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THE OPTIMAL ROUTE FOR CULTURAL TOURISM IN THE SPECIAL REGION OF YOGYAKARTA

Yusrizal Firdaus*, **Malkhamah Siti**, **Sudarmadji**, **Muhamad**
Faculty of Graduate School, Gadjah Mada University, Indonesia
*E-mail: firyusrizal@gmail.com

ABSTRACT
The Special Region of Yogyakarta is one of the most popular tourist destinations in Indonesia and offers a wide range of cultural wealth. Consequently, it is interesting to explore the many tourist attractions. A tour taking the optimal route can, of course, provide efficiency in terms of distance and travel time while also providing a quality experience to the traveler. Ignoring these factors can lead to a failed trip. To determine the optimal route, we spread a questionnaire to travelers (n = 507) and obtained their preferences when traveling to be used in designing the optimum route. We present two scenarios in this paper for comparison: the first is the common way tourists determine travel routes, and the second uses a genetic algorithm approach. We found that determining the optimal route of travel using methods of genetic algorithms can shorten the total travel distance of tourists by 68.8 kilometers (29.20%), reduce the travel time by 137.60 minutes (8.87%), and at the same time maintain tourist preferences during their tour. We also propose efforts to improve the optimization of cultural tourist travel routes, focusing on the travel aspects between tourist destinations and on the aspects of the tourist destination itself.

KEY WORDS
Optimal route, tourist preferences, genetic algorithm, travel time, travel distance.

Special Region of Yogyakarta (YSR) is one of the most popular tourist destinations in Indonesia that has many cultural tourism potential to visit such as traditional art, temples, museums, and cultural festivals. The traditional tourism theory, for example (Inskeep, 1991; Jafari & Brent Ritchie, 1981; Leiper, 1979; Medlik, 1997) puts the travel of the tourist as a linking variable between the region of origin and many cultural tourist destinations in YSR. At this stage, the route becomes an increasingly important and determining variable in the tourist trip (Flognfeldt jr., 2005; MacLeod, 2017; Meyer, 2004; Timothy & Boyd, 2015).

The primary goal in a tourist trip is essentially to gain a travel experience (Božić & Tomić, 2016; Coghlan & Pearce, 2010; Liao et al., 2021; MacLeod, 2017; Timothy & Boyd, 2015), and travelers' preferences are often used as the basis for designing a travel route (Kuo et al., 2012; Rodríguez et al, 2012). Usually, both Free Individual Traveler (FIT) tourists plan and organize their own trips with the aim of gaining a quality travel experience. Similarly, travel agencies design travel routes with the main purpose of providing satisfaction and quality travel experience. However, due to the large number of tourist destinations, it is often difficult to plan the optimal itinerary to visit all the desired travel destinations within the time constraints. Additionally, tourists often face a problem when they want to explore the cultural and historical uniqueness of each tourist attraction to the maximum, and they only consider visiting popular and preferred tourist destinations. They rarely consider efficiency in terms of travel distance and time, which can result in longer travel distances, longer travel times, and higher costs. While the characteristics and efficiency of a tourist route influences the quality of access and at the same time determines the number of visits of tourists to various tourist destinations (Flognfeldt jr., 2005), they also affect the improvement of the quality of life of the community, the length of stay of tourists, and the tourist experience (Goussous & Haddad, 2014). In addition, mistakes in choosing cultural travel destinations and determining the order of visits to tourist destinations can make a tourist trip fail to bring satisfaction and a valuable experience for tourists.

Therefore, a system or method is needed that can help tourists in planning cultural tourist itineraries in SRY more effectively and efficiently. In this study we saw the problem of travel itinerary planning can be considered as traveling salesman problem (TSP). TSP is a technique used to determine the best travel route from several different locations by considering the distance, time, cost, and other factors that influence travel (Baltz et al., 2015; Choi et al. 2022; Čičková et al, 2008; Pekár and al., 2020). In this study, cities in TSP theory are viewed as cultural tourist destinations. But the problem is more complex because it involves many tourists who share limited tourism resources and consider their different preferences. The differences in travel behavior and preferences (see: Han et al., 2014), as well as motivation and emotions (see: Coghlan & Pearce, 2010) that exist in each individual traveler have their own needs or generate different expectations and requirements.

