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Kediri Karesidenan Sharia Tourism Routes Optimization using Genetic Algorithm

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Abstract

Sharia tourism is a tour from nature, culture, or artificial tourism framed by Islamic values, which provides a sense of security and comfort. East Java, one of the thirteen provinces prepared by Indonesia to become a sharia tourism destination, has an excellent opportunity to be developed. One of them is Kediri Karesidenan. There are 154 destinations that can be explored and considered as sharia tourist destinations in Kediri Karesidenan. There has been no research that discusses sharia travel routes, as well as the need for government to develop sharia tourism in Indonesia, making this research very important to do. In planning the development of effective and efficient transportation routes, which reach sharia tourist destinations in Kediri Karesidenan, scientific and technological contributions are needed. A genetic algorithm is an alternative solution to searching and optimization problems. In this research, the genetic algorithm is used to determine the shortest route to reach sharia tourist destinations in five areas in Kediri Karesidenan, such as Kediri, Nganjuk, Blitar, Tulungagung, and Trenggalek. The conclusion is the length of the sharia tourism route in Kediri, Nganjuk, Blitar, Tulungagung, Trenggalek, respectively, are 249.32 km, 289.148 km 452.95 km, 341.68 km, 384.67 km. In addition, the authors used the K-means clustering algorithm to group sharia tourist destinations in Kediri Karesidenan, basic on four properties, namely: the city where the destination is located, the type of tourism, the price of admission, and the distance of the destination with the city center. It can be concluded that the best value of K is K=3, and in each resulting cluster, the authors apply the genetic algorithm to determine the shortest sharia tourism route.

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I. INTRODUCTION

The potential for sharia tourism in Indonesia is very large and can be an alternative to conventional tourism that already exists. Sharia tourism is not defined narrowly as pilgrimage tourism or to cemeteries, or to mosques only (pilgrimage / religious tourism = spiritual tourism), but tourism that is sourced from nature, culture, or artificial which is framed by Islamic values, which provides a sense of security and comfort. This type of trip can not only be enjoyed by the Muslim community, but non-Muslims can also enjoy it because of the excellent service with Sharia ethics. As one of the countries with the largest number of Muslims, Indonesia must start thinking about ways to package its tourism potential in new ways to develop Indonesian tourism that upholds Islamic culture and values. The sharia tourism industry is not a threat to the existing tourism industry but rather as a compliment and not hampering the progress of the current tourism business/industry. It is noted that several countries have thought about and developed the Sharia Tourism Industry, including in Asia there are seven countries: Malaysia, Singapore, Thailand, Korea, Taiwan, Japan, and China. Through the Queensland Tourism Agency, the State of Australia issued a sharia tourism program in 2012.

Thirteen provinces are prepared by Indonesia to become sharia tourism destinations, namely: West Nusa Tenggara, Nangroe Aceh Darussalam, West Sumatra, Riau, Lampung, Banten, DKI Jakarta, West Java, Central Java, Yogyakarta, East Java, South Sulawesi, Bali. This determination is based on the readiness of existing human resources in the area, the culture of the surrounding community, local tourism products, and existing tourist accommodations. East Java Province, one of thirteen provinces prepared to become a sharia tourism destination, has unique wealth and values that can be developed. The Residency of Kediri, part of East Java, has stunning natural resources. Among them are rows of beaches and many religious tourist destinations as well as large mosques and relics that hold historical value. In addition, the diversity of Indonesian culture and history in the Kediri Karesidenan has excellent potential to be processed into historical tourism objects as one of the possibilities for sharia tourism. The Kediri Residency area consists of five cities, namely: Kediri, Nganjuk, Tulungagung, Blitar, Trenggalek. Currently, the city of Kediri is undergoing the construction of Kediri Airport, which began construction in 2020. Currently, 154 tourist destinations can be developed and considered as tourist destinations sharia in Kediri Karesidenan. The many tourist destinations that have the potential to be set and considered as sharia tourist destinations in the Kediri Karesidenan require mapping and grouping efforts to see further the potential for tourism development in the Kediri Karesidenan. There has been no research that discusses the grouping of sharia tourist destinations in the Kediri Karesidenan, and there is no research on the shortest route that crosses all of these tourist destinations.

