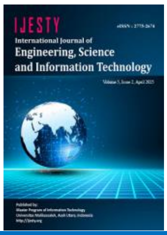
International Journal of Engineering, Science and Information Technology
Volume 5 No. 2 (2025) pp. 175-181
ISSN 2775-2674 (online)
Website: http://ijesty.org/index.php/ijesty
DOI: https://doi.org/10.52088/ijesty.v5i2.805
Research Paper, Short Communication, Review, Technical Paper



Implementation of Dijkstra and Ant Colony Algorithms for Web-based Shortest Route Search for LPG Gas Distribution

Rasna[1]*, Moh. Rahmat Irjii Matdoan[2], Nurlaela Kumala Dewi[3], Afferdhy Ariffien[4], Seno Lamsir[5]

[1]Department of Informations System, Universitas Yapis Papua, Indonesia
[2]Department of Informatics, Universitas Sains dan Teknologi Jayapura, Indonesia
[3]Department of Transportation Management,Universitas Logistik dan Bisnis Internasional, Indonesia
[3]Department of Logistics Management,Universitas Logistik dan Bisnis Internasional, Indonesia
[4]Department of Theology, STT Samuel Elizabeth, Indonesia

**Corresponding author Email: razna.anwar@gmail.com*

The manuscript was received on 18 June 2024, revised on 1 October 2024, and accepted on 2 February 2025, date of publication 3 April 2025

Abstract

National energy needs and efforts to fulfill them are currently vital issues to be discussed and resolved. One type of energy that still has various problems is fuel gas, especially LPG (Liquid Petroleum Gas). The gas scarcity in each region differs; not all regions experience gas shortages, and some areas have excess LPG gas stocks. The problem of the scarcity of 3 kilogram (Kg) LPG gas is not the first time this has happened. In recent months, people in some regions have complained about the scarcity of subsidized 3-kilogram (kg) LPG gas. This situation certainly makes it difficult for the community. Not only does the scarcity hamper community activities, but it also makes the price of gas refills more expensive than usual. With the increasing demand for LPG gas every year, the government must provide large stocks of LPG gas. But what power if the LPG gas stock is less or runs out at specific locations. Therefore, applying gas base route search is needed to overcome the shortage of gas stock at a location. This application applies two search methods, namely the Dijkstra algorithm and the ant colony algorithm, to find the fastest route to the location of the gas base in the XYZ area. In the algorithm process, Dijkstra requires distance data for each city before starting the algorithm process. The Ant Colony Algorithm does not require the distance of each city because, in an Ant Colony, the distance between towns is calculated after the ants complete their journey. From the results of the process of the two algorithms, it is known that the path produced by Dijkstra's algorithm is more consistent and precise than the Ant Colony algorithm, which gives results that are not necessarily the same for each process.

Keywords: *Algorithm, Djikstra, Ant Colony, Shortest Route.*

1. Introduction

Indonesia is a country rich in energy sources. Energy sources can come from mining and non-mining materials. Energy sources are mining materials such as petroleum, gas, and coal, while non-mining energy sources are wind, water, geothermal, and biomass [1]. One energy source that is owned and has been developed is petroleum [2]. Petroleum energy sources are processed into products such as kerosene, gasoline, diesel, lubricating oil, and asphalt [3]. During its development, petroleum energy sources are processed into several products, such as kerosene, gasoline, diesel, and lubricating oil. These petroleum products are then widely known and utilized by the people of Indonesia [4].
National energy needs and efforts to fulfill them are currently vital issues to be discussed and resolved. Gas fuel, especially LPG (Liquid Petroleum Gas), is one type of energy that still has various problems. The conversion policy from Kerosene to Gas Fuel is the beginning of the issues in efforts to fulfill sustainable energy for the community [5], [6]
The problem of the scarcity of 3-kilogram (Kg) LPG gas has happened before. In recent months, people in some regions have complained about the subsidized 3-kilogram LPG gas shortage. This situation certainly makes it difficult for the community. Not only does it hamper community activities, but this scarcity also makes gas refills more expensive than usual [7].

