Optimal Tourist Attraction Selection for a Tourist Package Based on Medical & Wellness Tourist Group Preferences

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Abstract. A medical and wellness tourist group usually consists of people of diverse ages and genders. The appeal of the group stems from these differences. It is challenging to choose which attractions to combine with medical and wellness treatments in order to put together a quality tourism package. This research aims to provide an effective method for selecting tourism destinations based on the interests of medical and wellness visitors. A mathematical model for the proposed problem is given, and an artificial multiple intelligence system (AMIS) is built to solve it. According to the computational results, in terms of finding a good solution, AMIS surpasses the genetic algorithm and differential evolution algorithm by 17.89 and 17.55%, respectively.

Keywords: Medical and Wellness tourism, Mixed Integer Programming, Artificial Multiple Intelligence System, Genetic Algorithm, Differential Evolution Algorithm

1. Introduction

Patients seeking medical care outside of their home country are referred to as medical tourists. People from low- and middle-income countries (LMICs) seeking higher-quality medical treatment and people from high-income countries (HICs) seeking low-cost medical care are the two main types of medical tourists [1]. In the host countries, medical tourism is considered as a source of revenue. The benefits of medical tourism outweigh the downsides of universal health care and medical supply limits, according to a previous study in Korea, a patient-accepting country [2]. Furthermore, medical tourism has the potential to be a significant tool for reducing global health care disparities [3]. As a result, boosting the value of medical tourism as a health care system is a critical public health concern.

Wellness tourism has exploded in popularity in recent decades [4]. The term refers to the phenomenon of people traveling to tourism destinations that offer beautiful natural settings and/or unique cultures in order to preserve or improve their health [5]. In contrast to medical tourism, wellness tourism refers to attaining health and wellness through a holistic approach while on vacation without the use of medical assistance [6-8].

Medical and wellness tourism refers to the confluence of these two key types of visitors, and we can ask what opportunities exist for merging medicine and wellness. Medical services are usually focused on treatments that can improve people’s health (tourists know what medical services they require ahead of time), but wellness is primarily concerned with the desire to rest without intervention while on vacation.

A tourist group can include persons of different genders and ages who require medical or wellness services. Example of quick services that can be included in this category include dental treatments, aesthetic services (Botox and fillers), and health checks. These medical services involve quick treatment and recovery times. Such medical treatment might be included in the same wellness tourism package as the previous one. Someone who is looking for a relaxing massage, spa, facial treatment, or massage is referred to as a wellness tourist.

To boost the competitiveness of tourist packages, travel agencies can offer them in conjunction with medical and wellness tourism activities. Such activities included in a tourist package require a short recovery period but still take time, and the person may not be fully healed for a few days. As a result, the attractions that will be included in the tourist package must be carefully chosen in order to achieve visitor happiness while also maintaining their health. In most cases, medical and wellness tourists go in groups. Each M&W group is made up of tourists of various ages and genders, each of whom has a distinct perspective on the available attractions. Some will enjoy cultural attractions, while others will enjoy natural attractions, and so forth. However, choosing which attractions to include in a tourist package is difficult.

Tourism is among the industries that have had significant growth in terms of revenue and technological advancements over the years [9]. This industry has significant direct and indirect impacts on the global economy, and promotes local development through the creation of jobs and the sustainable use of local resources [10,11]. However, the infrastructure and transportation networks in tourist areas impede tourism development. As a result, proper transportation is critical to ensure access to places of interest (POIs), and in some situations to determine the desirability of these locations [11,12]. There are also limitations in terms of supply and information access for supply chain actors; in general, tourist packages and static routes are planned, with a lack of instruments that allow for real-time itinerary planning [13]. All of these factors limit the potential to favorably adapt to the move from mass tourism to an independent travel industry based on customized tour itineraries [14–16].