II. RELATED WORKS

Sharia tourism, also known as halal tourism, is one of the new ways to develop Indonesian tourism that upholds cultural and Islamic values. In 2016, a number of potential attributes of halal accommodation were identified and applied to an analysis of the websites of accommodation providers in Auckland and Rotorua, two of New Zealand's main tourist destinations. [1]. The country is increasingly trying to position itself as a halal-friendly destination in Asia and the Middle East. Junaidi, in 2019, has conducted research to describe the concept of halal tourism, its business processes and investigate the dilemmas faced by the tourism industry. In addition, it is also investigated the influence of various factors on halal tourism [2]. Perbawasari, in the same year, has researched the halal tourism communication model [3]. In 2020, Valeriani conducted research to determine and analyze tourist perceptions and the potential for halal tourism in the province of the Bangka Belitung archipelago in achieving World Halal [4]. At the same time, Izwar has researched the potential and carrying capacity of Reusam Island, which is following the ideal Halal ecotourism area in Aceh, Indonesia [5].

In the field of Mathematics, some researchers are interested in combining concepts in graph theory to study. For example, Hendy in [6] and [7] combined two concepts, namely labeling and decomposition in graph theory, into a new topic. However, several other researchers are interested in studying the application of graph theory itself. The shortest route problem is one of the classic combinatoric problems, which uses a graph as its model. This problem continues to be studied until now because many issues in everyday life

have models such as the shortest route problem or what is often referred to as the TSP (Traveling Salesman Problem). In this problem, a salesman has several destination cities to visit, with the distance or travel time between the two cities. He wanted to take the shortest possible route or the shortest route of all these cities so that no city was missed, and no city was passed more than once. TSP is simple to explain but difficult to solve. If the number of cities is small, the answer can be easily found by looking at all the routes. Still, as the number of cities increases, this method becomes inefficient, and the complexity of solving the problem also increases. [8].

A genetic algorithm is one of the algorithms based on the principles of genetics and natural selection. The basic elements of natural genetics, such as reproduction, crossover, and mutation, are used in genetic algorithm procedures. This algorithm is widely used in solving combinatorial problems such as the traveling salesman problem, vehicle routing problem, flight crew scheduling, etc. The genetic algorithm is one of the pioneers in the metaheuristic approach. Research on CSR continues to grow. In 2017, Chandekan conducted a comparative study on the performance of two metaheuristic methods, GA and ACO, in solving CSR problems, based on several criteria such as quality and accuracy. [9]. Elizabeth, in 2018 has also studied the solution to the TSP-TS (TSP with dependent service times) problem by using a mixed-integer linear program and the branch and cut algorithm. In addition, the author also compares two metaheuristic methods in solving this problem. The two methods are GA and tabu search[10]. In 2019, Chen tried to improve the performance of GA by using a model called the evolutionary computational model in solving TSP problems [11]. In 2020, Cinar used a discrete tree-seed algorithm to solve TSP-symmetric issues [12]. In the same year, Izzah has shown that ACO can be implemented to optimize travel routes in Kediri [13].