With the increasing need for LPG gas every year, the government must provide LPG gas stocks on a large scale. But what power if the LPG gas stock is less or runs out at specific locations. To overcome things like this, the application of Geographic Information Systems (GIS) in finding the area of bases that still have LPG gas stocks is needed to help people find gas bases that still have gas stocks.
In this case, Dijkstra, A star, and Ant Colony algorithms are the most commonly used algorithms for finding the shortest route. These are simple to use using superficial nodes on uncomplicated road networks. Therefore, applying GIS to find the shortest path using Dijkstra and Ant Colony algorithms is the best solution to find the shortest route for LPG gas distribution, especially for rural areas where there are still many roads that Google Maps has yet to detect

2. Literature Review

A system is a collection or set of elements, components, or variables that are organized, interact with each other, depend on each other, and are integrated [8].
Information can refer to raw data, organized data, the capacity of a communication channel, and so on. Information is data classified, processed, or interpreted for decision-making [9] [10].
Geographic Information System (GIS) is a series of activities that collect, organize, process and analyze spatial data/facts to obtain spatial information to answer or solve a problem in a particular earth space [11]. This system existed before computers were invented and is a routine activity of a geographer [12].
Maps depict geographical areas and parts of the Earth's surface in various ways, from conventional printed maps to digital maps displayed on computer screens [13].
A flowchart is a chart that shows the sequence and relationship between processes and their instructions. It outlines the program or application being created [14].
UML (Unified Modeling Language) is a language for defining, visualizing, constructing, and documenting artifacts (pieces of information used or generated in a software development process) of software systems, such as in business modeling and other non-software systems [15]. Artifacts can be models, descriptions, or software) of software systems, such as in business modeling and other non-software systems.
Ant Colony Algorithm is adopted from the behavior of ant colonies known as ant systems, which is a probabilistic technique used to solve computational problems by finding the best path through the graph [16]. Ant colonies are naturally able to find the shortest route on their way from the nest to food sources. Ant colonies can find the shortest route between the nest and the food source based on the footprints on the path that has been traveled. The more ants pass through a path, the more precise the footprints will be [17].
As reviewed in Algorithmics, Djikstra's algorithm is greedy (Brassard and Bratley [1988, pp. 87-92]). It solves the shortest path problem for a directed graph with non-negative edge weights. For example, if the graph's vertices represent cities and the edge weights represent the distance between the cities. Dijkstra's algorithm can be used to find the shortest distance between two cities [18].
Google Maps is an online map application service that is quite popular and is provided by Google for free. Google Maps is a free and online virtual globe map service. Google Maps map services can be accessed officially through the website http://maps.google.com. On the site, geographical information can be seen on almost all surfaces except the north and south polar regions [19].
A website or site can be defined as a collection of pages that display information on text data, still or motion image data, animation data, sound, video, and or a combination of all of them, both static and dynamic, which form a series of interrelated buildings where each is connected by a network of pages (hyper/ink) [20].

3. Research Method

Data collection is done by collecting references about the Dijkstra method, ant colony method, web programming, and LPG gas base location data needed to support the system development process. The process of collecting data on the location of bases is carried out by visiting the places of bases in the Sigli City and Simpang Tiga District areas, then presenting them in the form of latitude & longitude (lat & lng) numbers with the help of google maps.
Researchers analyzed the problems in determining the shortest route in the LPG gas distribution process and used the most efficient route-finding method.
The workflow diagram of the research system that will be carried out in this study is illustrated in Figure 1:

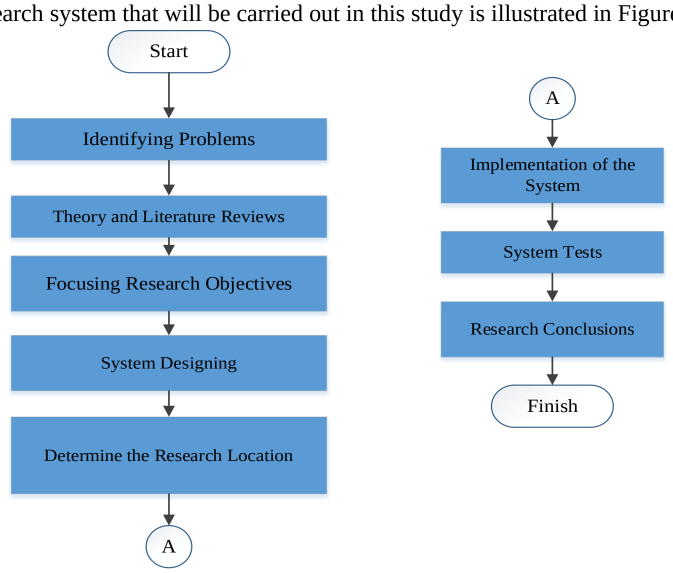


Fig 1. Diagram of the Research Workflow

Based on the workflow diagram above, starting with a problem, namely what issues are faced in research, understanding the situation, the data obtained from research is used to clarify a problem or information that is unknown and then known. Then, after the problem is formulated, continue to look for theories and literature reviews as research reference data, then proceed with determining the research objectives to be raised, and then proceed with the system design process. After the system design process is complete, the system will be implemented by testing the system to be created using a sample of lat & lng data on the location of the gas base that has been previously recorded. From the system test results, the accuracy level of the system work can be known so that conclusions can be obtained from this research.

4. Result And Discussions

4.1. Shortest Path Comparison

In comparing the shortest paths generated by the two algorithms, the authors tested both algorithms with the same input data and tested 11 (eleven) times. The testing steps for each algorithm are entering data on warehouse locations and base locations in the Dijkstra search while selecting locations on maps based on the exact location of the Dijkstra search location. In the ant colony algorithm, the parameter value of the number of ants and the maximum cycle is 50 and 50. The results of the process will appear after entering data and searching with each algorithm.

Before we compare the distance between the Dijkstra algorithm and the ant colony to find the shortest route, we should know the name and address of each location used in the sign application. The following is the location data used in this shortest route search, totaling 11 points of gas base locations in the Sigli city area of the Pidie district 3 base locations and 1 SPBE (LPG Bulk Filling Station) location in Pidie and Pidie Jaya districts. The following is a list of sample locations used in the siGAS application:

Table 1. Gas Station Location

No	Base Name	Location of Base
1	Maar Perkasa	Jl. Professor Abdul Majid Ibrahim, Lampeudeu Baroh, Pidie, Pidie Regency, Aceh 24112, Indonesia
2	UD. Jasa Keluarga	Lorong Mushalla, Kramat Luar, Sigli City, Pidie Regency, Aceh 24114, Indonesia
3	BKPS	Jl. Sigli - Kembang Tanjong, Blang Paseh, Sigli City, Pidie Regency, Aceh 24113, Indonesia
4	M Ali	Jl. Sigli - Kembang Tanjong, Sukon, Simpang Tiga, Pidie Regency, Aceh 24181, Indonesia
5	Rahma Yanti	Jl. Sigli - Kembang Tanjong, Pante, Simpang Tiga, Pidie Regency, Aceh 24181, Indonesia
6	Suci Hati	Jl. Sigli - Kembang Tanjong, Simpang Tiga, Pidie Regency, Aceh 24181, Indonesia
7	Mariah	Jl. Sigli - Kembang Tanjong, Simpang Tiga, Pidie Regency, Aceh 24181, Indonesia
8	Efendi	Jl. Kp. Blang Meunasah Juerong, Simpang Tiga, Pidie Regency, Aceh 24181, Indonesia
9	Jufri	Jl. Kp. Blang - Lampoih Saka Meunasah Juerong, Simpang Tiga, Pidie Regency, Aceh 24181, Indonesia
10	Rakan LPG	Jl. Sigli - Kembang Tanjong, Kulam Baro, Simpang Tiga, Pidie Regency, Aceh 24181, Indonesia
11	Maimun	Blang Leuen, Simpang Tiga, Pidie Regency, Aceh 24181, Indonesia

Each base above has an agent who distributes LPG gas from the SPBE to the warehouse. Then, the warehouse distributes it to each base below through agents.