The Tourism Trip Design Challenge (TTDP), which was introduced in the literature by Vansteenwegen and Van Oudheusden [17], is a problem linked with the creation of customized tourist itineraries. The TTDP entails creating a travel itinerary to visit multiple POIs while meeting the requirements of time, transportation, budget, and visitor preferences, among other constraints [14,16–20]. Medical and wellness tourist packages cannot use the concept of TTDP directly for the two reasons: (1) generally, medical and wellness tourists travel in large groups, and (2) the groups include members of different ages and genders, with different preferences for attractions.

In this research we present a mathematical model formulation to represent the selection of tourist packages based on the group preferences of medical and wellness tourists. Lingo v.16 optimization software and a novel heuristic are used to solve the proposed problem. This paper is organized as follows: the problem statement is presented in Section 2, Sections 3 and 4 describe the mathematical model formulation and proposed method (AMIS), and Sections 5 and 6 explain the computational results and provide a conclusion.

Table 1. Preferable Score of group tours to the attraction (Group 1)

Tourist Detail			Preferable score							
No	Age	Gender	T1	T2	T3	T4	T5	T6	T7	T8
1	14	M	10	4	10	5	9	7	5	8
2	17	M	4	5	4	4	6	10	7	7
3	60	F	6	4	10	8	7	8	6	5
4	37	F	8	7	4	9	5	4	10	10
5	49	F	8	10	8	4	10	10	9	4
6	71	F	8	7	7	7	9	4	8	9
7	15	F	10	10	6	4	9	4	6	4
8	25	M	5	9	5	5	8	4	8	6
9	34	M	5	5	4	5	10	5	9	10
10	48	M	4	5	8	6	9	7	5	4
11	57	M	5	6	4	7	5	6	10	5

Table 2. Preferable Score of group tours to the attraction (Group 2)

Tourist Detail			Preferable score							
No	Age	Gender	T1	T2	T3	T4	T5	T6	T7	T8
1	47	F	4	5	4	10	4	9	8	6
2	62	F	8	10	5	7	10	4	3	4
3	44	M	10	8	6	5	10	5	6	8
4	57	M	3	3	7	6	8	3	10	6
5	49	F	3	9	7	3	9	5	4	10
6	47	M	5	10	6	4	8	5	9	9
7	47	F	4	10	9	4	4	5	3	5
8	18	M	4	5	10	7	5	6	10	3

Table 3. Preferable Score of group tours to the attraction (Group 3).

Tourist Detail			Preferable score							
No	Age	Gender	T1	T2	T3	T4	T5	T6	T7	T8
1	18	M	3	3	4	9	3	5	3	9
2	55	F	4	10	5	4	6	4	8	6
3	54	F	7	8	5	7	5	5	6	7
4	34	M	6	6	6	5	3	5	6	6
5	43	F	6	3	10	10	5	9	10	5
6	45	M	3	10	4	9	6	5	8	10
7	60	F	3	9	10	8	6	10	9	4
8	63	M	6	4	7	9	6	7	6	4
9	42	F	4	6	7	4	4	10	5	4
10	41	M	3	4	3	3	10	7	6	9

Table 4. Preferable Score of group tours to the attraction (Group 4)

Tourist Detail			Preferable score							
No	Age	Gender	T1	T2	T3	T4	T5	T6	T7	T8
1	57	M	9	5	5	10	9	5	10	4
2	53	M	5	9	10	7	4	10	9	4
3	25	F	9	6	4	10	10	6	6	5
4	69	F	9	5	3	9	3	8	3	5
5	35	M	4	9	7	4	6	9	9	5
6	36	M	3	3	10	7	3	9	9	10
7	30	F	8	7	4	10	8	6	10	9
8	64	M	8	4	5	10	10	9	9	9
9	57	F	5	8	3	8	8	9	8	10
10	36	F	6	5	3	8	10	7	7	5

Table 5. Capacity and Profit generated from attraction 1 to 8

Attractions	Visiting time (minutes)	Cap (person)	Profit (Baht/person)
T1	90	35	481
T2	94	30	486
T3	83	25	515
T4	120	28	421
T5	60	38	376
T6	69	41	367
T7	70	25	501
T8	81	28	450

2. Problem Statement

A number of group tours and the details of each group's members are given. The age and gender of tourists are detailed in Tables 1 to 4. There are 10, 8, 10, and 10 tourists in groups 1, 2, 3, and 4, respectively. There are eight attractions (T1–T8) to include in the tourist package, as shown in Table 5. The statistical data gathered from the tourist survey reflect the preference scores. The opinions of tourists on the given attractions were elicited through a questionnaire, with scores ranging from 1 to 10.