It is important for every traveler and operator to plan the itinerary in order to improve the quality of the travel experience. Our paper aimed to produce optimal itinerary plans for recommended cultural tourist destinations. Therefore, we add a variable to the travelers preferences in designing a tour itinerary. In addition, we also suggest efforts that can be made to optimize travel, both from the aspect of inter-tourist destinations and from the aspects of the tourist destination. We hope this method can result in better cultural tourist itinerary planning than the methods generally used by tourists in Indonesia. This method can help tourists to plan travel routes more efficiently and in accordance with their preferences. By taking into account the preferences of tourists, we hope to provide a more satisfying travel experience and optimize the time and resources available.

LITERATURE REVIEW

In recent years, travel itinerary planning has become a popular research theme, introducing a variety of different variables and offering numerous research methods. Although for certain cases it is still considered new, these studies are generally more specialized in the search for optimal routes on modes of transport that support the economy. For example, Harks et al. (2013) performed routing optimization to capacity locations using approximation algorithms. Walteros et al. (2015) designed a route optimization for Rapid Transit Bus (RTB) to improve system efficiency and overall user satisfaction. Another study looked at the optimization of cargo vehicles, considering time windows that should already be known before the request is obtained. The optimization of the route reduces travel costs and ensures each destination is visited within the specified time windows (Spliet & Gabor, 2015).

Meanwhile, another interesting study conducted by Bertsimas et al. (2019) looked at the tendency of each district in Boston to have difficulty serving student intersections across schools at school hours without blasting the operating cost of school buses. He presented a model work for the School Time Selection Problem (STSP) that enables optimization of the combination between school time and school bus routes. Baltz et al. (2015) and Vansteenwegen and al. (2012) attempted to solve the optimal route problem from the point of view of the Traveling Salesman Problem (TSP) with its various variations. Vansteenwegen et al. (2012) included available accommodation locations in route planning, as a businessman who worked for several days would need accommodation. Baltz et al. (2015) used Methods of Integer Linear Programming (MILP) and heuristic methods to add time windows variables in addition to available accommodation in designing an optimal travel route for a trader.

A recent research report for the case of tourist route optimization stated that it is important to change the route of the tourist destinations to be safer during the pandemic period up to the post-pandemic, as there is a tendency of local authorities to reduce the duration of tourists' length of stays at the touristic destinations (Păcurar et al., 2021). They then adapted the Traveling Salesman Problem (TSP) method to produce a backtracking algorithm method for planning travel routes. Travel routes are optimized by finding the shortest path through multiple tourist destinations in Brasov, Romania. The results of the study show that the use of backtracking algorithms can help travelers navigate while traveling (Păcurar et al., 2021). Furthermore, the results of this study are also consistent with the view of Goussous and Haddad (2014) that marginal tourist destinations, which have been abandoned and rarely visited during the pandemic period, were successfully revived.

Zhu and Lan (2020) argue that differences in travelers' preferences will result in failure to plan tourist travel routes. On this basis, they then use the parameters of tourist preferences to accommodation, the distribution of destinations, the time window of the tourist destination, and the form of tourism travel carried out to design the optimal tourist travel route. The multi-destination optimization algorithms they use suggest that this algorithm is highly worthy to be used in planning landscape-themed travel routes. They also have a view that the planning model they produce can be applied to some other travel situations. According to S. Li et al. (2021) the decline in tourist satisfaction occurs because tourist routes are not rationally planned so that the authorities at the tourist destination fail to regulate the movement of tourists who have different preferences, in addition to the failure to cope with congestion, crowds, and tourist expectations. He then abstracted this problem from the TSP's point of view. In their research they proposed ants colony algorithms to design optimal tourist travel routes for each characteristic and preference of the tourist. Li et al., 2019 The optimum route as a function of the destination algorithm is to meet all the preferences and expectations of the traveler. Whereas consideration factors are the constraints used, among others: the total travel time of the tourist, the total cost of the entire trip, the upper limit of suitability at the touristic destination, and the number of tourists in a group of tours. The results of this study show that the optimization of the combination of tourism and the hybrid ants colony algorithm it proposes can enrich relevant fields of research and have some significant references for the allocation of tourist resources and future tourism development (S. Li et al., 2019 Based on the results of the optimization, the travel agency can get a better combination of tourists so that it can be a guide to improving the service of the agency, while also gaining financial benefits for the office. For the destination authority can calculate the load of tourist attractions according to the results of optimization.

