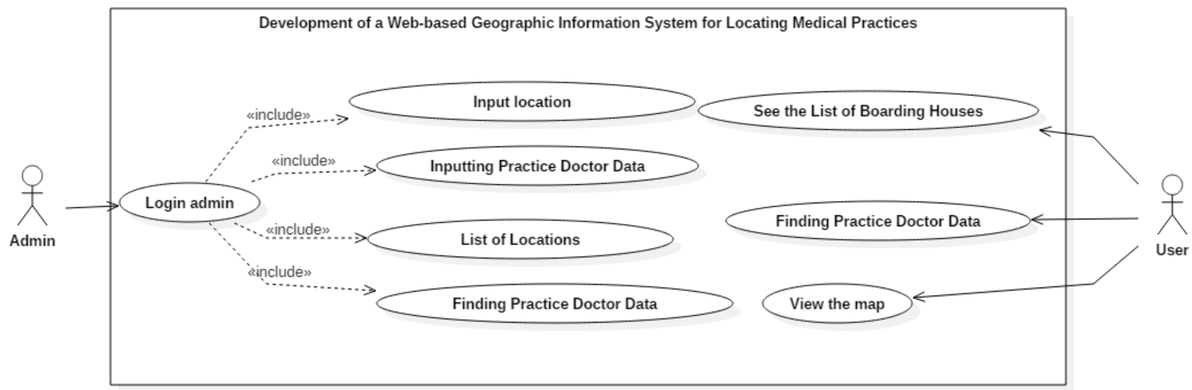

Figure. 2. Use a Case Diagram

In Figure 1, the actors involved in the system and their access rights are described in Tables 1 and 2.

Table 1. Description of Actors

Actor	Description
Admin	Has access rights to input data into the system.
User	Has access to search for locations of practising doctors.

Table 2. Description of Use Cases

Use Case	Description
Login	Admin logs in before accessing the main page.
Input Location	Has access to search for locations of practising doctors.
List Location	Displays the list of practising doctor locations.
Input Doctor	Data Inputs data of practising doctors.
Search Practicing Doctor	Searches for the location of practising doctors.

Results and Discussion

Result

When determining the destination point, a starting point location is needed as a reference point. In this research, the starting point was located at Universitas Teknologi Akba Makassar, while the destination point was at Dr. Mahyuni Arifin's location. The calculation steps are as follows:

Location : Universitas Teknologi Akba Makassar
Lon1 : 119.4864613
Lat1 : -5.1354362

a. Determining the destination location.
   Dr. Mahyuni Arifin (General Practitioner)
   Lon2 : 119.507866711596
   Lat2 : -5.13266327402263
b. Converting degrees to radians.
   Lon1 = 119.4864613 x 0.0174532925 radian

= 2.0854321589 radian
Lat1 = -5.1354362 x 0.0174532925 radian
= -0.0896302701 radian
Lon2 = 119.507866711596 x 0.0174532925 radian
= -2.0858057538 radian
Lat2 = 119.507866711596 x 0.0174532925 radian
= -0.0895818734 radian

c. Finding the values of X and Y

X = (lon2-lon1) * cos ((lat1+lat2)/2)
= (119.507866711596 – 2.0854321589)* cos ((-0.0896302701 + --0.0895818734)/2)
= - 0.0000367612

Y = (lat2 – lat1)
= ((-0.0895818734) – (-0.0896302701)))
= - 0.0000483967

d. Calculating the value of d (distance).

d = sqrt (X*X + Y*Y) *R
= sqrt (-0.0000367612 x -0.0000367612+ -0.0000483967 x -0.0000483967) x 6317
= 2.34224 km

Table 3. Distance Calculation

Latitude and Longitude of User	Doctor	Latitude and Longitude of Destination	Distance
Latitude: -5.1354362, Longitude: 119.4864613 (Universitas Teknologi Akba Makassar)	Drg. Sumiati Sanusi (Dental Specialist)	Latitude: -5.12907017755833, Longitude: 119.503515972962.	1.97
	Dr. Mahyuni Arifin (General Practitioner)	Latitude: -5.13266327402263, Longitude: 119.50786671159649	2.34
	Dr. Harun Ar Albar, Mkes, SpA (Pediatrician)	Latitude: -5.13894780015128, Longitude: 119.509491199857	2.52
	Drg. Fitri Tunni A.Skg (Dentist Specialist)	Latitude: -5.15109261664479, Longitude: 119.447979567878	4.51
	Dr. Usman Darwis, M.Kes, Sp.A (Pediatric Specialist)	Latitude: -5.16060435430255, Longitude: 119.4449246824	5.29
	Dr. Annisa (General Practitioner)	Latitude: -5.1613198800248, Longitude: 119.443290171021	5.48

1) Login Page

The admin login page is used to access the admin page. When the username and password entered match with the ones in the database, the page will redirect to the admin page.

