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The Application of TOPSIS Method and Djikstra Algorithm in The Development of Potential Tourist Attractions on The Jakarta to Dieng Route

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Abstract

Finding the optimal route for several vehicles to determine the destination according to travel needs. Route selection considers the cost savings of fuel, tolls, local levies, food or rest stops, and refueling stations (SPBU). This research was conducted through a survey of alternative routes from Jakarta to Dieng in Central Java, and interviews with motorcycle users for this trip (Motor Touring) by the motorcycle community. The application of the TOPSIS method which is then compared with the results of Dijkstra's Algorithm in determining a route, can be a solution in route selection. The selection of the right route recommendations makes this route the main choice for motorized vehicle users, with the traffic on this route having a positive impact on local residents who were previously vegetable or fruit farmers, by providing additional income through selling snacks, ready meals, coffee, parking lots, rest areas, toilets, and necessities while in Dieng, such as gloves, hats, and jackets.

Keywords: *Rute, Optimal,TOPSIS, Djikstra, Dieng (Jawa Tengah)*

Abstrak

Mencari rute optimal untuk beberapa kendaraan dalam menentukan tujuan sesuai dengan kebutuhan perjalanan. Pemilihan rute mempertimbangkan penghematan biaya bahan bakar, tol, retribusi daerah, tempat makan atau peristirahatan, dan stasiun pengisian bahan bakar (SPBU). Penelitian ini dilakukan melalui survei rute alternatif dari Jakarta menuju Dieng di Jawa Tengah, dan wawancara dengan pengguna sepeda motor untuk perjalanan ini (Motor Touring) oleh komunitas sepeda motor. Penerapan metode TOPSIS yang kemudian dibandingkan dengan hasil Algoritma Dijkstra dalam menentukan suatu rute, dapat menjadi solusi dalam pemilihan rute. Pemilihan rekomendasi rute yang tepat membuat rute ini menjadi pilihan utama bagi pengguna kendaraan bermotor, dengan ramainya lalu lintas di rute ini berdampak positif bagi warga sekitar yang sebelumnya adalah petani sayur atau buah, dengan memberikan penghasilan tambahan melalui berjualan makanan ringan, makanan siap saji, kopi, tempat parkir, tempat peristirahatan, toilet, dan kebutuhan selama di Dieng, seperti sarung tangan, topi, dan jaket.

***Kata-kata kunci**: Rute, Optimal,TOPSIS, Djikstra, Dieng (Jawa Tengah)*

1. Introduction

Indonesia is a vast country with extraordinary natural beauty that can be enjoyed by anyone. The sheer size of the nation presents its own challenges in reaching its many natural tourism destinations. Areas with stunning natural landscapes often lack adequate facilities, amenities, and infrastructure, sometimes requiring strong physical preparation and endurance—whether for vehicles or visitors themselves—to access these regions.

The Dieng Plateau (Dataran Tinggi Dieng) is a fascinating highland area in Central Java, located within Indonesia's diverse landscape. Here are some interesting details about it: The Dieng Plateau sits at the base of a caldera complex within the Dieng Volcanic Complex. Administratively, the region falls under Banjarnegara Regency and Wonosobo Regency. This highland is surrounded by a series of mountains stretching approximately 6 km from north to south and 14 km from east to west. It is the highest plateau on Java Island, with an average elevation of over 2,100 meters above sea level. The name "Dieng" originates from Old Javanese words: "di" (place) and "hyang" (ancestors or deities), meaning "abode of the ancestors" or "where the gods dwell. Heavy traffic in major cities poses significant challenges in planning optimal routes. Internet-based route searches often fail to provide suitable alternative options tailored to specific needs. Determining the most efficient routes for multiple vehicles—each with distinct travel objectives, such as customer service, tourism destinations, personal or family road trips, group tours, or logistics distribution—has become a critical necessity today. **Key Considerations in Route Selection** Choosing a route requires careful evaluation of multiple factors, including: **Cost efficiency** (fuel savings, toll fees, local levies), and **Convenience** (availability of rest stops, dining options, and fuel stations).

These elements are essential to achieving the goals of any journey. Route Options to Dieng Plateau currently, several route alternatives to Dieng can be identified through digital maps. These platforms provide vital information, such as: distance from the starting point, locations of fuel stations, estimated travel time, toll costs (for car travellers), and real-time traffic density or congestion levels. However, selecting the most suitable route remains a challenge. Meticulous consideration of these factors is necessary to ensure a journey that is comfortable, safe, and efficient.