A different view is expressed by Zheng et al. (2020) as well as Malkhamah and al. (2019). They see the importance of integrating different modes of public transport in designing optimal travel routes. At least three things: 1) different transportation will affect the amount of travel time between destinations; 2) level of congestion will have different impact on travel time depending on the mode of transport used; and 3) travelers will always have a different nature of uncertainty or risk may affect the choice of travel destination, the sequence of visits, and the allocation of time travel (Zheng et al., 2020). They then proposed daily travel models tailored to urban tourists by considering the choice of transport modes and temporal spatial structures in designing personalized tourist travel routes (Zheng et al., 2020). The results of his research showed that the proposed optimum route model was much better than the previous method because in this study an exchange of contradictory benefits and risks was obtained. They believe the optimum routes proposed are more reasonable, diverse, and tailored for urban tourists. Malkhamah et al. (2019) conducted a survey of 120 tourist bus drivers and conductors in three different locations. Several questions related to the preference of respondents were asked among others: the region of origin of the tourist group brought, the choice of routes to enter Yogyakarta City, the number of tourist bus use, the length of stay in Kota Yogyakarta, and preference tourist destinations visited. In addition, a travel time survey is also carried out to measure the time required to complete one route. The results of the analysis resulted in four options of TransJogja bus routes that tourists can use from the location of the tourist bus parking place to access the overall selection of tourist destinations available. Another finding is the need for integration between TransJogja transportation modes with other transport modes because the four stops have a distance of about 400 meters on foot.

METHODS OF RESEARCH

We presented and compared two different approaches to planning cultural tourist routes. The first scenario uses the methods commonly used by today's travel agencies. The second scenario uses the route optimization approach. In the first phase we identified 9 cultural tourist destinations nodes in SRY recommended by local tourism authorities, plus 1 entrance to SRY namely: YIA airport (N1); Prambanan temple (N2); Kotagedhe area (N3); Gamplong tourism village (N4); Tembi tourism town (N5); Kasongan Town (N6); Giriloyo Batik Village (N7); Dusun Banyusumurup (N8); Keraton Yogyakarta (N9); Wayang Kekayon Museum (N10). Our coordinate points and distance between nodes are obtained from the Googlemaps.API application as shown in Table 1. Using the assumption of the speed of the vehicle cruise of 30 kilometers per hour, and then we can get the time to travel between cultural destinations. The travel time between cultural destinations for the next we add with the preference time spent in each tourist destination, thus generating the total time spent during the tour travel in SRY as in Table 2.

Table 1 – The Coordinates of Cultural Themed Tourist Destinations and Distance Matrix between Nodes (in kilometers)

Coordinates (DMS)	Node	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10
7°53'48.1"S, 110°03'37.4"E	N1	∞	64,9	48,4	30,4	40	41,3	43,6	42,7	41,9	51,9
7°45'14.8"S, 110°29'43.3"E	N2	65	∞	17	40,3	26,2	24,8	25,6	27,7	18,4	13,9
7°49'27.5"S, 110°23'39.7"E	N3	49	16,9	∞	22,5	9,8	9,2	12,3	13,8	6	3,6
7°48'24.2"S, 110°14'12.7"E	N4	30,3	38,6	22,8	∞	22,1	16,3	30	29,1	17,2	23,5
7°52'21.1"S, 110°21'16.4"E	N5	39,9	26,1	9,5	22,1	∞	4,8	9,4	10,1	9,3	12,9
7°50'43.3"S, 110°20'15.6"E	N6	41,2	25,6	8,8	16,5	4,8	∞	14	14,8	6,7	12,4
7°54'57.1"S, 110°23'53.9"E	N7	43,4	25,8	12,3	30	9,4	14,1	∞	2,9	16	14,1
7°55'47.4"S, 110°23'34.5"E	N8	42,5	28,4	13,9	29	10,1	14,8	2,9	∞	16,9	16,1
7°48'18.2"S, 110°21'48.8"E	N9	41,8	18,3	6,1	17,2	9,3	6,7	16	17	∞	7,5
7°48'53.3"S, 110°24'46.9"E	N10	51,6	14,4	3,7	23,5	12,6	12	14,1	15,9	7,1	∞

Source: Googlemaps.API interpretation results, 2022.