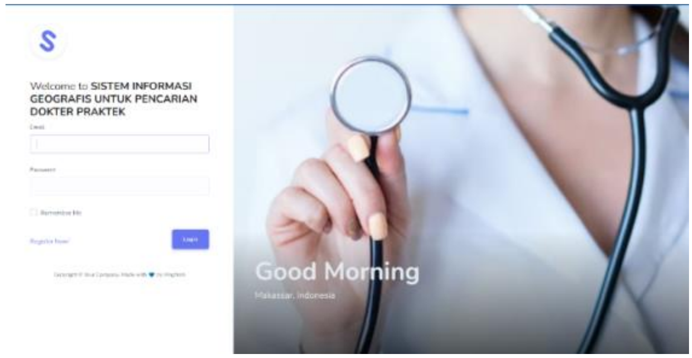

Figure 3. Login Page

2) Homepage

On the main menu page, the admin can manage data. This page includes menus for doctor practice data, doctor practice data management, specialities, and maps of doctor practice coordinates.

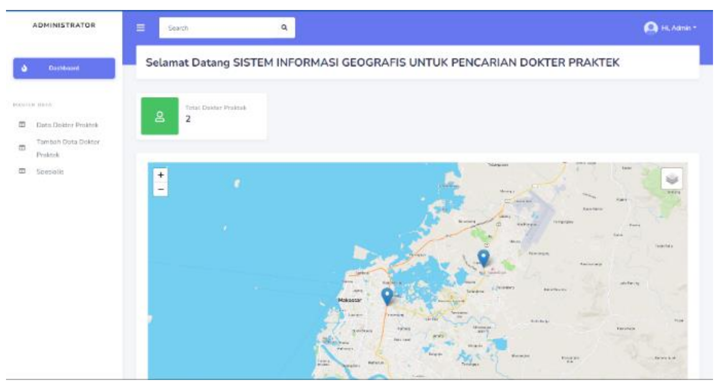

Figure 4. Homepage

3) Input Data and Location of Medical Practitioners Page.

On this page, the admin can input and process the data of existing medical practitioners such as the name of the practice location, doctor's name, practice address, specialization type, practice hours, and doctor's photo.

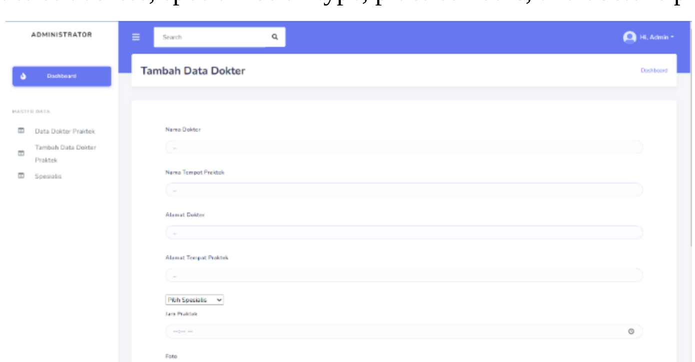

Figure 5. Input Data and Location of Medical Practitioners Page

4) Doctor Search Page

This page is used by users to access and obtain information about the location of the doctor's practice.

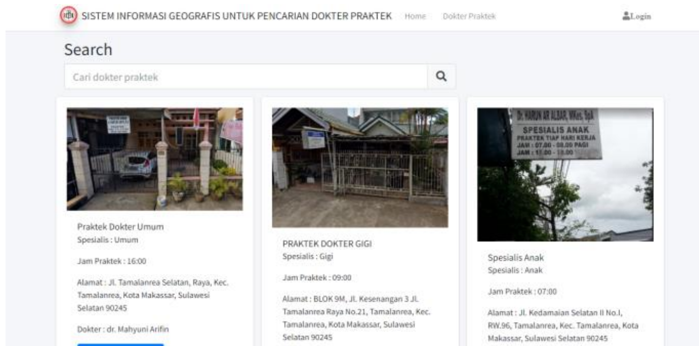

Figure 6. Doctor Search Page

This testing was conducted objectively and directly tested by respondents by creating questions to measure the feasibility of the system that was created based on the design that has been outlined.

