Fuel Efficiency Analysis for Backpacker Travelers With Cultural Tourism Destinations Gedong Songo Temple, Railway Museum, Maria Kerep Ambarawa Cave With Saving Matrix Method

Yudho Purnomo per 1st Affiliation
Lecturer Sekolah Tinggi Ilmu Ekonomi Cendekia Karya Utama Semarang
Semarang-Indonesia
yudhocendekiaku@gmail.com

Riska Amalia per 2nd Affiliation
Student Sekolah Tinggi Ilmu Ekonomi Cendekia Karya Utama Semarang
Semarang-Indonesia
riska3653@gmail.com

Abstract- The purpose of this study is to determine the travel route of a backpacker traveler to travel from drop points (Sisemut Terminal, Tawang Train Station and Ahmad Yani International Airport) to cultural attractions gedong songo temple, railway museum and Ambarawa Maria Cave with the saving matrix method. One of the methods used to solve this problem is the matrix saving method. This method is the shortest route determination method by optimizing the travel route so as to save distance and minimize fuel costs.

The results of the study concluded that the results of the route comparison, namely the initial route from the initial matrix data and the Saving Matrix which were processed to get the Saving Matrix route, obtained the percentage of distance savings, fuel and travel costs from the Sisemut terminal drop point point with a percentage of 10%, then from Tawang station by 4% and from Ahmad Yani International airport with a saving value of 1%. . In addition, the latest routes using the Saving Matrix are able to reduce the use of fleets or travel facilities and optimize routes.

Keywords- **Efficiency, Saving Matrix, Route Determination**

I. INTRODUCTION

Semarang Regency is one of the regencies in Central Java. This area has a million charms, including natural panoramas and cultural panoramas that are very amazing. But in this regency there are still many hidden tourist attractions so that many people / tourists / tourism investors do not know about the beauty and elegance of cool (contemporary) places in Semarang Regency.

Tourism can be said to be an industry that is growing rapidly. Almost all cities and countries in the world are vying to develop their tourist attractions. The tourism industry is seen as having bright prospects and is quite promising and brings many benefits, including increasing the country's foreign exchange, increasing regional income, opening new jobs, and prospering the surrounding community. Tourism itself consists of natural tourism, cultural tourism, artificial tourism, special interest tourism, and so on. In this study, the author will choose cultural tourism as the object of research.

According to Pitana (2009), cultural tourism is a type of tourism that is involved and stimulated by the performing arts, visual arts, and festivals. There is a lot of evidence in the literature about the benefits of cultural festivals for tourism purposes. This shows that the festival contributes to the goals of regeneration and local well-being. In addition, cultural festivals can create new jobs and encourage the development of friendly and sustainable infrastructure.

This cultural development can be a forum to introduce to people throughout the city and country that Semarang Regency has a variety of arts and cultures that need to be developed and preserved.

There are several cultural tourism areas that are very interesting to visit in Semarang Regency. The following is data on cultural tourism recreation places and the number of visitors:

Table 1
Data on the Number of Visitors in Cultural Tourism Recreation Places in Semarang Regency

Recreation Areas	Number of Visitors in Recreation Places in Semarang Regency (2020)		
	Domestic	Foreign	Sum
1. Gedong Songo Temple	28.8771	175	288.946

2. Palagan Ambarawa Museum	12.248	0	12.248
3. Railway Museum	81.905	188	82.093
4. Tomb of Hasan Munadi Nyatnyono	0	0	0
5. Maria Kerep Ambarawa Cave	19.100	15	19.115
6. Maria Rosa Mistika Cave	0	0	0
7.New Tourism Bandungan	12.795	0	12.795
Amount	41.4819	378	415.197

Source: BPS Semarang Regency, 2020

From the table above, we can find out the highest number of visitors in 2020. The top three and most visited recreation places are Gedong Songo Temple, Railway Museum and Maria Kerep Ambarawa Cave. Therefore, the researcher chose the place to be recommended to backpackers and used as a measurement of the distance from the drop point. The drop point referred to here is the starting point for a backpacker traveler to start a trip to the recommended tourist attractions. The drop points that the researchers used were Sisemut Bus Terminal Semarang, Tawang Train Station Semarang and Ahmad Yani International Airport Semarang.

Domestic tourists and foreign tourists who travel to a tourist spot definitely want efficiency both in terms of fuel costs, mileage / time, and so on. In an effort to minimize this, it is necessary to pay attention to related factors that provide benefits for backpacker travelers.