Table 2 – Travel Time Matrix plus Time at Cultural Themed Tourist Destinations (in minutes)

Destination	Heading to									
	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10
N1	∞	249,8	216,8	180,8	200	120	207,2	205,4	203,8	223,8
N2	250	∞	154	200,6	172,4	169,6	171,2	175,4	156,8	147,8
N3	218	153,8	∞	165	139,6	138,4	144,6	147,6	132	127,2
N4	180,6	197,2	165,6	∞	164,2	152,6	180	178,2	154,4	167
N5	199,8	172,2	139	164,2	∞	129,6	138,8	140,2	138,6	145,8
N6	202,4	171,2	137,6	153	129,6	∞	148	149,6	133,4	144,8
N7	206,8	171,6	144,6	180	138,8	148,2	∞	125,8	152	148,2
N8	205	176,8	147,8	178	140,2	149,6	125,8	∞	153,8	152,2
N9	203,6	156,6	132,2	154,4	138,6	133,4	152	154	∞	135
N10	223,2	148,8	127,4	167	145,2	144	148,2	151,8	134,2	∞

Source: Processed data, 2022.

In the second phase we spread a questionnaire to 507 travelers to ask their preferences when traveling to YSR. Some questions related to travelers' preferences include: 1) preference for modes of transportation towards YSR; 2) time to start tourist activities; 3) length of stay in YSR; 4) preferred tourist destinations; 5) time spent at a tourist destination; 6) choice of time to visit a favorite travel destination.

In the third phase, we designed tourist travel routes in SRY on both scenarios. The first scenario is the route planning that is usually used by tourists and travel agencies when travelling in SRY where a route is designed following the cultural tourist destinations that are the tourists' favorites. Destinations with the highest value will be visited first, until the lowest value destination. Then for the second scenario, we chose to complete the search for optimal cultural travel itinerary using the help of the solver add-in program on the Microsoft Excel software. Furthermore, the Microsoft Excel solver program that uses the evolutionary algorithm which is one type of genetic algorithm (The Microsoft 365 Marketing Team, 2009), has metaheuristic properties so it is very possible to obtain results in the form of optimal solutions while maintaining the quality of the solutions (Pekár et al., 2020). This algorithm is inspired by effective biological processes, especially evolution as a form of natural selection.

by Li, 2010 This algorithm then generates a random solution population, applying selection, crossover, and mutation operators to gradually generate a new generation of better solutions (Choi et al., 2022; Koca et al, 2018; S.-G. by Li, 2010). In genetic algorithms, the solution is represented as a chromosome, and the search process involves manipulation of chromosomes to produce new solutions (Choi et al., 2022). As for the optimum route solution steps using the solver add-in Microsoft Excel follows Pekár (2020) as follows:

1. Understand problems and model problems that occur in the form of non-directional weighted graphs;
2. Making a distance matrix between travel destinations;
3. Convert the distance between destinations into travel time with the assumption of a vehicle speed of 30 km/h;
4. Create a combined matrix between time on the trip plus time spent at each travel destination;
5. Get the optimum solution with the add-in solver, by entering the cells of the objective function and the constraint function as follows:
    - Total cell distance as an objective function;
    - Choose Min because what will be sought is a route with a minimum travel time;
    - Enter a travel destination array on By changing variable cells;
    - Click add to add variables;
    - Choose an evolutionary method;
    - Run the solve.
6. Check out the output results one by one, and consult the results with other factors;
7. Present the calculation results in the form of a weighted graph model.