The weight of the questionnaire assessment is used to determine the level of user satisfaction with the geographic information system for searching medical practices. This assessment is done by giving a score to each answer provided by the respondent. The "Strongly Agree" score weights 5, the "Agree" score has a weight of 4, the "Neutral" score has a weight of 3, the "Disagree" score has a weight of 2, and the "Strongly Disagree" score has a weight of 1. By using this weighting, the questionnaire results can be analyzed and translated into numerical form to facilitate decision-making.

To calculate the percentage of the feasibility of the geographical information system for searching medical practitioners based on the questionnaire results, we can use the following formula:

$$Percentage\ Value = \frac{Number\ of\ Interpretation\ Values}{Number\ of\ Questions} \qquad (4)$$

The percentage interval of the suitability of the geographic information system for searching for practising doctors can be classified as follows: if the score percentage is between 0% to 20%, then the system is classified as "Very Unsuitable". If the score percentage is between 21% to 40%, then the system is classified as "Unsuitable". If the score percentage is between 41% to 60%, then the system is classified as "Neutral". If the score percentage is between 61% to 80%, then the system is classified as "Suitable". And if the score percentage is between 81% to 100%, then the system is classified as "Very Suitable". The answer choices in the questionnaire have the following descriptions: "Strongly Agree" (SA), "Agree" (A), "Neutral" (N), "Disagree" (D), and "Strongly Disagree" (SD).

Table 4. Calculation of Questionnaire Responses

Aspect	Statement	Result	Percentage
Design	The user interface of the doctor practice search application is easy to understand	85	86%
	The design of the doctor practice search application is appealing.	80	80%
	The map displayed in the doctor practice search application is easy to understand.	86	86%
Functionality/Utility	The doctor practice search application is user-friendly.	84	84%
	The doctor practice search application can assist the public.	88	88%
Information	The information displayed in the doctor practice search application is clear.	81	81%
	The displayed information is helpful enough.	87	87%

To obtain the feasibility percentage, first, we need to find the interpretation value of respondents for each question by using the formula Y = highest score x number of respondents. Where the highest score is 5 with several respondents of 20 people, then Y = 5 x 20 = 100, so the interpretation value can be calculated using the formula total score / Y x 100. Please refer to Table 5 for details.

Table 5. Processing Questionnaire.

Total Score	Interpretation Value
85	85%
80	80%
86	86%
84	84%
88	88%
Total	591%

Based on 20 respondents, the percentage value obtained is 84.42%. Therefore, the nearest doctor search system can be considered very feasible according to the feasibility table. This indicates that in general, the respondents agree and trust the built geographic information system.

Discussion

In the development of a web-based Geographic Information System (GIS) for searching for medical practitioners, several limitations or constraints need to be considered. Firstly, the main constraint is the availability of data. To build an accurate and comprehensive system, detailed data on the location and information of medical practitioners in Makassar City are required. If the available data is incomplete or outdated, the system may provide users with inaccurate or incomplete information (Ali et al., 2020; Flanagin & Metzger, 2008). Therefore, it is important to have mechanisms in place to ensure the completeness and currency of the medical practitioner data in the system.

Another constraint is the technical limitation of using the Haversine method. The Haversine method calculates the distance between two points based on their latitude and longitude coordinates (Prasetya et al., 2020). However, this method does not consider other factors that can affect travel time, such as traffic conditions or potentially inefficient travel routes (Andersson Granberg et al., 2022). Consequently, although the system provides the nearest location of medical practitioners based on distance, it does not guarantee that the location is the optimal choice in terms of time and travel convenience.

These limitations can either reinforce or contradict each other. For example, if the available data is incomplete or outdated, the Haversine method used in the system may not produce accurate results. Conversely, if the obtained data is highly comprehensive and regularly updated, the Haversine method can provide more accurate results in determining the nearest location of medical practitioners. If the data used is inaccurate or incomplete, the search results for the nearest medical practitioner locations may be inaccurate or not meet user expectations. Additionally, if the Haversine method does not consider other factors that affect travel time, users may obtain inefficient results in finding the nearest medical practitioner locations.