There are some limitations or problems of backpacker travelers, such as confusion in determining the order of routes of tourist attractions, resulting in longer trips and causing expensive transportation costs. With these problems, it is necessary to determine the route to be traveled so that it can minimize transportation costs.

Based on these problems, it requires an appropriate determination of the path to reduce waste in terms of distance, means of transportation (fleet), transportation costs and getting feasible time, with these problems, research is carried out using the saving matrix method in the hope that a more efficient route / travel route can be determined so that lower transportation costs are produced. The saving matrix method is a method to minimize distance or time by considering existing constraints.

II. RESEARCH METHODS

The type of research used in this study is a qualitative type of research. The object studied as a drop point is: Sisemut Bus Terminal Semarang (Jl. Hos. Cokroaminoto, Krajan, Ungaran, Ungaran District, Semarang Regency, Central Java 50511), Tawang Semarang Train Station (Jl. Taman Tawang No. 1, Tanjung Mas, North Semarang District, Semarang City, Central Java 50211), Ahmad Yani International Airport Semarang (Jl. PUAD Achmad Yani, Semarang, Central Java 50145).

With cultural tourism destinations, namely: Gedong Songo Temple (Jl. Candi, Krajan, Banyukuning, Bandungan, Semarang Regency, Central Java 50614). Railway Museum (Jl. Station No.1, Panjang Kidul Ambarawa District, Semarang Regency, Central Java 50614.

The data source is divided into two there is primary data and secondary data. The data collection method is carried out by observation steps, interviews, documentation, internet. In this study, the method used in analyzing the data was to use the saving matrix method.

III. RESULTS

A. First Research Objectives

Determining the Distance Matrix and Discussion
A distance matrix is a matrix that contains the distance between a region and another region. if there are a number of regions, a distance matrix of n x n will be formed because a region will measure its distance from all the other regions in the data. The following is a list of distances between drop points and cultural tourism recreational places.

Table 2
Distance Matrix from Sisemut Terminal I

DISTANCE	SSMT	GDS	MKAI	GOA
SSMT	0			
GDS	21,9	0		
MKAI	21,7	12,8	0	
GOA	25,4	11,1	1,5	0

Table 3
Distance Matrix from Sisemut Terminal II

SSMT - GDS - GOA - MKAI – SSMT (DISTANCE)					
SSMT	GDS	MKAI	GOA	SSMT	TOTAL
	21,9	12,8	1,5	25,4	61,6
SSMT	GOA	MKAI	GDS	SSMT	TOTAL
	25,4	1,5	12,8	21,9	61,6
SSMT	GDS	GOA	MKAI	SSMT	TOTAL
	21,9	11,1	1,5	21,7	56,2

Source: Google Maps

Information:
SSMT   : Sisemut Terminal
GDS   : Gedong Songo Temple
MKAI   : Railway Museum
GOA   : Maria Kerep Ambarawa Cave

The table above explains that there are 3 routes that allow a bapcpacker traveler to travel. Here are the route options that can be traveled:
1) From Sisemut Terminal then head to the first cultural tourist destination, namely Gedong Songo Temple which is 21.9 km away. After that, continue the journey back to the Railway Museum which is 12.8 km from Gedong Songo Temple, then continue to the third tourist attraction, namely Maria Kerep Ambarawa Cave which is 1.5 km away and back again to the Sisemut terminal with a distance of 25.4 km. So the total distance traveled by the backpacker traveler is 61.6 km.
2) From Sisemut Terminal then head to the first cultural tourist destination, namely Maria Kerep Ambarawa Cave which is 25.4 km away. After that, continue the

journey back to the Railway Museum which is 1.5 km from the Maria Kerep Ambarawa Cave, then continue to the third tourist attraction, namely Gedong Songo Temple which is 12.8 km away and back again to the Sisemut terminal with a distance of 21.9 km. So the total distance traveled by the backpacker traveler is 61.6 km.

3) From Sisemut Terminal then head to the first cultural tourist destination, namely Gedong Songo Temple which is 21.9 km away. After that, continue the journey back to Maria Kerep Ambarawa Cave which is 11.1 km from Gedong Songo Temple, then continue to the third tourist attraction, namely the Railway Museum which is 1.5 km away and back again to the Sisemut terminal with a distance of 21.7 km. So the total distance traveled by the backpacker traveler is 56.2 km.