The challenge is to determine the best tourist route for each M&W tour group. While tuning the optimal solution, the following criteria must be met: (1) all members of the same M&W group must travel on the same route; (2) each attraction cannot handle more than its daily capacity of tourists; (3) groups can visit as many attractions as they want to increase their satisfaction; (4) all groups must depart at 9:00 a.m. and return to their hotel by 5:00 p.m. (lunch is included at the attractions); and (5) the distance between locations *i* and *j* determines the journey time, which is determined at a speed of 60 kilometer per hour.

3. Mathematical Model Formulation

The proposed problem was formally modelled using mixed integer programming (MIP). The following are the indices, parameters, and decision variables that were used.

Indices

- i — Tourist index $i = 1 \ldots I$
- j — Group of tourist $j = 1 \ldots J$
- k,j — Attraction index $k,j = 0..K$; $k,j=0$ means hotel of the tourists.

Parameters

- d_{jk} — Distance from i to j (km)
- h — Travelling time per km (minutes/km)
- A — Maximum traveling time per day(minutes)
- p_k — Profit obtained from assigning tourist to attraction k (Baht/person)
- c_k — Capacity of attractions *k* (persons)
- s_{ik} — Preferable score of tourist i to attraction k.
- t_{jk} — Travelling cost from j to k
- b_{ij} — $\begin{cases} 1 & if \ tourist \ i \ is \ in \ group \ j \\ 0 & otherwise \end{cases}$
- u_{ik} — $\begin{cases} 1 & if \ tourist \ i \ can \ visit \ k \\ 0 & otherwise \end{cases}$
- n_j — Number of tourists in group tour j

Decision Variables

- X_{jkl} — $\begin{cases} 1 & if \ group \ tour \ j \ travel \ to \ attraction \ k \ be \\ 0 & otherwise \end{cases}$
- Y_{jk} — $\begin{cases} 1 & if \ group \ tour \ j \ visit \ attraction \ k \\ 0 & otherwise \end{cases}$
- W_{ik} — $\begin{cases} 1 & if \ tourist \ i \ visit \ attraction \ k \\ 0 & otherwise \end{cases}$

Objective function

$$Max \ Z = \sum_{k=1}^{K}\sum_{j=1}^{J} n_j p_k Y_{jk} - \sum_{l=1}^{K}\sum_{k=0}^{K}\sum_{j=1}^{J} t_{jk} X_{jk} \quad (1.1)$$

$$Max \ Z = \sum_{k=0}^{K}\sum_{i=1}^{I} s_{ik} W_{ik} \quad (1.2)$$

Constraints

$$\sum_{k=0,k\neq l}^{K} X_{jkl} \leq 1 \qquad \forall \ l = 1..K, j = 1...J \quad (2)$$

$$\sum_{l=1}^{K} X_{j0l} = 1 \qquad \forall \ j = 1..J \quad (3)$$

$$\sum_{k=0,k\neq l}^{K} X_{jkl} = \sum_{k=0}^{K} X_{jlk} \qquad \forall \ j = 1..J, l = 0 \ldots K \quad (4)$$

$$\sum_{j=1}^{J} n_j Y_{jk} \leq c_k \qquad \forall \ k = 0 \ldots K \quad (5)$$

$$\sum_{k\in S}\sum_{l\in S,k\neq l} X_{jkl} \leq |S| - 1 \qquad \forall S \subseteq \{1 \ldots K\}, \ \forall \ j = 1..J \quad (6)$$