Cluster analysis or grouping analysis is one of Data Mining which organizes a collection of objects into clusters (groups) based on their similarities. Objects in a cluster will have the same characteristics or properties as objects in other clusters. The purpose of cluster analysis is to group objects based on the similarity of characteristics between these objects. In 2018 Mohammadrezapour used two clustering algorithms, namely fuzzy c-means and K-means based on a genetic algorithm, to identify the homogeneity of groundwater quality in an area. [14]. In 2019, Shorbagy proposed a new methodology for performing cluster analysis based on genetic algorithms [15]. At the same time, Wang studied the use of the K-means clustering method to group incomplete data [16]. In 2020, Sinaga also developed the K-means clustering algorithm, which is to become an unsupervised K-means clustering algorithm. [17]. Then in 2021, Jin uses a data clustering technique based on CAABA-K-means (chaotic adaptive artificial be colony) and compares it with several other types of metaheuristic methods. [18]. This study identifies tourist destinations in the Kediri Karesidenan that have the potential to be developed as sharia tourist destinations in five cities that are members of the Kediri Karesidenan, namely: Kediri, Nganjuk, Tulungagung, Blitar, and Trenggalek. Of the 154 tourist destinations that have been identified, a genetic algorithm is applied to determine the optimization of sharia travel routes in each city. In addition, a cluster analysis was carried out on 154 existing destinations, and then optimization of sharia tourism travel routes from each cluster was carried out using genetic algorithms.

III. METHODS

In this study, the identification of tourist destinations that can be developed as sharia tourist destinations in five cities that are members of the Kediri Residency is needed. This tourist destination is divided into four groups, namely: nature tourism, historical tourism, religious tourism, and culinary tourism. There are 154 destinations that have been successfully identified based on information from the surrounding community and information through the internet electronic media. The results are as presented in Table 1.

Table 1. Sharia tourism destination in Kediri Karesidenan

City	Sharia tourism Destination

Kediri	**Natural Tourism**: Simpang Lima Gumul Monument, Gunung Kelud, Dolo waterfall natural tourism, Sumber Ubalan tourism park, "Kampung Inggris Pare" Education Tourism, Irenggolo waterfall, Pagora, Kediri Waterpark, Kilisuci Park, Joyoboyo Forest, Guava tourism park, Wirituri Dam, Taman Brantas. **Religion Tourism:** the magnificent Mosque of Kediri City, Tomb of Gus Miek, Asmaul Husna Tower, Pondok Lirboyo, Setono Gedong Mosque, + tomb of Syeh Sulaiman Syamsudin Al Wasil or Syeh Ali Ayamsu Zain, Agung An-nur Mosque. **Historical Tourism:** Penataran Temple / Palah Temple, Selomangleng Cave, Surawana Temple, Tjoe Hwie Kiong, Tegowangi Temple, Setono Gedong Temple, Airlangga Kediri Museum. **Culinary Tourism:** Soto Tamanan in the Terminal area, Mbah Darmo Emprit Satay, Nasi Pecel Tumpang, Tahu Takwa Pakelan, Gethuk Pisang Doho.