This research employs the TOPSIS method (Technique for Order of Preference by Similarity to Ideal Solution). TOPSIS is a multi-criteria decision-making method based on selecting

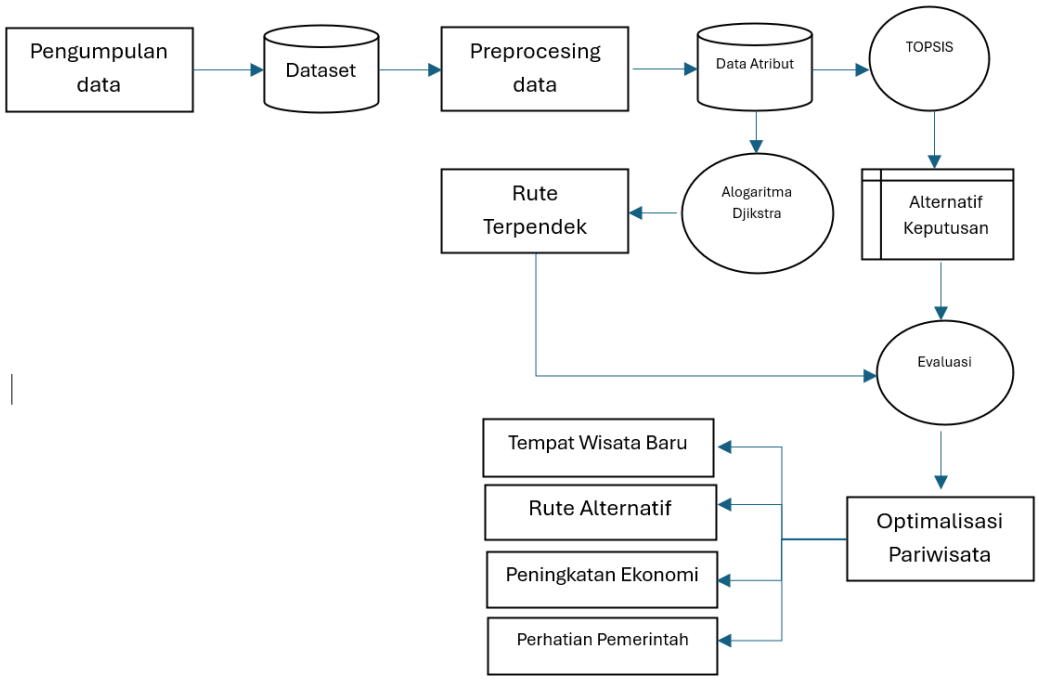
alternatives that have the shortest distance from the positive ideal solution and the farthest distance from the negative ideal solution. However, an alternative that has the smallest distance from the positive ideal solution does not necessarily have the largest distance from the negative ideal solution **[1].** To provide a comparative analysis with the TOPSIS method, Dijkstra's algorithm will be employed. Dijkstra's algorithm is a method designed to identify the shortest path from a single source node to all other nodes within a weighted graph. In transportation systems, this algorithm utilizes weights to represent distances between cities **[2].** Based on the explanations, the author conducts research titled: "**Implementation of TOPSIS Method and Dijkstra's Algorithm in Tourism Potential Development for Jakarta-Dieng Route.**" This study aims to provide optimal considerations for determining travel routes from Jakarta to Dieng by evaluating the tourism potential along each possible route. Relevant research is conducted to compare previous research related to the research being conducted and to strengthen the position of this research itself. Comparative research will explain the topics and techniques used. Conducted by Dede Wira Trise Putra, Susi NoviaSanti, Ganda Yoga Swara, and Eva Yulianti from the Informatics Engineering Department, Faculty of Technology Padang in 2020 with the title "**TOPSIS Method in Decision Support Systems for Selecting Tourist Objects**" aims to develop a web-based decision support system that helps tourists choose tourist destinations that match criteria such as distance, time, cost, access, facilities, transportation, and type of tourism. This study uses the topsis method because it has fast and simple computing. The results of this study indicate that this system can provide alternative tourist destinations that suit the needs of tourists, improve the experience in choosing the right tourist destination, and can be used as a guide for tourists in choosing tourist destinations that suit their preferences **[3]**. The next research is entitled "**Research on Optimal Route Planning for Self-Driving Tour Based on Road Network Structure**" written by Zong, Ping Yao Han, and Chenbo Xu in 2022 in the Journal Security and Communication Networks Beijing. This research discusses the importance of the ability of "Self Driving tours", the complexity of the traffic network, and the use of the Dijkstra Algorithm in calculating the optimal route for tourists so that it can improve the experience or comfort of traveling with high levels of congestion during holidays **[4].** The next study entitled "**Analysis of Student Shuttle Transportation Route Optimization Using the CGVRP Model and Dijkstra's Algorithm at SDIT Darus Sunnah**" written by Koko Hermanto in 2019 in the Unisda Journal of Mathematics and Computer Science. This study uses the CGVRP (Cluster