To improve or expand the system in the future, several steps can be taken. First, it is important to continuously collect and update data on the location and information of medical practitioners in Makassar City. This can involve collaboration with medical institutions and relevant authorities to obtain the latest and most comprehensive data. Furthermore, the development of other methods that consider factors such as traffic conditions and travel route efficiency can help improve the quality of the system. Additionally, implementing additional features such as user reviews, doctors' practice schedules, and information on additional services provided by medical practitioners can expand the system's functionality and provide users with a more comprehensive experience.

The development of the system may involve integration with other platforms or applications, such as online appointment booking systems or digital health applications. This will allow users not only to find the nearest medical practitioner locations but also to make appointments directly or access their health records.

Conclusions and Suggestions

Conclusions
The geographic information system for searching medical practices using the Haversine algorithm can help people locate medical practices in Makassar. Additionally, it can identify the nearest coordinates for searching medical practices. After conducting testing of the geographic information system for searching the nearest medical practices using the Haversine algorithm among several experts and users, it can be concluded that the system is categorized as feasible based on the questionnaire results from 20 respondents with seven questions, resulting in an average score of 84.42%.

Suggestions
Several suggestions are proposed to further enhance the system:
1. Regularly updating the medical practice data will ensure the accuracy and completeness of the information provided to users.
2. Incorporating real-time information, such as waiting times and appointment availability, would provide users with more comprehensive and up-to-date information.
3. Allowing users to provide feedback and ratings for medical practices can assist others in making informed decisions based on the reputation and quality of services.
4. Creating a mobile application would enhance accessibility and convenience for users, allowing them to access the system easily through their smartphones.
5. Implementing robust security protocols and privacy measures will ensure the protection of user data and foster trust in utilizing the system.
6. Collaborating with medical associations, hospitals, and clinics can facilitate data sharing, support system updates, and encourage participation from healthcare providers.

Acknowledgements: We would like to express our gratitude for the support received from Akba Makassar University and several medical practitioners in Makassar City throughout this research. Their contributions and collaboration have been instrumental in the successful completion of this study.

References

Al-Shorbaji, N. (2021). Improving Healthcare Access through Digital Health: The Use of Information and Communication Technologies. *Healthcare Access*, *10*.

Ali, U., Shamsi, M. H., Bohacek, M., Purcell, K., Hoare, C., Mangina, E., & O'Donnell, J. (2020). A data-driven approach for multi-scale GIS-based building energy modeling for analysis, planning and support decision making. *Applied Energy*, *279*, 115834.

Andersson Granberg, T., Erlander, S., Fredman, D., Olovsson, L., & Persson, E. (2022). Predicting Volunteer Travel Time to Emergencies. *19th International Conference on Information Systems for Crisis Response and Management, Tarbes, France, May 22-25, 2022*, 44–54.

Azdy, R. A., & Darnis, F. (2020). Use of haversine formula in finding distance between temporary shelter and waste end processing sites. *Journal of Physics: Conference Series*, *1500*(1), 12104. https://doi.org/https://doi.org/10.1088/1742-6596/1500/1/012104

Bhutta, Z. A., Darmstadt, G. L., Hasan, B. S., & Haws, R. A. (2005). Community-based interventions for improving perinatal and neonatal health outcomes in developing countries: a review of the evidence. *Pediatrics*, *115*(Supplement_2), 519–617. https://doi.org/https://doi.org/10.1542/peds.2004-1441

Bicen, H., & Arnavut, A. (2015). Determining the effects of technological tool use habits on social lives. *Computers in Human Behavior*, *48*, 457–462. https://doi.org/https://doi.org/10.1016/j.chb.2015.02.012

Boulos, M. N. K., & Wheeler, S. (2007). The emerging Web 2.0 social software: an enabling suite of sociable technologies in health and health care education. *Health Information and Libraries Journal*, *24*(1), 2–23. https://doi.org/https://doi.org/10.1111/j.1471-1842.2007.00701.x

Candra, A., Rachmawati, D., & Faradillah, I. N. (2021). Haversine and Tabu Search in Determining the Nearest Bus Stop based on GIS. *2021 International Conference on Data Science, Artificial Intelligence, and Business*

Analytics (DATABIA), 176–179. https://doi.org/https://doi.org/10.1109/DATABIA53375.2021.9650155

Chique, C., Cullinan, J., Hooban, B., & Morris, D. (2019). Mapping and analysing potential sources and transmission routes of antimicrobial resistant organisms in the environment using geographic information systems—an exploratory study. *Antibiotics*, *8*(1), 16. https://doi.org/https://doi.org/10.3390/antibiotics8010016

Cohen, B. (2006). Urbanization in developing countries: Current trends, future projections, and key challenges for sustainability. *Technology in Society*, *28*(1–2), 63–80. https://doi.org/https://doi.org/10.1016/j.techsoc.2005.10.005

Dauni, P., Firdaus, M. D., Asfariani, R., Saputra, M. I. N., Hidayat, A. A., & Zulfikar, W. B. (2019). Implementation of Haversine formula for school location tracking. *Journal of Physics: Conference Series*, *1402*(7), 77028.