Table 2. Gas Warehouse Location

No	Name of Warehouse	Warehouse Locations
1	CV.Muhammad Noernikkmat	Jl. Kp. Blang - Lampoih Saka Meunasah Juerong, Simpang Tiga, Pidie Regency, Aceh 24181
2	PT.Indung Tulot Energy	Garot Cut, Indrajaya, Pidie Regency, Aceh 24182, Indonesia
3	PT.Maar Perkasa Jaya Gas	Jl. Pesantren Kuta Krueng Ulee gle, Pidie Jaya, Muko Kuthang, Aceh, Pidie Jaya Regency, Aceh 24152
4	SPPBE Rahmat Seulawah Jantan	Hagu, Panteraja, Pidie Jaya Regency, Aceh

Based on the above base and warehouse location data, we will calculate the distance from the warehouse to each base under it. PT. Indung Tulot Energy has four bases under it, namely Efendi, Suci Hati, and UD.Jasa Keluarga and BKPS. CV. Muhammad Nuernikmat oversees six bases under him: Jufri, M Ali, Rakan LPG, Maimun, Rahma Yanti, and Mariah. Meanwhile, PT Maar Perkasa Jaya Gas only oversees one base in the Sigli area, Maar Perkasa. SPBE distributes to every warehouse in the Pidie and Pidie Jaya districts. Here are the route search results from the warehouse to the base.

Table 3. Comparison Results of Shortest Route Search

No	Location		Algorithm Calculation Results	
	Origin	Destination	Djikstra	Ant Colony
1	PT.Indung Tulot Energy	Efendi	**17 mins**	25.38 Mins
2		Suci Hati	**23 mins**	33.63 Mins
3		UD. Jasa Keluarga	**18 mins**	28.56 Mins
4		BKPS	**20 mins**	29.70 Mins
5	CV.Muhammad Nuernikmat	Jufri	**1 mins**	1 Mins
6		M Ali	**9 mins**	13.17 Mins
7		Rakan LPG	**9 mins**	12.36 Mins
8		Maimun	**11 mins**	15.23 Mins

9		Rahma Yanti	**6 mins**	8.53 Mins
10		Mariah	**7 mins**	10.86 Mins
11	PT.Maar Perkasa Jaya Gas	Maar Perkasa	**71 mins**	104.72 Mins
	Total time		192	282.14
	Total distance		90.14	

Based on Table 3, it can be concluded that the search using the Dijkstra algorithm is faster than the ant colony algorithm, where the distance between the two is 90.14 mins. In contrast, the search with Dijkstra only takes 192 minutes, while the ant colony takes 282.14 minutes. However, the location accuracy after searching the ant colony algorithm is higher than that of Dijkstra. Based on these results, the authors decided that applying the ant colony algorithm to find the shortest route in the siGAS application is more appropriate than using the Dijkstra algorithm.

4.2. Manual Calculation

4.2.1. Calculation of Shortest Distance Using Ant Colony Algorithm

Suppose a graph*:*

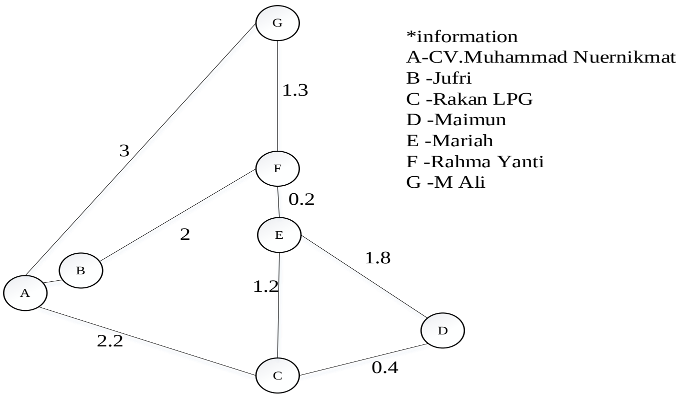


Fig 2. Graph siGAS

The distance between cities (dij) is as follows:

Table 4. Distance between gas station locations in miles

	A	B	C	D	E	F	G
A	0	0.1	2.2				3
B	0.1	0				2	
C	2.2		0	0.4	1.2		
D			0.4	0	1.8		
E			1.2	1.8	0	0.2	
F		2			0.2	0	1.3
G	3					1.3	0

The parameters used were:
Alpha (a) = 1.00
Beta (ß) = 1.00
Rho (ρ) = 0.50
initial = 0.01
τij
Maximum cycles (NCmax) = 2
Ant cycle rate (Q) = 1
Number of ants (m) = 5
From the known city distance, we can calculate the visibility between cities (ηij) = 1/dij
Calculate:
Visibility A to B ηij = 1/0.1 = 10
A to C ηij = 1/2.2 = 0.454545
A to G ηij = 1/3 = 0.333333

The following results can be seen in the table below:

Table 5. Inter-base visibility calculation results

	A	B	C	D	E	F	G
A	0	10	0.454545	0	0	0	0.333333
B	10	0	0	0	0	0.5	0
C	0.454545	0	0	2.5	0.833333	0	0
D	0	0	2.5	0	0.555556	0	0
E	0	0	0.833333	0.555556	0	5	0
F	0	0.5	0	0	5	0	0.769231
G	0.333333	0	0	0	0	0.769231	0

The probability from city A to each next city can be calculated with the equation that the next town cannot be on the ant's path.

$$p\frac{k}{ij} = \frac{[\tau_{ij}]^{\propto}.[\eta_{ij}]^{\beta}}{\sum[\tau_{ik}]^{\propto}.[\eta_{ik}]^{\beta}} \quad for\ j\epsilon\{N - tabu_k\}$$

For $[\tau_{ij}]^{\propto}.[\eta_{ij}]^{\beta}$ = (0.01*10) +(0.01*0.454545) + (0.01*0.333333) = 0.1079

Table 6. Calculation results for τ_{ij}

	A	B	C	D	E	F	G	Probability
A	0	0.1	0.0045	0	0	0	0.0033	0.1079
B	0.1	0	0	0	0	0.005	0	0.105
C	0.0045	0	0	0.025	0.0083	0	0	0.0379
D	0	0	0.025	0	0.0056	0	0	0.0306
E	0	0	0.0083	0.0056	0	0.05	0	0.0639
F	0	0.005	0	0	0.05	0	0.0077	0.0627
G	0.0033	0	0	0	0	0.0077	0	0.0110

Thus, the probability from city A to each base can be calculated.

Base
B = $(0.01)^{1.00}$. $(0.1)^{1.00}$/ 0.1079= 0.0093
C = $(0.01)^{1.00}$. $(2.2)^{1.00}$/ 0.1079= 0.0004
D = 0
G = $(0.01)^{1.00}$. $(3)^{1.00}$/ 0.1079= 0.0003

Table 7. Probability calculation results

	A	B	C	D	E	F	G
A	0	0.0093	0.0004	0	0	0	0.0003
B	0.0095	0	0	0	0	0.0005	0
C	0.0012	0	0	0.0066	0.0022	0	0
D	0	0	0.0082	0	0.0018	0	0
E	0	0	0.0013	0.0009	0	0.0078	0
F	0	0.0008	0	0	0.0080	0	0.0012
G	0.0030	0	0	0	0	0.0070	0

After we know the following probability, we add up each route traveled so that we find the result of the cumulative probability as follows:
Cumulative probability = 0.00927 0.009691 0.009691 0.009691 0.009691 0.01

Table 8. Cumulative Probability

	B	C	D	E	F	G
A	0.00927	0.009691	0.009691	0.009691	0.009691	0.01
B	0.009524	0.009524	0.009524	0.009524	0.01	0.01

C	0.0012	0.0012	0.0078	0.01	0.01	0.01
D	0	0.008182	0.008182	0.01	0.01	0.01
E	0	0.001304	0.002174	0.002174	0.01	0.01
F	0.000798	0.000798	0.000798	0.008773	0.008773	0.01
G	0.003023	0.003023	0.003023	0.003023	0.01	0.01

The random number generated is 0.00981, so the route chosen is C. The path chosen is A => C.
The calculation will continue until the ants have completed their journey to visit each city. This will be repeated until it matches the predetermined Ncmax or has converged. Then, the shortest distance between the ants and each cycle will be determined.