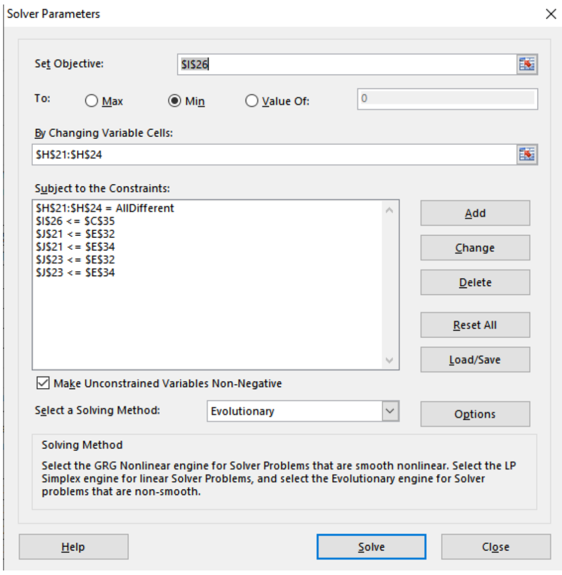

Figure 1 – Parameters of the Microsoft Excel add-in solver

Due to the limitations, we use a number of assumptions in the planning of this cultural tourist itinerary, among others: 1) each tourist destination operates daily; 2) each touristic destination opens at 07.00 AM and closes at 19.00 PM; 3) tourists stay in accommodation with a maximum distance of 1 km from the last tourism destination visited on a day; 4) congestion is assumed to be nonexistent; and 5) traffic lights are not counted.

RESULTS AND DISCUSSION

In this section we present the results of this research consisting of the profile and preferences of tourists who come to Yogyakarta (SRY). The results of the study also include the optimization of tourist routes for cultural tourism in SRY. The results are explained through the following discussion.

Tourist Profile and Preferences. Out of 507 survey questionnaires, the gender statistics revealed that the ratio between male and female respondents was almost the same, although women were slightly more (55,03%) than men (44,97%). The age groups 18-25 years (31,56%) and 26-35 years (29,19%) were the predominant age groups of respondents. They were adequately educated people who had a bachelor's degree (42.60%) and had a secondary education degree (34.91%), very few who only had a basic education degree (1,78%). Interestingly, most of the survey respondents are people with low incomes, below Rp. 3 million (33.14%) This number is slightly larger than the group with the average income of Rp. 1 million – Rp. 6 million (21.30%) People with high income (above Rp. 12,000,000) seem less interested in traveling to SRY(11.24%).

Most tourists turned out to like to travel in SRYfor 3 days (30,97%). To come to YSR, they chose to use the transport mode of aircraft (32.35%) compared to other modes of transport. Most tourists prefer to start touring activities in the morning (52.47%). Interestingly, most of them prefer to spend 2 – 4 hours at a tourist destination (30,77%). The tourist destination that is the favourite of tourists during their stay in SRYis the Prambanan Temple (26.92%), and they prefer to visit their favorite tourist destinations at the beginning of the tourist series (47.44%).

The optimal route for cultural tourism trips. In the first scenario, the cultural-themed tourist itinerary is determined using the factors that become the tourist's preference. Based on the survey questionnaire, the preferences of tourists to cultural tourist destinations are: Prambanan Temple (N2) (26.92%); Kotagedhe Cultural Reserve Area (N3) (12.82%); Tembi Tourist Village (N5) (5.13%); Gamplong Tourist District (N4) (7.69%); Kasongan Town (N6) (2,56%); Giriloyo Batik Village (N7) (10.26%); Dusun Banyusumurup (N8) (3.85%); Keraton Yogyakarta (N9) (24.36%); Wayang Kekayon Museum (N10) (6.41%). From the survey questionnaires also found the destinations that are the highest preference tourists will visit for the first time (dalam hal ini Candi Prambanan). Based on the preferences of such tourists, then the tourist itinerary with cultural themes follows the first scenario is: N1 → N2 → N9 → N3 → N7 → N10 → N5 → N4 → N8 → N6 → N1 as in Figure 2. The total travel distance of the cultural-themed tour using this scenario is 235.6 kilometers. Then the total time spent when this first travel route scenario was used was 1.551,2 minutes.