$$\sum_{l=0}^{K}\sum_{k=0,k\neq l}^{K} h d_{ik} X_{jkl} \leq A \qquad \forall \ j = 1..J \quad (7)$$

$$Y_{jk} \leq \sum_{l=1,l\neq k}^{K} X_{jkl} \qquad \forall \ j = 1..J, k=1..K \quad (8)$$

$$W_{ik} \leq \sum_{j=1,j\neq k}^{J} b_{ij} Y_{jk} \qquad \forall \ i = 1..I, k=1..K \quad (9)$$

$$\sum_{k=1}^{K} Y_{jk} \geq 1 \qquad \forall \ j = 1..J \quad (10)$$

$$\sum_{k=1}^{K} W_{ik} \geq u_{ik} \qquad \forall \ i = 1..I \quad (11)$$

In constructing the MIP, the first objective (1.1) is to maximize profit by assigning group *j* to travel paths *k* and *l*, whereas the second objective (1.2) is to maximize tourist satisfaction or preferable score by assigning tourist *j* to attraction *k*.

Constraint (2) ensures that if a group of tourists *j* enters node *k*, they can only enter node *l* once. Constraint (3) guarantees that each group of tourists will only be able to leave the hotel once per day.

Table 6. Initial set of WPs

	1	2	3	4	5	6	7	8
1	0.11	0.87	0.67	0.61	0.08	0.94	0.52	0.41
2	0.23	0.39	0.10	0.16	0.23	0.44	0.54	0.05
3	0.24	0.47	0.06	0.56	0.21	0.55	0.67	0.69
4	0.61	0.65	0.11	0.79	0.46	0.87	0.95	0.10
5	0.12	0.08	0.00	0.74	0.84	0.72	0.11	0.69

Constraint (4) ensures that when a group of tourists visits attraction k, they must leave. Constraint (5) ensures that attraction *k* does not exceed its capability to serve tourists. Constraint (6) assures that the solution does not contain any cycles that are not linked to the hotel. Constraint (7) guarantees that group *j* will arrive at the hotel before 5 p.m. Constraint (8) is used to create the relationship between variables Y_{jk} and X_{jkl}; it ensures that group *j* can only be assigned to *k* if it has a travel route between *k* and *j*. Tourist *i* can only be assigned to attraction *k* if tourist group *j* of which tourist *i* is a member is assigned to *k*. Tourist *i* and tourist group *j* must be assigned to at least one attraction according to constraints (10), while constraint (11) ensures that only suitable tourists can visit attraction *k* (based on health status after medical treatment).

4. AMIS for Selecting Optimal Tourist Package

The artificial multiple intelligence system (AMIS) is a new heuristic with five steps: (1) create a set of initial solutions (WPs), (2) WPs choose intelligence boxes (IBs), (3) WPs perform in selected IBs, (4) update heuristic information, and (5) repeat steps 2–4 until the termination condition is satisfied.

4.1 Randomly generated the set of initial solution

Let us designate *E (e = 1 … E)*, the size of each WP, and Q *(q = 1 … Q)*, the total number of WP. V_{qet} is the value in position *e* of WP number *q* in iteration *t*. V_{qe1} is the first set of WP, which is created at random from 0 to 1. Table 6 shows an example of WP with Q = 5 and E = 8.

The number of candidate attractions is the WP dimension. Based on the proposed problem, the coded values displayed in Table 6 can be decoded. The following is an explanation of the decoding method.

Decoding method

The following steps allow tourist groups to create their own itinerary.

Step 1: Pick a tourist group at random with the same likelihood, for instance, group 2.

Step 2: Pick one WP at random from *Q* WP, for instance, WP = 4.

Step 3: Sort the value in increasing order of the selected WP using the rank position value; [0.10(8), 0.11(3), 0.46(5), 0.61(1), 0.65(2), 0.79(4), 0.87(6), 0.95(7)] is the result of sorting WP = 4.