Generalized Vehicle Routing Problem) Model and the Dijkstra Algorithm to obtain the optimal route for school transportation. The purpose of this study is to produce the closest distance with lower fuel consumption than the existing or previous route. The results found that the route was shorter, namely from the previous 2,744 meters to 2,333 and savings of Rp. 332,280 per month **[5].** Further research "**Determining the Best Package Delivery Route using the Topsis Method**" was written by Rahmat, Saleh Dwiyatno, Muhamad Aqil Farhan, Ari Maulana Pahmi, and Garin Ananda Pinileh in 2021. This writing aims to obtain the optimal route for package delivery using the TOPSIS method. This method is implemented in the Decision Support System, resulting in reduced costs and faster time for package delivery (goods) **[6].**

2. Method

2.1 Research Flow

This section elaborates in detail the steps of the research design to be employed, including the research framework and development techniques. The purpose of these steps is to obtain optimal results that will facilitate the research process. Below is clear diagram of the research methodology to be implemented.



The research began with data collection, both literature studies related to the topic, surveys, location observations and conducting interviews with village officials in Kepakisan Village, Batur District, from this stage the primary dataset was obtained from the Head of

Kepakisan Village after the data was collected, the next step was data preprocessing which produced attribute data. The dataset was processed using the Dijkstra algorithm to produce the shortest route, while the dataset processed using the Topsis algorithm produced alternative decisions. The results of processing the two algorithms were then evaluated in order to produce optimization of tourism objectives to determine new tourist attractions, alternative routes to destinations, economic growth and government attention.

2.2 TOPSIS Method

This section explains about data processing, which is obtained to answer the main problem through data and information obtained in the research. In this method, the calculation of Determining Route Selection from Jakarta to Dieng is made clear in **Table 1**. Determining the route criteria with the following determining criteria.

Table 1. Path Determination Criteria

C1	Scenery (View, Pemandangan, suhu..)
C2	Kondisi Jalan
C3	Jarak Tempuh
C4	SPBU
C5	Mini Market, toko, Tempat Makan, Istirahat,

Table 1 is explained that for the first criterion (C1) the route to be taken has criteria with scenery, temperature, atmosphere according to the determination of the weight made. In the 2nd criterion (C2) this route has the criteria of the road conditions passed, the weight in this criterion will be explained in the weighting table. The 3rd criterion (C3) explains that the determination of the route must consider the distance needed to reach the destination, regarding the details of the intended distance weight will be explained in the table below. In the 4th criterion (C4) the existence of a Public Fuel Station (SPBU) also greatly influences the selection of the route. In this last criterion (C5) are places where riders can rest, eat or repair vehicles or rider equipment. From the 5 criteria above, weighting is given based on the results of surveys and interviews with several Motorbike Riders (Touring). The clear explanation is **Table 2.**

Table 2. Weights

BOBOT	KEPENTINGAN
1	Tidak Penting
2	Kurang Penting
3	Cukup Penting
4	Penting
5	Sangat Penting

The weighting results of the above criteria are written in Table 3, with the clear criteria:

Table 3. Weighting Criteria

BOBOT	C1	C2	C3	C4	C5
	4	4	5	3	3

The explanation in the table is, criterion 3 Mileage has the highest weight because Mileage is "very important" in determining the route to be taken in Motorcycle Touring. Then for the criteria Scenery and Road conditions have an important weight in determining the route and the criteria of gas stations and stopping places (mini markets, cafes, places to eat...) have a "quite important" weight in determining a route.

In each Criteria for determining the path created, a Comparison Matrix and Return Criteria are provided to facilitate the selection of the Main Criteria. In criterion 1 (C1), the clear Comparison Matrix is in **Table 4**.