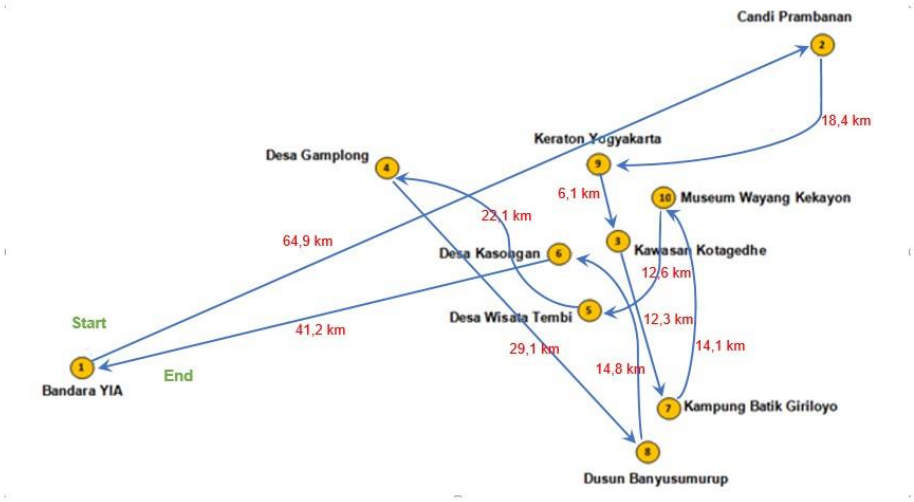

Figure 2 – Illustration of Cultural Theme of Tourism Routes Using Scenario 1

Using the same data as scenario 1, we subsequently used the help of the Microsoft Excel add-in solver to find optimized travel routes. The solving method used in this software is evolutionary; by entering the cell total time of visit as a set objective, and selecting the optimization function minimize (Min). Then the cells that contain the initial order of destination are inserted as changing variable cells. Subject to the constraints: 1) the YIA airport is the first order; 2) the Prambanan temple is the second order; 3) the entire 10 nodes = alldifferent; and 4) total travel time <= 3 days (4.320 minutes). The results of the calculation of Microsoft Excel solver are presented in Table 3. There are calculation results that show a cultural-themed tourist itinerary. This route has a sequence of tourist destinations to be visited, namely N1 → N2 → N10 → N3 → N7 → N8 → N5 → N6 → N9 → N4, and back to N1 as shown in Figure 3. The route has a total distance of 166.8 kilometers and takes a total of 1.413,6 minutes.

Table 3 – Optimum Route Calculation Results

Sequence of Visit	Distance (Kilometer)	Time (Minutes)
N-1	65	249,8
N-2	13,9	147,8
N-10	3,7	127,4
N-3	12,3	144,6
N-7	2,9	125,8
N-8	10,1	140,2
N-5	4,8	129,6
N-6	6,7	133,4
N-9	17,2	154,4
N-4	30,3	60,6
T o t a l	166,8	1413,6

Source: Processed data, 2022.

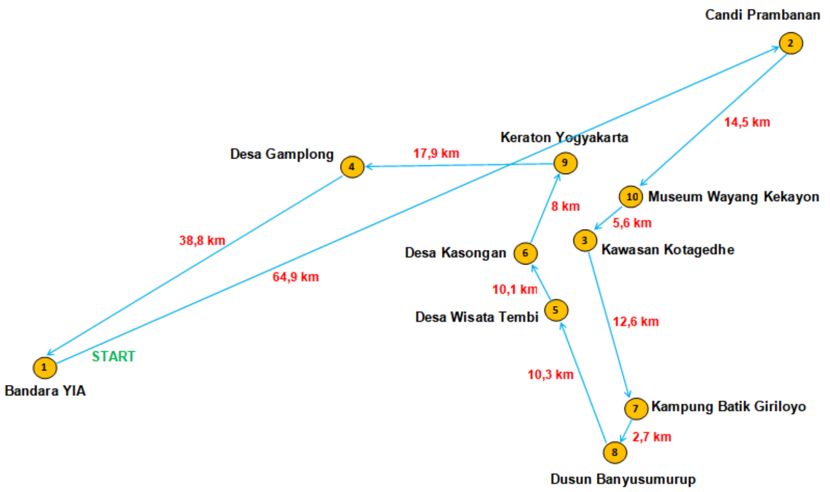

Figure 3 – Illustration of Optimum Routes for Cultural Theme Tourism Using Scenario 2

The findings in the previous section showed that evolutionary methods such as the second scenario are consistent with the realities of tourism and have qualifications that significantly have practical relevance in planning or designing a cultural-themed tourist itinerary in YSR. The findings were able to demonstrate the efficiency of the aspects of travel distance and travel time by giving consideration to several variables of traveler preferences as a constraining factor. When compared with the route planning in scenario 1, a cultural-themed tour using scenario 2 was able to shorten the total travel distance by 68.8 kilometers. This means producing an efficiency of 29.20%. In addition, the total travel time was also shortened by 137.60 minutes, which means a time efficiency of 8.87%. Thematic tourist travel route planning developed in this study reinforces Flognfeldt Jr. (2005)'s statement that the efficiency of a tourist route has a significant impact on the quality of access that determines the number of tourist visits. Furthermore, without comparing the effectiveness of the optimization methods used, the findings on this study are consistent with some other studies for example (Chen et al., 2020; Choi et al. 2022; Hua, 2016; S. Li et al., 2021;

Păcurar et al. 2021, 2020; Vansteenwegen et al, 2012; Zheng and al., 2020; Zhu & Lan, 2020) found that travel routes can be optimized at various levels of efficiency that may not be the same.