Step 4: Assign the attractions to the selected group in step 2 based on the list generated in step 3. When allocating attractions to tourist groups, the following conditions must be met: (1) the tourists must return to the hotel on time (travelling time and visiting time); (2) the capacity of the attractions must not be exceeded; and (3) prohibited attractions must be strictly monitored. For example, if attractions 8, 3, and 5 are assigned to group 2, the following details of the travel itinerary are determined: The tour on route 0-8-3-5 takes 412 minutes of travelling time, thus the hotel arrival time is 4:52 p.m. Customer satisfaction is rated at 163 points. The total income is THB 10,728 and the trip expenses amount to THB 1,204. Finally, a total profit of THB 9,524 is realized.

Step 5: Repeat steps 1–4 until all groups have completed their daily trip.

4.2 WP select their preferred intelligence boxes (IB)

Equation (11) is used to determine which IB will be used by the WP and is derived from the historical data of that IB's search quality:

$$P_{bt} = \frac{FN_{bt-1} + (1-F)A_{bt-1} + KI_{bt-1} + \rho|A_{bt-1} - A_{t-1}^{best}|}{\sum_{b=1}^{B} FN_{bt-1} + (1-F)A_{bt-1} + KI_{bt-1} + \rho|A_{bt-1} - A_{t-1}^{best}|} \quad (11)$$

where P_{bt} is the probability of choosing the black box in iteration *t*, N_{bt-1} is the number of WPs that chose an IB in the previous iteration, A_{bt-1} is the average objective value of the best IB in the current iteration, A_{t-1}^{best} is the average objective value of all WPs that selected an IB in the previous iteration *t*, I_{bt-1} is a reward value that goes up by one if a WP finds the best answer in the last iteration, *Q* is the total number of IBs, *F* is the scaling factor (F = 0.5), and *K* is the predefined parameter (*K* = 0.3).

4.3 Perform the selected IB

IBs are used to improve the quality of the current solution (WPs). Eight intelligence boxes were designed in this paper, and Table 7 shows them in detail. Equations (12)–(19) are as follows:

Table 7. AMIS IBs

IB's operators	Value of Y_{ijq}	
ACO-inspired move (AIM)	$V_{qeh} = \rho V_{ret} + F1(B_e^{gbest} - V_{ret}) + F2(V_{met} - V_{ret})$	(12)
PSO-inspired move (PIM)	$V_{qeh} = V_{ret} + F1(B_e^{gbest} - V_{ret}) + F2(B_{qe}^{pbest} - V_{ret})$	(13)
DE-inspired Move (DIM)	$V_{qeh} = V_{ret} + F1(V_{met} - V_{net})$	(14)
MANT-inspired move (BIM)	$V_{qeh} = V_{ret} + \emptyset_{re}(V_{ret} - V_{net})$	(15)
Restart	$V_{qeh} = \mathbb{R}_{qe}$	(16)
Random-Transit (RT)	$V_{qeh} = \begin{cases} V_{qeh-1} & if\ \mathbb{R}_{qe} \leq CR \\ R_{qeh} & otherwise \end{cases}$	(17)
Inter-Transit (IT)	$V_{qeh} = \begin{cases} V_{qeh-1} & if\ \mathbb{R}_{qe} \leq CR \\ V_{neh} & otherwise \end{cases}$	(18)
Scaling Factor (SF)	$V_{qeh} = \begin{cases} V_{qeh-1} & if\ \mathbb{R}_{qe} \leq CR \\ \mathbb{R}_{qe} V_{qeh-1} & otherwise \end{cases}$	(19)

where $\emptyset_{re}$ is a random real number in the range [-1,1], $\mathbb{R}_{qe}$ is a random number in the range [0,1], B_e^{gbest} is the best WP created so far and B_{se}^{pbest} is the personal best of WP s, and $F1$ and $F2$ are predefined scaling numbers, and in this study we used 0.5 and 0.5, respectively. If WP q selects IB b as the improvement method, WP q will be defined as WP set Z while the others will be members of set A, and Q = Z ∪ A. Q is the total number of WPs. We define set Y_{net} and $Y_{met} \in A$ and $V_{ret} \in$ Z. WP n and m are randomly chosen from WPs in set A, while WP r is randomly selected from set Z. The ρ position's evaporation rate is predefined and set at 0.05. The sub-iteration update position of V_{qeh+1} is executed using Equation (20), while h is a predefined parameter.