4.2.2. Calculation of Shortest Distance Using Djikstra Algorithm

Suppose a graph:

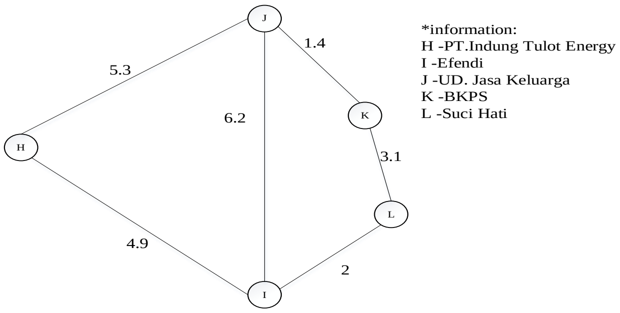


Fig 3. HIJKL Graph

Based on the graph above, the Dijkstra calculation can be done by finding the initial route and comparing it with the new route, then taking the road at a faster distance. This process is carried out until the destination location is found. The following table shows the quickest route search results with the Dijkstra algorithm.

Table 9. Calculation of Djikstra distance

Location		Trajectory	
Origin	Destination	Shortest	Distance/miles
H	I	H-I	4.9
	J	H-J	5.3
	K	H-J-K	6.7
	L	H-I-L	6.9
J	K	J-K	1.4
	L	J-K-L	3.1
	I	J-I	6.2
K	L	K-L	3.1
	I	K-L-I	5.1

The table above shows the results of finding the shortest route from the origin to the destination location based on the Dijkstra algorithm on siGAS.

5. Conclusion

The application for finding the shortest route for LPG gas distribution, abbreviated as siGAS, is built using a web programming language and uses the Google Maps API as a map for online route searches. This siGAS application applies two route search methods, namely, Djikstra and Ant Colony as the results are as follows:

1. Dijkstra search results are faster than ant colony; however, the route or base position has shifted from the original location at several points when searching.
2. Ant colony search results are slower, but the level of position accuracy is more accurate, and there is no shift as occurs in the Dijkstra algorithm. In the ant colony search, if the location being searched is far from the road, then there will be a shift in position to be closer to the road.
3. The Dijkstra search can only search for one destination route, while the ant colony search can do up to 10 different destination locations in 1 search process

References

[1] F. Albertus and Y. Zalukhu, "Dampak dan pengaruh pertambangan batubara terhadap masyarakat dan lingkungan di Kalimantan Timur," *Leg. J. Ilm. Ilmu Huk.*, vol. 4, no. 1, pp. 42–56, 2019.
[2] M. Fuad, D. E. Rachmawati, L. Herlina, D. I. Setiawan, and R. I. Anugrah, "Pengembangan Metode Identifikasi Karakteristik