In general, we see efforts to optimize cultural-themed travel routes can be done on two factors. First on the aspect of travel between travel destinations, and second on the aspects of the tourist destination itself. We believe that a number of proper arrangements can optimize the travelled journey. On the aspect of travel between tourist destinations, local authorities can improve the quality and expand the public transport network. For example, through the integration between different types of transport modes (Malkhamah et al., 2019), it can encourage local communities to use public transport to travel. This will reduce the number of vehicles (especially private vehicles) on the highways, while streamlining traffic and making it easier for tourists to access tourist destinations. Improving the quality of highways, repairing broken roads, installing traffic lights, ramps, and easy-to-understand road signs, as well as strictly enforcing traffic rules can shorten the travel time from one tourist destination to another. It is also important to provide adequate parking facilities in strategic places to reduce parking on the road shoulders that could potentially cause congestion.

Then on the aspects of tourist destinations, a number of correct settings we believe can shorten the time tourists spend at a tourist destination without reducing the quality of their experience. Setting the time of a visit at a certain time can avoid crowds and speed up the hangover at a particular point. Placing landmarks, tourist destinations, and other strategic information can ensure tourists save time to find and explore tourism destinations. Tourist destination managers can adopt and leverage the latest technologies such as mobile apps, augmented reality, as well as audio-based guides so that tourists can explore tourist destinations independently, offer better privacy, and do not need to take a group tour given by a tour guide. The next important thing is to expand the parking facility. When a tourist destination has a difficult parking problem, the manager can expand the parking area or consider alternative transportation such as a shuttle to the tourist site. In this way, tourists do not need to look for parking lots far from a tourist destination and at the same time reduce their duration in a touristic destination. Online ticketing with a non-cash payment system needs to be considered so that travelers can book tickets online before arriving at a tourist destination. This affects the reduction of the trays in the ticket box. Tourists can directly enter the tourist destination area without spending a lot of time waiting in the ticket box.

CONCLUSION

In this paper, it has been discussed the use of the genetic algorithms contained in the solver add-in of Microsoft Excel to optimize cultural travel routes in YSR. Through the optimization process using genetic algorithms on the add-in solver Microsoft Excel, found the best travel routes that optimize travel time and distance, thus providing quality experience to tourists who visit cultural tourist destinations in SRY efficiently. With shorter travel time travelers can allocate their time to do other additional travel activities that may not be in their initial plans. The remaining time can be used for shopping, visiting local dining places, visiting tourist destinations they may never have heard of before, spending time in a coffee shop, or just getting a break in longer accommodations. The same benefits can also be felt by a travel agency. Route optimization also allows travel agencies to quickly offer a wide range of attractive route options to customers, while improving efficiency in work. By using optimization methods, misleading ways in determining the best routes generally occurring can be avoided, especially when travelers' typologies vary.

However, it is important to keep in mind that there are many related variables and determine a travel route planning to be optimum. For example, variables those come from tourists, the environment, technology, economics, and others. On that basis, several suggestions can be given for future research among others: 1) a case study at different locations: a study involving case studies at different sites can be carried out to compare the results of the same thematic tourist itinerary planning model. In this way, the optimum travel itinerary planning model resulting from this study can be validated as well as find its limitations and advantages; 2) further research on travelers' preferences: it may be considered to conduct further research on different travelers' preferences that may affect their decision making when planning a travel route. It is also important to conduct research that reveals what types of tourists like are interested in tourism travel in addition to culture, and the factors that influence their decisions in choosing a travel route can also be done; 3) Increased accuracy and efficiency of algorithms: a future study can develop more efficient and accurate algorithms in calculating the optimum tourist travel route. These enhancements can help improve the quality and speed of route planning, so users can enjoy a better travel experience.

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