$$V_{qeh+1} = \begin{cases} V_{qeh} & if\ f_{rt} \leq f_{qh}\ and\ update\ f_{rt} = f_{qh}\ and\ V_{ret} = V_{qeh} \\ V_{ret} & otherwise \end{cases} \quad (20)$$

f_{qh} and f_{rt} is calculated using Eq. (21).

$$f_{qh} = w^1 f_{qh}^1 + w^2 f_{qh}^2 \quad (21)$$

where f_{qt} denotes WP q's objective function at sub-iteration h; w^1 is the random weight for objective 1, w^2 = $(1 - w^1)$, and $w^1 = U(0,1)$. f_{qh}^1 and f_{qh}^2 are the objectives of objective Z^1 and Z^2, respectively.

To keep the nondominant solution, the Pareto front was applied. The goal functions of objectives 1 and 2 of tracks r and s are denoted by $f^1(y_r)$ and $f^2(y_r)$, respectively. Let $\Re$ represent a set of feasible solutions, denote y = $(y_1, y_2, ..., y_i)$ as the set of decision vectors, and f^v(y) = (f^1(y), f^2(y), …, f^V(y) as the set of objective functions of vector y. y will dominate y' if and only if f^v(y) ≤ f^v(y') for all v = 1, 2, 3, …, V.

The technique for order of preference by similarity to ideal solution (TOPSIS) is used to determine the most promising set of parameters. TOPSIS was first presented by Hwang and Yoon [21]. In this paper, it begins by constructing a standard decision matrix, which is used to convert the dimensions of various attributes into a non-dimensional attribute using Equations (22)–(28).

$$r_{lv} = \frac{x_{lv}}{\sqrt{\sum_{l=1}^{L}(X_{lv})^2}} \quad (22)$$

$$U_{lv} = w_v r_{lv} \quad (23)$$

$$U_v^* = \{ \max_L U_{lv}\ if\ v \in V\ ;\ \min_L U_{lv}\ if\ v \in V^* \} \quad (24)$$

$$U_v' = \{ \min_L U_{lv}\ if\ v \in V\ ;\ \max_L U_{lv}\ if\ v \in V' \} \quad (25)$$

$$S_l^* = \sqrt{\sum_{v=1}^{V}(U_v^* - U_{lv})^2} \quad (26)$$

$$S_l' = \sqrt{\sum_{v=1}^{V}(U_v' - U_{lv})^2} \quad (27)$$

$$C_l^* = \frac{S_l'}{S_l^* + S_l'} \quad (28)$$

where x_{lv} is the value of the objective function of point l of objective v, l is the number of points in the Pareto front, V^* represents a set of positive objective functions, and V' represents a set of negative objective functions. The weight of each goal function is set by the predefined parameter w_v , and U^*($U^* = \{U_1^*, U_2^*, ..., U_n^*\}$) and U' ($U' = \{U_1', U_2', ..., U_n'\}$) are the positive and negative ideal solutions, respectively. S_l^* and S_l' are the separation measures used to compute the relative closeness to the ideal solution for each alternative from the positive and negative ideal solutions, respectively (C_l^*). The set of parameters with a C_l^* value closest to 1 will be chosen as the most promising solution.

4.4 Update Heuristic Information

In order to use the solution as a foundation for future iterations, some heuristic data must be updated. The rule for updating is shown in Table 8.