Nganjuk	**Natural Tourism:** Margo Tresno Cave, Sedudo Waterfall, Roro Kuning Waterfall, Singokromo Waterfall, Sumber Manik Waterfall, Grojogan Duwur Sumbermiri, Putri Wilis Spring, Songgong Hill Tourism, Anjuk Ladang Recreation Park, Pandan Wilis Park, Embung Estumulyo, Selopark Labyrinth Park, Watu Gundul, Perning Reservoir, Watu Lawang, Goa, and Grojogan Putri Ayu, Bukit Danau Ngetos, Pring Jowo Waterfall, Coban Tretes Waterfall, Oro-oro Ombo Reservoir, Gedangan Waterfall, Sri Gunting Waterfall. **Historical Tourism:** Ngetos Temple, Lor Temple, Dr. Soetomo Monument, Jenderal Soedirman Monument, Anjuk Ladang Museum. **Religion Tourism:** Religious tours of Sheikh Sulukhi, historic Yoni Al-Mubarok Mosque & Kanjeng Jimat Tombs, Hok Yoe Kiong Temple, Kerta Buana Temple. **Culinary Tourism:** *Becek* rice Nganjuk, *Sego Banting* Nganjuk.
Blitar	**Natural Tourism:** Tambakrejo Beach, Jolosutro Beach, Pangi Beach, Serang Beach, Peh Pulo Beach, Coban Wilis Waterfall, Sirah Kencong Waterfall, Grenjeng Waterfall, Jurug Bening Waterfall, Tirto Galuh Waterfall, Lawean Waterfall, "Kampung Wisata" Ecological Puspa Jagad, Embultuk Cave, Mount Buthak Nature Tourism, Lake Rambut Lake, Sumberudel Waterpark, Soko Adventure Rafting Tour, Pegong Ponggok Srengat Mountain, Maliran Deer Captivity, Kebonrojo, Sentul Green Park, Blitar City Park, Kampung Cokelat. **Historical Tourism:** Penataran Temple, Weton Image Temple, Mleri Temple, Warak Statue, Kalicilik Temple, Sawentar Temple, Bung Karno's Tomb, and Residence, Trisula Monument. **Culinary Tourism:** Ice Drop, "Tahu Bumbu Lawu," "Beef Soto Bok Ireng," "Sego Contong."
Tulungagung	**Natural Tourism:** Sine Beach, Popoh Beach, Mount Joko Budheg, Coro Beach, Molang Beach, Lumbung Beach, Sanggar Beach, Pathok Gebang Beach, Ngalur Beach, Klatak Beach, Sidem Beach, Brumbun Beach, Kedung Tumpang Beach, Pandan Wangi Waterfall, Goa Tan Tek Sue, Lawean Waterfall, Jambooland Waterpark, Tebing Banyu Mulok, Belimbing Agro Tourism, Pacar Beach, Niyama River, Giri Bolo. **Historical Tourism:** Dadi Temple, Penampihan Temple, Boyolangu Temple. **Religion Tourism:** Al-Munawwar Great Mosque, Al-Mimbar Mosque (the legacy of KH. Hasan Mimbar, the great scholar of the Mataram Kingdom), Almaghfirullah Sheikh Basyarudin (the first propagator of Srigading Islam). **Culinary Tourism:** Ayam Lodho.
Trenggalek	**Natural Tourism:** Pelang Beach Waterfall, Kedung Maron Waterfall, Pasir Putih Beach, Cengkrong Beach, Karanggongso Beach, Prigi Beach, Mbangko'an Beach, Ngampiran Beach, Pelang Beach, Damas Beach, Blado Beach, Ngulung Wetan Beach, Ngadipuro Beach, Konang Beach, Taman Kili-kili Beach, Pancer Cengkrong Mangrove Forest Tourism, Banyon Hill, Pesona Puncak Sepikul Mount, Goa Lowo, Coban Rambat Dompyong, Goa Ngerit, Jurug Waru Dongko. **Religion Tourism:** Tomb of Kyai Mesir, Astono Gunung Cilik Kamulan. **Culinary Tourism:** "Sego Gegog Bendungan", Tahu lontong khas Trenggalek, Prigi Smoked Fish.