Table 4
Distance Matrix from Tawang Station I

DISTANCE	SSMT	GDS	MKAI	GOA
TWG	0			
GDS	46,9	0		
MKAI	46,3	12,8	0	
GOA	48,9	11,1	1,5	0

Table 5
Distance Matrix from Tawang Station II

TWG - GDS - GOA - MKAI – SSMT (DISTANCE)					
TWG	GDS	MKAI	GOA	TWG	TOTAL
	46,9	12,8	1,5	48,9	110,1
TWG	GOA	MKAI	GDS	TWG	TOTAL
	48,9	1,5	12,8	46,9	110,1
TWG	GDS	GOA	MKAI	TWG	TOTAL
	46,9	11,1	1,5	46,3	105,8

Source: Google Maps

Information:
TWG   : Tawang Station
GDS   : Gedong Songo Temple
MKAI   : Railway Museum
GOA   : Maria Kerep Ambarawa Cave

The table above explains that there are 3 routes that allow a backpacker traveler to travel from the tawang station drop point. Here are the route options that can be traveled:

1) From Tawang Station then head to the first cultural tourist destination, namely Gedong Songo Temple which is 46.9 km away. After that, continue the journey back to the Railway Museum which is 12.8 km from Gedong Songo Temple, then continue to the third tourist attraction, namely The Cave of Maria Kerep Ambarawa which is 1.5 km away and back again to Tawang Station with a distance of 48.9 km. So the total distance traveled by the backpacker traveler is 110.1 km.

2) From Tawang Station then head to the first cultural tourist destination, namely Maria Kerep Ambarawa Cave which is 48.9 km away. After that, continue the journey back to the Railway Museum which is 1.5 km from Maria Kerep Ambarawa Cave, then continue to the third tourist attraction, namely Gedong Songo Temple which is 12.8 km away and back again to Tawang Station with a distance of 46.9 km. So the total distance traveled by the backpacker traveler is 110.1 km.

3) From Tawang Station then head to the first cultural tourist destination, namely Gedong Songo Temple which is 46.9 km away. After that, continue the journey back to Maria Kerep Ambarawa Cave which is 11.1 km from Gedong Songo Temple, then continue to the third tourist attraction, namely the Railway Museum which is 1.5 km away and back again to Tawang Station with a distance of 46.3 km. So the total distance traveled by the traveler backpacker is 105.8 km.

Table 6
Distance Matrix from Ahmad Yani International Airport I

DISTANCE	AMDY	GDS	MKAI	GOA
AMDY	0			
GDS	50,2	0		
MKAI	52,7	12,8	0	
GOA	52,2	11,1	1,5	0

Table 7
Distance Matrix from Ahmad Yani International Airport II

AMDY - GDS - GOA - MKAI – AMDY (DISTANCE)					
AMDY	GDS	MKAI	GOA	AMDY	TOTAL
	50,2	12,8	1,5	52,2	116,7
AMDY	GOA	MKAI	GDS	AMDY	TOTAL
	52,2	1,5	12,8	50,2	116,7
AMDY	GDS	GOA	MKAI	AMDY	TOTAL
	50,2	11,1	1,5	52,7	115,5

Source: Google Maps

Information:
AMDY :Ahmad Yani Internationl Airport
GDS   : Gedong Songo Temple
MKAI   : Railway Museum
GOA   : Maria Kerep Ambarawa Cave

The table above explains that there are 3 routes that allow a backpacker traveler to travel from the tawang station drop point. Here are the route options that can be traveled:

1) From Ahmad Yani International Airport then head to the first cultural tourist destination, namely Gedong Songo Temple which is 50.2 km away. After that, continue the journey back to the Railway Museum which is 12.8 km from Gedong Songo Temple, then continue to the third tourist attraction, namely Maria Kerep Ambarawa Cave which is 1.5 km away and back

again to Ahmad Yani International Airport with a distance of 52.2 km. So the total distance traveled by traveler backpackers is 116.7 km.

2) From Ahmad Yani International Airport then head to the first cultural tourist destination, namely The Cave of Maria Kerep Ambarawa which is 52.2 km away. After that, continue the journey back to the Railway Museum which is 1.5 km from the Maria Kerep Ambarawa Cave, then continue to the third tourist attraction, namely Gedong Songo Temple which is 12.8 km away and back again to Ahmad Yani International Airport with a distance of 50.2 km. So the total distance traveled by traveler backpackers is 116.7 km.

3) From Ahmad Yani International Airport then head to the first cultural tourist destination, namely Gedong Songo Temple which is 50.2 km away. After that, continue the journey back to Maria Kerep Ambarawa Cave which is 11.1 km from Gedong Songo Temple, then continue to the third tourist attraction, namely the Railway Museum which is 1.5 km away and back again to Ahmad Yani International Airport with a distance of 52.7 km. So the total distance traveled by backpackers is 115.5 km.