Table 4. Comparison Matrix Criteria 1

BOBOT	KEPENTINGAN
1	Tidak Indah
2	Kurang Indah
3	Cukup Indah
4	Indah
5	Sangat Indah

The table above explains that if a route has a Weight of 5, it means it has a "very beautiful" view, temperature, atmosphere compared to other routes. Likewise for the next Weight. In Criterion 2 (C2) the clear weight comparison matrix is in **Table 5.**

Table 5. Comparison Matrix Criteria 2

BOBOT	KEPENTINGAN
1	Krikil- Tanah Batu-Pasir
2	Jalan Baik Kondisi D
3	Jalan Baik Kondisi C
4	Jalan Baik Kondisi B
5	Jalan Baik Kondisi A

In this comparison matrix, it is explained that the road condition with the level of importance or condition "Road Condition A" during the trip will have the highest weight (5). Clear Criteria 3 (C3) Comparison Matrix weight is in **Table 6.**

Table 6. Comparison Matrix Criteria 3

BOBOT	KEPENTINGAN
1	Tidak Cepat dan Jauh
2	Dekat tetapi Lambat (Macet, jalan rusak)
3	Paling Dekat
4	Paling Cepat
5	Paling Dekat dan Cepat

This table explains that in determining the "Distance Traveled" the highest weight is with "Closest and Fastest". Criteria 4 (C4) The clear comparison matrix in determining Public Fuel Filling Stations (Gas Station) is in **Table 7.**

Table 7. Comparison Matrix Criteria 4

BOBOT	KEPENTINGAN
1	Eceran Botol
2	POM Mini Swasta
3	POM MINI Resmi
4	SPBU Swasta
5	Pasti PAS PERTAMINA

In this comparison matrix, motorcyclists gave the highest weight to Pertamina's gas station "Pasti PAS PERTAMINA", due to the guaranteed size and purity of the fuel provided. Criteria 5 (C5) Comparison Matrix in determining places to stop for rest or eating for a short time. Clear comparison in **Table 8.**

Table 8. Comparison Matrix Criteria 5

BOBOT	KEPENTINGAN
1	Tidak Enak
2	Kurang Enak
3	Cukup Enak
4	Enak
5	Sangat Nyaman

This matrix explains that for stopping places, the places with the highest weight are those that are "Sangat Nyaman", such as having air-conditioned rooms, large parking lots, and various choices of drinks or food.

3. Results and Discussion

From the results of the survey and interviews with touring motorcycle riders by providing 3 alternative routes from Jakarta to Dieng, namely,

1. The first route, Jakarta - Cirebon - Bawang (Batang Regency) - Khayangan Toll Road (name Location Sigemblong Hill) - Dieng Km 0
2. The second route, Jakarta Cirebon - Wonosobo (Sambi Tea Plantation) - Dieng Km0
3. The third route, Jakarta - Cirebon - Kajen (Pemalang Regency) - Dieng Km0

In accordance with the theoretical basis used to create the Alternative and Criteria Comparison Matrix. The results are clear as in **Table 9.**

Table 9. Alternative and Criteria Comparison Matrix

JALUR	C1	C2	C3	C4	C5
Bawang - Tol Khayangan	5	4	5	2	4
Dieng - Wonosobo	5	4	2	4	3
Kajen - Wanayasa	5	5	1	5	3

This Normalized Matrix Decision is obtained using the following calculation equation, Equation (1),

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^2}}$$

With i=1,2,...m; and j=1,2,...n;

Where:

rij= Element Matrix normalized [i][j]

xij= Element matrix X's decision (1)

The results are as follows.

Table 10. Normalized Decision Matrix

Jalur	8.660254	7.549834	5.477226	6.708203932	5.830952
	C1	**C2**	**C3**	**C4**	**C5**
Bawang - Tol Khayangan	0.57735	0.529813	0.912871	0.298142397	0.685994
Dieng - Wonosobo	0.57735	0.529813	0.365148	0.596284794	0.514496
Kajen - Wanayasa	0.57735	0.662266	0.182574	0.745355992	0.514496

Then for the calculation results of the Normalized and Weighted Matrix Decision with the following formula or equation,

$$yij=wj \times rij$$

(2)

Where Vij is the value that has been assigned a weight to alternative i against criterion j, and Wj is the weight for criterion j. With the following results,

Table 11. Normalized and Weighted Decision Matrix

	C1	C2	C3	C4	C5
Bawang - Tol Khayangan	2.309401	2.119252	4.564355	0.894427191	2.057983
Dieng - Wonosobo	2.309401	2.119252	1.825742	1.788854382	1.543487
Kajen - Wanayasa	2.309401	2.649065	0.912871	2.236067977	1.543487

Continued by searching for the Positive Ideal Solution Value (max) and the Negative Ideal Solution (min). with the following equation,

1. Positive Ideal Solution (A^+) :A^+={max(v_{ij})for benefit criteria, min(v_{ij})for cost criteria}
2. egative Ideal Solution (A^-) :A^-={min(v_{ij})for benefit criteria, max(v_{ij})for cost criteria (3)

With the clear results in Table 12.