Table 8. Heuristic Information Update Detail

Variables	Update procedure
N_{bt}	Total number of WP that select IB b from iteration 1 to iteration t
A_{bt}	Average objective value of all IB that select IB b $(\frac{\sum_{s=1}^{N_{bt}} f_{st}}{N_{bt}})$
I_{bt}	$I_{bt} = I_{bt-1} + G$
	when $G = \begin{cases} 1 & if\ black\ box\ b\ contain\ global\ best\ solution\ in\ iterati \\ 0 & \end{cases}$
B_e^{gbest}	Update global best WP.
B_{qe}^{pbest}	Update IB' s best WP
R_{qeh}	Select the value in position of all WP, all positions at random.

5. Computational Result

AMIS was used to create travel itineraries for 15 tourist groups utilizing 148 possible destinations. These 15 groups had a total of 912 tourists of various ages and genders. The tourism information is listed in Table 9.

Table 9. Detail of tourist group

TG\MS	Male	Femail	1-12 yr.	13-21 yr.	22-39 yr	40-60 yr.	61 yr. up	total
1	20	45	5	9	21	16	14	65
2	38	26	7	12	13	21	11	64
3	18	53	10	21	16	13	11	71
4	41	18	14	11	8	7	19	59
5	38	25	5	19	13	10	16	63
6	28	32	8	19	10	7	16	60
7	38	14	9	19	8	5	11	52
8	18	22	4	10	14	7	5	40
9	21	31	8	8	19	10	7	52
10	22	45	6	19	15	20	7	67
11	39	22	13	15	8	17	8	61
12	27	34	14	5	15	7	20	61
13	31	29	10	14	12	7	17	60
14	38	28	16	15	10	15	10	66
15	31	40	8	15	20	13	15	71
Total	448	464	137	211	202	175	187	912

The proposed method was written in Python and tested on a PC with a 1.6 GHz Intel ® Core TM i5-2467 M CPU. AMIS was tested against two well-known heuristics, GA and DE. Both of these approaches were modified using [22,23].

As shown in Table 10, the traveling tour of all groups is formed as a daily tour. The total travel time for all 15 groups is 6,586 minutes, with an average of 439.07 minutes per group. There are 480 minutes in a day, therefore we utilized 91.47% of the day to produce a total profit of THB 233,277, or an average of THB 15,551.8 for each tourist group. Finally, a total of 26,770 points was achieved, with each group averaging 1784.67 points. The average tourist preference score was 29.35 points per person, with a profit of THB 255.78 per tourist.

Table 10. Results of proposed methods using w1 and w2 equal to 0.5 (AMIS).

Group	Route	Travelling time (minutes)	Total Profit (Baht)	Preferable Score
1	0-141-104-7-6-0	466	16,770	1,755
2	0-8-41-114-104-0	442	18,112	1,536
3	0-54-59-104-85-0	411	16,827	1,988
4	0-104-111-5-8-0	448	16,225	1,652
5	0-43-104-94-0	437	13,860	1,512
6	0-13-18-107-140-0	427	12,660	1,920
7	0-35-45-104-19-0	453	16,536	1,664
8	0-54-43-104-112-0	454	7,640	1,440
9	0-56-54-59-0	420	15,444	1,560
10	0-59-138-140-0	450	15,812	1,206
11	0-4-8-137-49-0	421	14,762	2,440
12	0-7-132-9-6-0	470	15,372	2,196
13	0-139-13-59-4-0	417	16,020	2,400
14	0-89-103-94-1-0	400	21,120	1,584
15	0-103-49-95-0	470	16,117	1,917
Total		**6,586**	**233,277**	**26,770**

Table 11. Comparison result of GA,DE and AMIS using w^1 and w^2 equals to 0.5 (TOPSIS)

	GA	DE	AMIS
Travelling time (minutes)	6,549	6,491	**6,586**
Total Profit (Baht)	219,135	218,740	**233,277**
Preferable Score	25,192	25,224	**26,770**

Based on the data in Table 11, GA, DE, and AMIS create profits of THB 219,135, 218,740, and 233,277, respectively, when using a value of 0.5 for w1 and w2. In other words, AMIS generates 6.06 and 6.23% greater profit than GA and DE, respectively. AMIS also has a higher preference score than GA and DE, by 5.89 and 5.77%, respectively.