B. Second Research Objective

Calculating the Saving Matrix Value and Discussion

This saving matrix is created on the basis of a distance matrix, so this saving matrix is also a symmetrical matrix. The savings matrix presents distance savings that will affect against the effective time of travel.

The calculation of this saving matrix uses the equation:

$$S(I,j) = d(D,i) + d(D,J) - D(I,j)$$

Here is the calculation value of the saving matrix from the three drop points:

Table 8
Saving Matrix of Sisemut Terminal I

SAVING	GDS	MKAI	GOA
GDS	0		
MKAI	30,8	0	
GOA	36,2	45,6	0

Table 9
Saving Matrix of Sisemut Terminal II

SSMT-GDS-GOA - MKAI - SSMT (SAVING MATRIX)				
SSMT	GDS	MKAI	GOA	TOTAL
		30,8	45,6	76,4
SSMT	GOA	MKAI	GDS	TOTAL
		45,6	30,8	76,4
SSMT	GDS	GOA	MKAI	TOTAL
		36,2	45,6	81,8

From the resulting saving value, the best route that can be passed by traveler backpackers is TWG-GDS-GOA-MKAI with the highest saving value of 178.4. So if the backpacker traveler

uses the Tawang Station drop point, then the chosen route should be:

"Sisemut Terminal - Gedong Songo Temple - Maria Kerep Ambarawa Cave - Railway Museum"

Table 10
Saving Matrix of Tawang Station I

SAVING	GDS	MKAI	GOA
GDS	0		
MKAI	80,4	0	
GOA	84,7	93,7	0

Table 11
Saving Matrix of Tawang Station II

TWG-GDS-GOA - MKAI -TWG (SAVING MATRIX)				
TWG	GDS	MKAI	GOA	TOTAL
		80,4	93,7	174,1
TWG	GOA	MKAI	GDS	TOTAL
		93,7	80,4	174,1
TWG	GDS	GOA	MKAI	TOTAL
		84,7	93,7	178,4

From the resulting saving value, the best route that can be passed by traveler backpackers is TWG-GDS-GOA-MKAI with the highest saving value of 178.4. So if the backpacker traveler uses the Tawang Station drop point, then the chosen route should be:

"Tawang Station - Gedong Songo Temple - Maria Kerep Ambarawa Cave - Railway Museum"

Table 12
Saving Matrix of Ahmad Yani International Airport I

SAVING	GDS	MKAI	GOA
GDS	0		
MKAI	90,1	0	
GOA	91,3	103,4	0

Table 13
Saving Matrix of Ahmad Yani International Airport II

AMDY-GDS-GOA-MKAI -AMDY (SAVING MATRIX)				
AMDY	GDS	MKAI	GOA	TOTAL
		90,1	103,4	193,5
AMDY	GOA	MKAI	GDS	TOTAL
		103,4	90,1	193,5
AMDY	GDS	GOA	MKAI	TOTAL
		91,3	103,4	194,7

From the resulting saving value, the best route that can be passed by traveler backpackers is AMDY-GDS-GOA-MKAI with the highest saving value of 178.4. So if the backpacker traveler uses the ahmad yani international airport drop point, then the route chosen should be:

"Tawang Station - Gedong Songo Temple - Maria Kerep Ambarawa Cave - Railway Museum"

C. Third Research Objectives

Calculating Fuel Cost Savings and Discussion
How to calculate savings, namely:

1-   Fuel costs after using the saving matrix

    Fuel costs before using the saving matrix

The results of these calculations can be selected in the calculation table below:

Table 14
Fuel costs before using the saving matrix

Types of Vehicles	Initial Route	Total Distance	Fuel Prize/ Liter	Km/ L	Fuel Costs
AVANZA CARS	Sisemut Terminal - Maria Kerep Ambarawa Cave - Railway Museum - Gedong Songo Temple - Sisemut Terminal	61,6 km	IDR 7.650	12	IDR 39.270
	Tawang Station - Gedong Songo Temple - Railway Museum - Maria Kerep Ambarawa Cave - Tawang Station	110,1 km	IDR 7.650	12	IDR 70.188 ,75
	Ahmad Yani International Airport - Gua Maria Kerep Ambarawa - Railway Museum - Gedong Songo Temple - Ahmad Yani International Airport	116,7 km	IDR 7.650	12	IDR 74.396 ,25

Table 15
Fuel costs after using the saving matrix

Types of Vehicles	Initial Route	Total Distance	Fuel Prize/ Liter	Km/ L	Fuel Costs
AVANZA CARS	Sisemut Terminal - Maria Kerep Ambarawa Cave - Railway Museum - Gedong Songo Temple - Sisemut Terminal	56,2 km	IDR 7.650	12	IDR 35.827 ,5
	Tawang Station - Gedong Songo Temple - Railway Museum - Maria Kerep Ambarawa Cave - Tawang Station	105,8 km	IDR 7.650	12	IDR 67.447 ,5
	Ahmad Yani International Airport - Gua Maria Kerep Ambarawa - Railway MusSeum - Gedong Songo Temple - Ahmad Yani International Airport	115,5 km	IDR 7.650	12	IDR 73.631 ,25

Based on the fuel cost calculation table before using the saving matrix, it can be seen that there is a difference in fuel costs.