Minyak Berat Hasil Ekstraksi Oil Sand Iliran High Dengan Formula Perhitungan Berdasarkan Komposisi Elementer," *Lembaran Publ. Miny. dan gas bumi*, vol. 56, no. 2, pp. 99–109, 2022.
[3] A. I. B. Ekejiuba, "Natural Petroleum: Chemistry and Valuable Products Fractions," *Carbon N. Y.*, vol. 82, no. 87.1, pp. 80–85, 2021.
[4] S. Yana, M. Nizar, D. Mulyati, and others, "Biomass waste as a renewable energy in developing bio-based economies in Indonesia: A review," *Renew. Sustain. Energy Rev.*, vol. 160, p. 112268, 2022.
[5] N. Rahmadania, "Pemanasan Global Penyebab Efek Rumah Kaca dan Penanggulangannya," *J. Ilmu Tek.*, vol. 2, no. 3, 2022.
[6] L. N. Nainggolan, K. Akbar, T. Yuliaty, and S. Suhaimi, "TINJAUAN KEBIJAKAN PEMERINTAH BAGI MASYARAKAT PRASEJAHTERA DALAM MENGHADAPI FENOMENA SUBSIDI LISTRIK, BAHAN BAKAR MINYAK DAN GAS DI INDONESIA," *J. Ekon. Pembang. STIE Muhammadiyah Palopo*, vol. 10, no. 1, pp. 114–130, 2024.
[7] N. K. Lubis and S. Suhairi, "Pengawasan Pendristribusian Penggunaan Gas LPG 3 Kg Terhadap Masyarakat Oleh Dinas Pendistribusian Dan Perdagangan Kota Tanjung Balai," *J. Manaj. Akunt.*, vol. 2, no. 4, pp. 704–720, 2022.
[8] M. Sony and S. Naik, "Industry 4.0 integration with socio-technical systems theory: A systematic review and proposed theoretical model," *Technol. Soc.*, vol. 61, p. 101248, 2020.
[9] K. Purwantini, E. Endaryati, and I. Koerniawan, "Perancangan Sistem Informasi Akuntansi Pengendalian Persediaan BBM Kapal Laut Dengan Menerapkan Metode Eoq," *Kompak J. Ilm. Komputerisasi Akunt.*, vol. 14, no. 2, pp. 256–264, 2021.
[10] D. C. Nguyen *et al.*, "Enabling AI in future wireless networks: A data life cycle perspective," *IEEE Commun. Surv. \& Tutorials*, vol. 23, no. 1, pp. 553–595, 2020.
[11] S. Ridha, P. Annaba, and A. Wahab, "Designing geospatial technology learning material based on spatial thinking for high school students," *Int. J. Innov. Creat. Chang.*, vol. 13, no. 7, pp. 816–838, 2020.
[12] N. Fuada, *Aplikasi GIS pada Bidang Gizi dan Kesehatan Masyarakat*. Penerbit Adab, 2021.
[13] E. Khoerotunnisa, "SISTEM INFORMASI GEOGRAFIS (SIG) BERBASIS WEBGIS UNTUK PEMETAAN PERSEBARAN OBJEK WISATA DI KOTA TASIKMALAYA," Universitas Siliwangi, 2022.
[14] I. F. A. Syahbana, "Rancang Bangun Aplikasi Pembelajaran Keberagaman Budaya Indonesia Untuk Tematik 7 Kelas 4 SD Berbasis Android," Universitas 17 Agustus 1945 Surabaya, 2021.
[15] M. Prabowo, *Metodologi pengembangan sistem informasi*. LP2M Press IAIN Salatiga, 2020.
[16] A. Hidayat, I. Purnamasari, and M. Siringoringo, "Penentuan Jalur Terpendek dengan Metode Heuristik Menggunakan Algoritma Sarang Semut (Ant Colony)," *EKSPONENSIAL*, vol. 11, no. 1, pp. 93–98, 2021.
[17] D. Amalia and B. Firmansyah, "Penerapan Algoritma Semut Dalam Penentuan Distribusi Jalur Pipa Pengolahan Air Bersih," *J. Nas. Inform.*, vol. 3, no. 1, pp. 1–5, 2022.
[18] R. Perayoga, P. Hendradi, and A. Setiawan, "Implementasi Algoritma Dijkstra Pada Pencarian Rute Terpendek Objek Wisata," *KLIK Kaji. Ilm. Inform. dan Komput.*, vol. 4, no. 3, pp. 1471–1482, 2023.
[19] A. S. Shibghatullah, A. Jalil, M. H. A. Wahab, J. N. P. Soon, K. Subaramaniam, and T. Eldabi, "Vehicle tracking application based on real time traffic," *Int. J. Electr. Electron. Eng. \& Telecommun.*, vol. 11, no. 1, pp. 67–73, 2022.
[20] T. Berners-Lee, J. Hendler, and O. Lassila, "The Semantic Web: A new form of Web content that is meaningful to computers will unleash a revolution of new possibilities," in *Linking the World's Information: Essays on Tim Berners-Lee's Invention of the World Wide Web*, 2023, pp. 91–103.