To compare the performance of GA, DE, and AMIS in achieving satisfactory results, the average ratio of the Pareto-optimal solution (ARP) was employed. N_1, N_2, …, N_k, in experiment k represents the number of iterations employed. The number of Pareto-optimal solutions identified in the kth experiment is n_1, n_2, …, n_k, and the total number of experiments is K. As a result, Equation (29) is used to determine the ARP.

$$ARP = \frac{\frac{n_1}{N_1}+\frac{n_1}{N_2}+\dots+\frac{n_k}{N_k}}{K} \quad (29)$$

Table 12. ARP of all methods

iterations	GA		DE		AMIS	
	Number of Pareto Points	ARP	Number of Pareto Points	ARP	Number of Pareto Points	ARP
200	324	1.62	319	1.60	401	2.01
500	572	1.14	602	1.20	894	1.79
800	943	1.18	894	1.12	1036	1.30
1000	1129	1.13	1210	1.21	1237	1.24
1200	1344	1.12	1312	1.09	1565	1.30
1500	1580	1.05	1578	1.05	1821	1.21
Average	982.00	1.21	985.83	1.21	1159.00	1.47

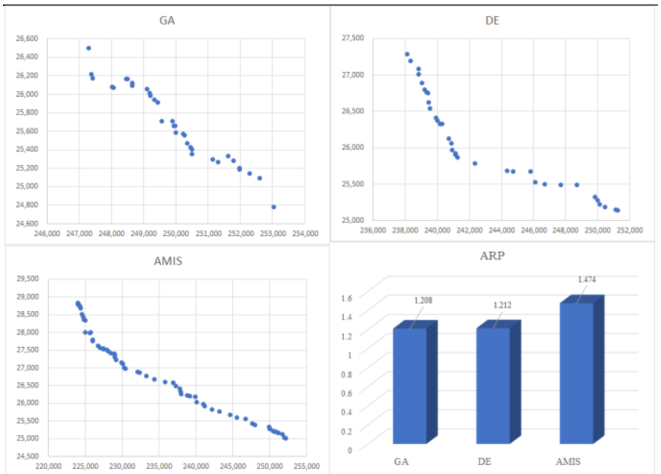

Fig. 2 Pareto front of GA, DE, and AMIS and their ARP values.

Table 12 shows that AMIS finds 17.89 and 17.55% more Pareto points than GA and DE. However, we can infer that when utilizing TOPSIS to find a promising solution, AMIS exceeds GA and DE, and when comparing the performance of the two approaches to locate the Pareto front, AMIS outperforms both. The Pareto front graph and the ARP values of GA, DE, and AMIS are shown in Figure 2.

When comparing the gap between points in the front of AMIS to GA and DE, we can see that the front of AMIS has a smaller gap. As a result, AMIS will be able to locate additional spots in the Pareto front.

6. Conclusion and Outlooks

The goal of this study was to develop the best itinerary for medical and wellness tourist groups. A mathematical model was created to depict the inclusion of tourist attractions in such tourism packages. For the following reasons, selecting attractions for tourist packages for medical and wellness tourists is more difficult than selecting attractions for other types of tourists:

(1) Due to health concerns, people may be unable to visit certain places following medical or wellness treatment.
(2) Depending on the health situation, more time may be required for each attraction.
(3) Tourist satisfaction is complicated by the fact that most visitors arrive as part of a group that includes people of diverse genders and ages. Creating tours is difficult and time-consuming, and it is difficult to satisfy all types of tourists.

To handle the presented problem, multi-objective AMIS was designed, and the computational results demonstrate that AMIS outperforms GA and DE by 18.04 and 17.77%, respectively, by exploring a better solution. Restaurants and souvenir shops are currently classified as travel attractions. For more specificity, they should be identified as other factors in order to distinguish them from attractions. It is also important for trip planners to consider multiple time periods in order to deal with more complex problems.

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