Table 16
Fuel savings earned

Titik Drop Point	Before	After	Savings	Perce ntage
Sisemut	Rp39,270.00	Rp35,827.50	Rp 0.10	10,00 %
TWG	Rp70,188.75	Rp67,447.50	Rp 0.04	4,00 %
AMDY	Rp74,396.25	Rp73,631.25	Rp 0.01	1,00 %

From the savings table above, you can find out the total distance savings and fuel costs. The drop point that has the highest saving value is from Sisemut Terminal with a percentage of 10%, then from Tawang station by 4% and from Ahmad Yani International airport with a saving value of 1%.

IV. CONCLUSIONS AND SUGGESTIONS

A. Conclusion

From the data processing and discussion that has been carried out based on existing problems, it can be concluded:

1) Route options that are formed and can be passed by backpacker travelers
   A. From the Sisemut Terminal drop point, namely:
      1. Sisemut Terminal – Gedong Songo Temple – Railway Museum – Maria Kerep Ambarawa Cave – Sisemut Terminal (total distance 61.6 km).
      2. Sisemut Terminal - Maria Kerep Ambarawa Cave - Railway Museum - Gedong Songo Temple - Sisemut Terminal (total distance 61.6 km)
      3. Sisemut Terminal – Gedong Songo Temple – Maria Kerep Ambarawa Cave – Railway Museum – Sisemut Terminal (total distance 56.2 km)
   B. From the tawang station drop point, namely:
      1. Tawang Station - Gedong Songo Temple - Railway Museum - Maria Kerep Ambarawa Cave - Tawang Station (total distance 110.1 km)
      2. Tawang Station - Maria Kerep Ambarawa Cave - Railway Museum - Gedong Songo Temple - Tawang Station (total distance 110.1 km)
      3. Tawang Station - Gedong Songo Temple - Maria Kerep Ambarawa Cave - Railway Museum - Tawang Station (total distance 105.8 km).
   C. From the drop point of Ahmad Yani International Airport, namely:
      1. Ahmad Yani International Airport - Gedong Songo Temple - Railway Museum - Maria Kerep Ambarawa Cave - Ahmad Yani International Airport (total distance 116.7 km).
      2. Ahmad Yani International Airport - Gua Maria Kerep Ambarawa - Railway Museum - Gedong Songo Temple - Ahmad Yani International Airport (total distance 116.7 km).
      3. Ahmad Yani International Airport - Gedong Songo Temple - Maria Kerep Ambarawa Cave - Railway Museum - Ahmad Yani International Airport (total distance 115.5 km).

2) The fastest and most efficient route distance and fuel for cultural tourism destinations Gedong Songo Temple, Railway Museum and Maria Kerep Ambarawa Cave, with saving matrix method:
      1. Sisemut Terminal – Gedong Songo Temple – Maria Kerep Ambarawa Cave – Railway Museum (saving value 81.8).
      2. Tawang Station - Gedong Songo Temple - Maria Kerep Ambarawa Cave - Railway Museum (saving value 178.4).
      3. Ahmad Yani International Airport - Gedong Songo Temple - Maria Kerep Ambarawa Cave - Railway Museum (saving value 194.7).

3) Cost savings that can be minimized by using the saving matrix method:
      1. The cost savings from the Sisemut Terminal drop point before and after using the new route is 10%.
      2. The cost savings from tawang station drop point before and after using the new route is 4%.
      3. The cost savings from the Ahmad Yani International Airport drop point before and after using the new route is 1%.

B. Suggestion

Suggestions that can be given based on the results of data processing from this study are:
   1. From the results of research that produces new routes, it gives positive results, because in terms of time, mileage and costs can benefit backpackers. So it is recommended for backpacker travelers to make route improvements so that travel cost savings can be made optimally.
   2. n order for the results of the study to be more optimal, it is recommended to make a simulation of the distribution process for the resulting route by looking at the existing constraints so that backpacker travelers can make improvements to the next travel process.

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