From the data of 154 tourist destinations in **Table 1**, look for the distance of each two tourist destinations, then this distance data is presented in the form of a distance matrix (adjacency matrix) to be processed or used as input data in the Matlab program, in determining the shortest distance with genetic algorithms. The

steps of this algorithm in solving the problem of sharia tourism routes in this study are as shown in Figure 1.

The next stage will be grouping tourist destinations using the K-means algorithm. In this step, tourist destinations are grouped into one or more clusters so that tourist destinations with the same characteristics are grouped in the same cluster, and tourist destinations with different characteristics are grouped into other clusters. This grouping is based on four criteria: tourist location, type of Tour, entrance ticket price, and distance from the city/district center. Determination of the best K value is done using the Elbow method. Then from each cluster, the decision of sharia tourism routes is carried out using a genetic algorithm.

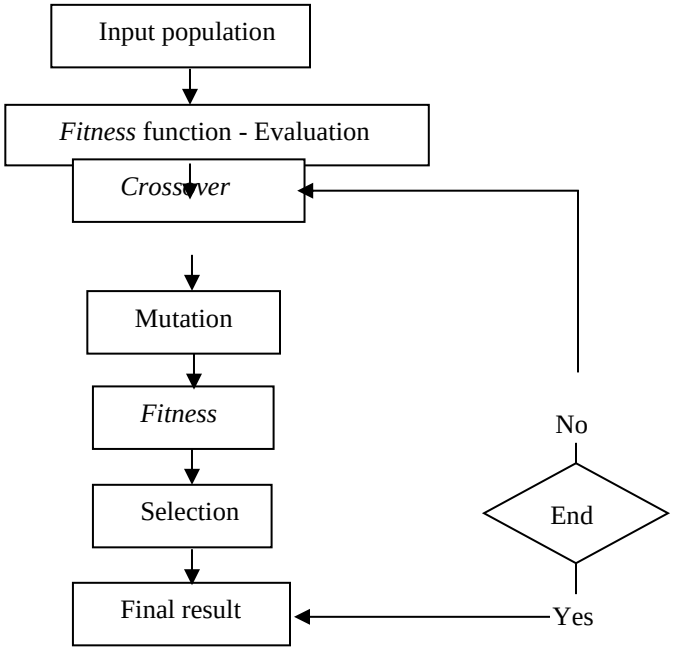
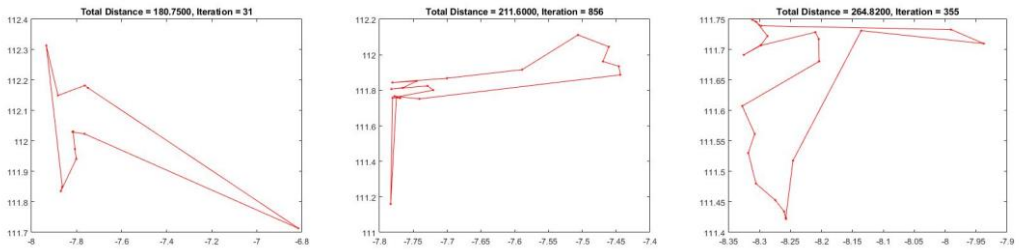


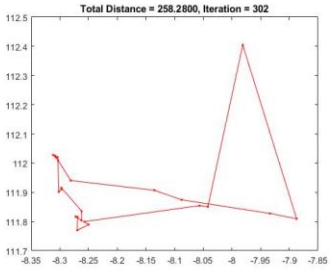
Figure 1. Diagram of steps in Genetic Algorithm

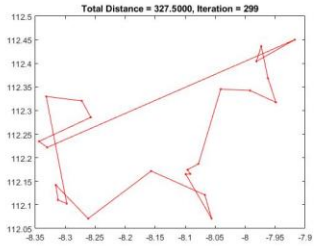
IV. RESULTS AND DISCUSSIONS

From the results of matlab programming using a series of genetic algorithm procedures, the results of the shortest distance of sharia travel routes in five cities within the Kediri Karesidenan, namely Kediri, Nganjuk, Blitar, Tulungagung, Trenggalek, are 249.32 km, 289.148 km, 452.95 km, 341.68 km, 384.67 km respectively. In addition, Figure 2 presents natural sharia tourism travel routes in five cities in the Kediri Residency.



(a) (b) (c)





(d) (e)

Figure 2 . Sharia Natural Tourism route in: (a) Kediri, (b) Nganjuk, (c) Trenggalek, (d) Tulungagung, (e) Blitar

The 154 Sharia tourist destinations in the Kediri Karesidenan are grouped using the *K*-means Algorithm. The grouping is based on four criteria: the location of the tourist destination, the type of tourist destination, the price of the entrance ticket, and the distance of the tourist destination to the city/district center. The value of $K = 2$ to $K = 10$ is set, and the *sse* value is obtained for each K value, as shown in Table 2.