Davenhall, W. F., & Kinabrew, C. (2022). Geographic Information Systems in Health and Human Services. In *Springer Handbook of Geographic Information* (pp. 781–805). Springer. https://doi.org/https://doi.org/10.1007/978-3-030-53125-6_29

Diyasa, I. G. S. M., Prasetya, D. A., Idhom, M., Sari, A. P., & Kassim, A. M. (2022). Implementation of Haversine Algorithm and Geolocation for travel recommendations on Smart Applications for Backpackers in Bali. *2022 International Conference on Informatics, Multimedia, Cyber and Information System (ICIMCIS)*, 504–508. https://doi.org/https://doi.org/10.1109/ICIMCIS56303.2022.10017760

Flanagin, A. J., & Metzger, M. J. (2008). The credibility of volunteered geographic information. *GeoJournal*, *72*, 137–148.

Jia, Q., Guo, Y., Wang, G., & Barnes, S. J. (2020). Big data analytics in the fight against major public health incidents (Including COVID-19): a conceptual framework. *International Journal of Environmental Research and Public Health*, *17*(17), 6161. https://doi.org/https://doi.org/10.3390/ijerph17176161

Jo, O., Kruger, E., & Tennant, M. (2021). GIS mapping of healthcare practices: do older adults have equitable access to dental and medical care in the UK? *British Dental Journal*, 1–9. https://doi.org/https://doi.org/10.1038/s41415-021-3406-0

Kasmi, M., Kumalasari, T., Amir, S. M., Usman, A. F., Ahmad, I., Aman, A., & others. (2022). Design of an Educational Application for Conservation and Ornamental Fish Capture Areas Based on Android. *Ceddi Journal of Education*, *1*(2), 13–18. https://doi.org/10.56134/CJE.V1I2.26

Lü, G., Batty, M., Strobl, J., Lin, H., Zhu, A.-X., & Chen, M. (2019). Reflections and speculations on the progress in Geographic Information Systems (GIS): a geographic perspective. *International Journal of Geographical Information Science*, *33*(2), 346–367. https://doi.org/https://doi.org/10.1080/13658816.2018.1533136

Organization, W. H., & others. (2002). *The work of WHO on HIV*.

Prasetya, D. A., Nguyen, P. T., Faizullin, R., Iswanto, I., & Armay, E. F. (2020). Resolving the shortest path problem using the haversine algorithm. *Journal of Critical Reviews*, *7*(1), 62–64.

Şahin, T., Ocak, S., & Top, M. (2019). Analytic hierarchy process for hospital site selection. *Health Policy and Technology*, *8*(1), 42–50. https://doi.org/https://doi.org/10.1016/j.hlpt.2019.02.005

Sebillo, M., Vitiello, G., Grimaldi, M., & De Piano, A. (2020). A citizen-centric approach for the improvement of territorial services management. *ISPRS International Journal of Geo-Information*, *9*(4), 223. https://doi.org/https://doi.org/10.3390/ijgi9040223

Ullah, A., Pinglu, C., Ullah, S., Abbas, H. S. M., & Khan, S. (2021). The role of e-governance in combating COVID-19 and promoting sustainable development: a comparative study of China and Pakistan. *Chinese Political Science Review*, *6*(1), 86–118. https://doi.org/https://doi.org/10.1007/s41111-020-00167-w

Vinod, B. (2022). The Last Frontier: Room Attribute Pricing and Inventory Control. In *Revenue Management in the Lodging Industry: Origins to the Last Frontier* (pp. 189–219). Springer. https://doi.org/https://doi.org/10.1007/978-3-031-14302-1_5

Zwack, J., & Schweitzer, J. (2013). If every fifth physician is affected by burnout, what about the other four? Resilience strategies of experienced physicians. *Academic Medicine*, *88*(3), 382–389. https://doi.org/https://doi.org/10.1097/ACM.0b013e318281696b