Table 12. Positive Ideal Solution (Max) and Negative Ideal Solution (Min) Value Matrix

	C1	C2	C3	C4	C5
MAX	2.309401	2.649065	4.564355	2.236067977	2.057983
MIN	2.309401	2.119252	0.912871	0.894427191	1.543487

From the Max and Min values obtained, the calculation for finding D+ and D- Alternatives is continued with the following equation,

$$D_i^+ = \sqrt{\sum_{j=1}^{n}(v_{ij} - A_j^+)^2}$$

$$D_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} - A_j^-)^2} \quad (4)$$

With the clear results,

Table 13. Calculation Matrix D+ and D-

Jalur	D+	D-
Bawang - Tol Khayangan	1.442464	3.721267
Dieng - Wonosobo	2.871482	1.278019
Kajen - Wanayasa	3.687552	1.442464

The final result of the TOPSIS method is the Preference Value or Alternative Calculation of the path as a recommendation that can be selected by giving a rating or ranking. With the following equation,

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \quad (5)$$

The route to Dieng from Jakarta is recommended via Bawang (Batang Regency) then via Khayangan Toll Road (Bukit Sigemblong) because it has the first ranking preference. As in the clear table below,

Table 14 Matrix Recommendation

Jalur	PREFERENSI (V)	RANKING
Bawang - Tol Khayangan	0.720654735	1
Dieng - Wonosobo	0.307993485	2
Kajen - Wanayasa	0.281181162	3

In this method, in accordance with the Formulation in the Theoretical Basis and the research conducted, the calculation simulation is obtained as follows. The alternative routes provided are the same as the Route in the TOPSIS method above, namely,

1. First route, Jakarta - Cirebon - Bawang (Batang Regency) - Khayangan Toll Road (location name Bukit Sigemblong) - Dieng Km 0
2. Second route, Jakarta Cirebon - Wonosobo (Sambi Tea Plantation) - Dieng Km0
3. Third route, Jakarta - Cirebon - Kajen (Pemalang Regency) - Dieng Km0

However, in this method, the calculation starts at the Cirebon city point as the starting point of the Route (Point A). The data obtained for the Distance from each Destination point (city) which is an alternative route taken is as follows.

Table 15. Distance Traveled Each Point

Jalur	A (Cirebon)	B (Kajen)	C (Bawang Batang)	D (Tambi via Waleri)	E (Dieng 0 KM)
1	0	140	0	0	71
2	0	0	189		18
3	0	0	0	244	13

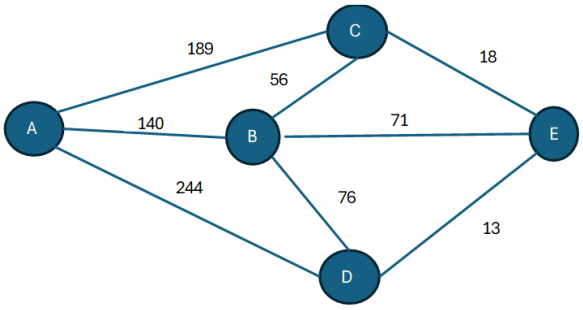
In the Table 15, it can be explained that,

Route 1, Point A (Cirebon City) as the starting point to Kajen (Point B) is 140km, then from Kajen to Dieng Km0 (Point E) is 71 km.

Route 2, Point A (Cirebon City) as the starting point to Bawang (Batang Regency) is 189km and to Dieng Km0 (Point E) it takes 18 km.

Route 3, Point A (Cirebon City) as the starting point to Tambi (Point D) it takes 244km then to Point E (Dieng Km0) it takes 13km.

If made in the form of a picture it is as follows,



According to the image above, if it is formed in a calculation table, the following results will be obtained:

Table 16. Shortest Route

Point	Shortest Distance	Previous Node
A	0	
B	140	A
C	189	A
D	216	B
E	207	C

With the explanation, for the Final Destination Point E from Point A with the closest distance is via Point C with a Total distance of 207km. This DJISKTRA method is obtained to go to Dieng from Jakarta with the same Starting Point, namely Cirebon City (Point A) via the Bawang Route (Batang Regency) Point C until arriving at Dieng Km0 Point E is the recommended route for Motorbike or Touring users.