Table 2. Value of sse (*sum square error*)

K	sse (*sum square error*)
2	14,3932
3	6,098257
4	3,903435
5	2,54838
6	1,80507
7	1,34553
8	1,012213
9	0,833191
10	0,687799

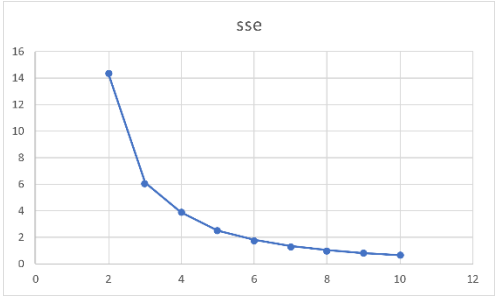


Figure 3. Graph of sum square error value

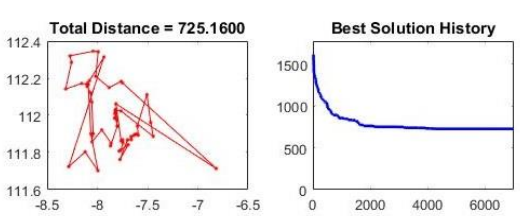
From the graph of this *sse* value in Figure 3, based on the Elbow method, it can be seen that the best K value or the best number of clusters is K=3. The results of the grouping of Sharia tourist destinations in the Kediri Residency for K=3 as shown in Table 3.

Table 3. The results of the grouping of sharia tourist destinations in the Kediri Karesidenan for K=3

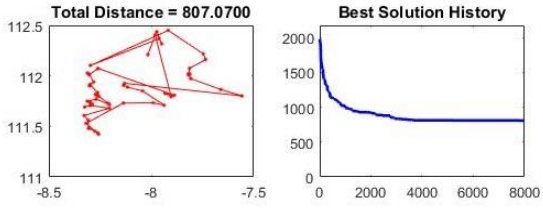
Cluster	Sharia Tourism Destination
Cluster 1	Simpang lima gumul, Dolo Waterfall, Sumber Ubalan Tourism Park, Kampung Inggris Pare, Irenggolo Waterfall, Pagora, Kediri Waterpark, Kilisuci Park, Joyoboyo Forest, Guava Tourism

	Park, Wirituri Dam, Taman Brantas, The Magnificient Mosque of Kediri, Tomb of Gus Miek, Asmaul Husna Tower, Pondok Lirboyo, Setono Gedong Mosque, Agung An-Nur Mosque, Watu Gundul, Perning Reservoir, Watu Lawang, Goa and Grojogan Putri Ayu, Bukit Danau Ngetos, Pring Jowo Waterfall, Coban Tretes Waterfall, Oro oro ombo Reservoir, Gedangan waterfall, Sri Gunting Waterfall, Ngetos Temple, Lor Temple, Dr. Soetomo Monument, Jenderal Soedirman Monument, Anjuk Ladang Museum, Grenjeng Waterfall, Jurug Bening Waterfall, Kampung wisata Ecological Puspa Jagad, Sumberudel Waterpark, Soko Adventure Rafting Tour, Pegong Ponggok Srengat Mountain, Maliran Deer Captivity, Kebonrojo, Sentul Green Park Blitar, Blitar City Park, Kampung Cokelat, Penataran Temple, Airlangga Kediri Museum, Soto Tamanan Terminal Area, Tahu Takwa Pakelan, Hok Yoe Kiong Temple, Kerta Buana Temple, Becek Rice Nganjuk, Sego Banting, Ice Drop, Tahu Bumbu Lawu, Beef Soto Bok Ireng, Sego Contong, Al Munawwar Great Mosque, Al Mimbar Mosque, Almaghfirulloh Sheikh Basyarudin, Ayam Lodho, Sego Gegog Bendungan, Tahu Lontong Khas Trenggalek, Prigi Smoked Fish, Tambak Rejo Beach
Cluster 2	Trisula Monument, Palah Temple, Selomangleng Cave, Surawana Temple, Tjoe Hwie Kiong, Tegowangi Temple, Setono Gedong Temple, Mbah Darmo Emprit Satay, Nasi Pecel Tumpang Jalan Doho, Gethuk Gedhang Jalan Pemuda, Sheih Sulukhi, Yoni Al Mubarok Mosque, Coban Willis Waterfall, Sirah Kencong Waterfall, Tirto Galuh Waterfall, Lawean Waterfall, Embultuk Cave, Mounth Buthak, Rambut Lake, Sine Beach, Popoh Beach, Mount Joko Budheg, Coro Beach, Molang Beach, Lumbung Beach, Sanggar Beach, Pathok Gebang Beach, Ngalur Beach, Klatak Beach, Sidem Beach, Brumbun Beach, Kedung Tumpang Beach, Pandan Wangi Waterfall, Goa Tan Tek Sue, Lawean Waterfall, Jambooland Waterpark, Tebing Banyu Mulok, Dadi Temple, Penampihan Temple, Boyolangu Temple, Pelang Beach Waterfall, Kedung Maron Waterfall, Pasir Putih Beach, Cengkrong Beach, Karanggongso Beach, Prigi Beach, Mbangko'an Beach, Ngampiran Beach, Pelang Beach, Damas Beach, Blado Beach, Ngulung Wetan Beach, Ngadipuro Beach, Konang Beach, Taman Kili-kili Beach, Pancer Cengkrong Mangrove Forest, Banyon Hill, Pesona Puncak Sepikul Mount, Goa Lowo, Coban Rambat Dompyong, Goa Ngerit
Cluster 3	Margo Tresno Cave, Sedudo Waterfall, Roro Kuning Waterfall, Singokromo Waterfall, Sumbermanik Waterfall, Grojogan Duwur Sumbermiri, Putri Wilis Spring, Songgong Hill Tourism, Anjuk Ladang Recreation Park, Pandan Wilis Park, Embung estumulyo, Selopark Labyrinth Park, Weton Image Temple, Mleri Temple, Warak Statue, Kalicilik Temple, Sawentar Temple, Bung Karno's Tomb, Jolosutro Beach, Pangi Beach, Serang Beach, Peh Pulo Beach, Belimbing Agro Tourism, Pacar Beach, Niyama River, Giri Bolo, Jurug Waru Dongko, Tomb of Kyai Mesir, Astono Gunung Cilik Kamulan