The choice of route to Dieng via Khayangan Toll Road (Bukit Sigemplong) has a positive impact on residents around this route, especially at rest points or at points with the best views. This route was opened in 2017, the initiative of which began in 2014. Before this route was opened, people needed 4 hours to leave Dieng for big cities such as Batang, Pemalang or Tegal via the Kajen (Pemalang) route.

In the guide to the Theory of increasing Regional Income through economic growth, it can be explained that the **Location Theory Gunn, C.A. & Var, T. (2002). Tourism Planning: Basics, Concepts**, Cases with access to infrastructure and strategic resources such as scenery, tourist attractions or comfortable temperatures can easily increase its income. Sigemplong Hill has Indirect Income such as,

1. Multiplier Effect of Tourist Spending: Money is used by tourists in hotels/lodgings, transportation (tourist jeeps, motorcycle taxis, car/motorcycle rentals), transportation, culinary, souvenirs, which increase the circulation of money in the area.
2. Creation of employment opportunities such as the emergence of tour guides, drivers for rented cars/jeeps, lodging employees, culinary business employees, which can increase the income of the region.
3. Increase in Property Value such as increasing land/land value for sale or rent, increasing selling price of housing that can be rented as accommodation.

Indirect income as explained above can be calculated using the following assumptions,

1. The number of tourists who stop on the Khayangan toll road, especially at Sigemplong Hill, in one day on average on weekdays, weekends and national holidays is 50 people, so in a year (360 days) the average is 18,000 tourists.
2. On average, tourists who stop at Sigemplong Hill spend 20 thousand Rupiah to buy hot drinks such as coffee, tea, ginger or others, food such as fried foods (banana, tofu, tempeh, bakwan), instant noodles, meatballs or chicken noodles, money for parking and money for the toilet or restroom.
3. The multiplier effect of developing tourist areas is 1.5-2.5. For Sigemplong Hill, we use 1.8 as the multiplier effect calculation.

Using the assumption data above, it can be calculated that the Indirect Income for the Sigemplong Hill tourist attraction or rest area is,

Total Tourist Expenditure

18.000 Tourist X Rp. 20.000 = Rp. 360 million/year

Total Economic Impact

Rp. 360 million/year X 1.8 = Rp. 648 million/year

The main income of the residents around this route are sharecroppers or farm laborers who are very dependent on agricultural products (vegetables and fruits). With this route, the income of residents has increased from 25% to 100% per day, such as previously getting IDR 50 thousand per day to IDR 100 thousand, which is obtained from the sale of ready-to-eat food (Instant), coffee, parking attendants, provision of parking lots and provision of toilets. According to the results of the Interview with the Head of Kepakisan Village, Batur District.

The application of the TOPSIS method in selecting a route from Jakarta to Dieng for a Touring motorcycle, produces the best recommendation value via the Cirebon route towards Bawang city (Batang Regency), then towards Dieng KM0 via the Khayangan Toll Road (Sigemplong hill). This route provides the best choice for getting views, stopping places, and refueling places.Testing the results obtained with the TOPSIS Method using the DJIKSTRA Algorithm with the same alternative routes also obtained results that in terms of Distance or Departure Point to the Main Destination Point, the selection of the Cirebon Route towards Bawang City (Batang Regency) then to Dieng KM0 via the Khayangan Toll Road (Sigemplong Hill) is the option with the shortest distance (Closest).

4. Conclusion

From the results of the research conducted, the following conclusions can be drawn:

a. The application of the TOPSIS method can provide optimal recommendations in selecting existing alternative routes, especially for the Jakarta to Dieng route using a motorbike, either individually or together (community).
b. Testing using the DIJKSTRA Algorithm confirmed that the recommended route given is the shortest route that can be comfortably traversed by motor vehicles.
c. Opening new routes to tourist attractions provides added value in the form of increasing the income of residents passing through by 25% to 50% per day and also increasing regional income at the village level by 25%.

This research is still limited to route selection using a motorbike method, so suggestions for further research can use car mode so that users of these vehicles also have a choice of routes to get to Dieng tourist attractions.The opening of this nearest route (Khayangan Toll Road) has the potential to be further improved by widening the road and tidying up the water channels so that 4-wheeled or more vehicles can pass through this road safely and comfortably. This request was conveyed by local residents and the relevant Village Heads to the Batang Regency Government and Banjarnegara Regency.

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