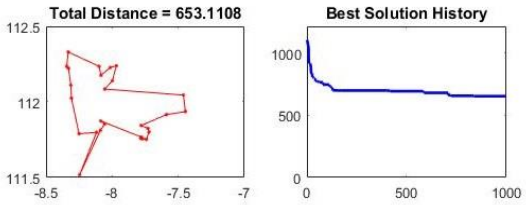
Furthermore, a study was conducted on the shortest route of sharia travel from each cluster in Table 3. The results showed that the shortest distance of sharia tourism travel in cluster 1 was 725.16 km, in cluster 2, it was 807.07 km, and in cluster 3, it was 653.11 km. The genetic algorithm shows convergence at the 4000th iteration on the search for sharia tourism routes in cluster 1, in the 6000th iteration on the search for sharia tourism routes in cluster 2, and convergence at the 1000th iteration in the search for sharia tourism routes in cluster 3. This can be seen in Figure 4.



Cluster 1



Cluster 2



Cluster 3

Figure 4. The shortest sharia tourism routes in Cluster 1,2,3 and GA Convergence

V. CONCLUSIONS AND RECOMMENDATIONS

From the explanation of the research results above, it can be concluded that the genetic algorithm is able to solve the problems in the tourism sector, especially in this case is the determination of the shortest travel route from sharia tourism which is very important to be developed in the Kediri Residency area. In addition, from the results of grouping sharia tourist destinations using the K-means algorithm and the elbow method in determining the best K value, the number of destination groups K = 3. This can be input for business people and travel service bureaus in determining their service products. The results of this study can be input or recommendations for policymakers in local and central governments, such as the Deputy for Tourism Marketing, Deputy for Overseas Marketing, Deputy for Tourism Destination Development, and Tourism Stakeholders. The results of this study can also be input for business people and travel service bureaus. It is hoped that Indonesia will be able to develop the sharia tourism sector as one of the mainstays in contributing to the community's welfare.

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