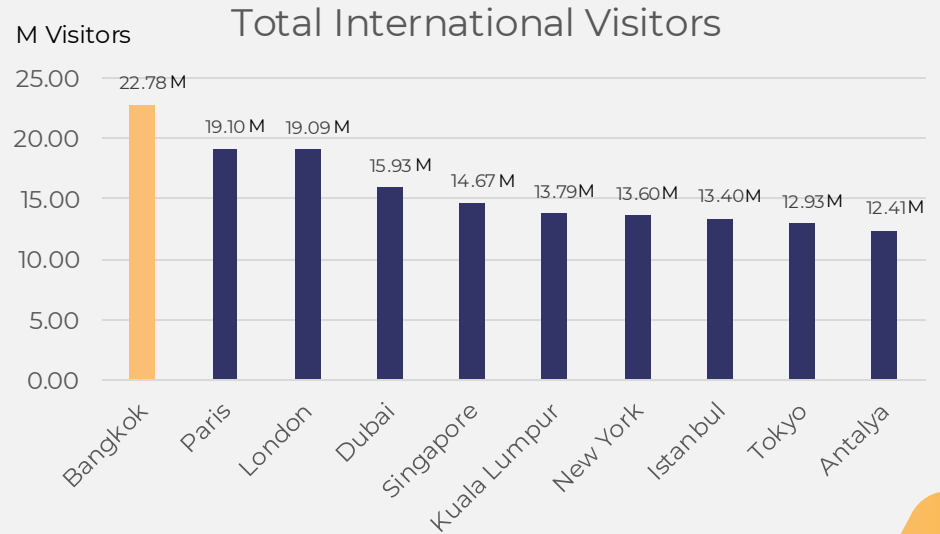


Tourism Route Planning **via Goal Programming and** **Multi-Objective Linear Programming:** **A Case Study in Bangkok**

Chanida Leelayutto



Bangkok is the most visited city in the world in 2022-2023



Bangkok is the most visited city in the world in 2022-2023



Source: <https://janinesjourneys.com/how-to-plan-your-online-travel-itinerary/>



Source: <https://global.chinadaily.com>



Source: <https://www.express.co.uk/travel/articles/1788103/>

Bangkok is the most visited city in the world in 2022-2023

↑ 51 Suggestions on places to stay, see, and avoid in Bangkok?

B Barry Champlin • Apr 12, 2021



What can I see in 2 days in bangkok?

Jan 3, 2024, 10:22 AM

8 of us are coming to **Bangkok** for the Coldplay concert this month end. We have booked a stay in Ramada riverside for 2 days. What would be a good itinerary? Day time we would like to visit cultural, common attraction or historical places and would like to party a bit at the night

Source: <https://janinesjourneys.com/how-to-plan-your-online-travel>

first time in Bangkok

Hi [VT member 93f85]! Would like to ask for your help/suggestion... we'll be going to Bangkok this November 4days, any suggestions on places to visit and must see and also hotel? I heard the shopping area is in Pratunam....

I really appreciate any advice you can give. thank you!

Thailand Holiday plan help needed

6 years ago

Hllo friends,

We are planning to travel to **Bangkok** in June 2017 from new Delhi with one 3 yr plus. Could you please help me out to make an itinerary for 6-7 days? Also want to add on either **Pattaya** or **Phuket** advice needed. Budget would be rs. 100000 for couple and child. Pls guide me.



planning a trip to Thiland with my wife

We are into a trip to Bangkok , Pattaya as couple in late fourties into spicing up in life style .would like to know like wise couples .or the right bars clubs for couples with no restrictions . Any one to give us some advise.

Source: <https://www.express.co.uk/travel/articles/1788103/>

↑ 5 Any recommendations on things to do in Bangkok, Thailand?

D David Terry • Jan 5, 2021



Four night stay in Bangkok

Dec 26, 2023, 1:33 AM

Suggestions for great places to stay in **Bangkok** please.

No large impersonal hotel chains

Quiet area but close to street food , markets, temples and more a traditional thai feel. I like being near water so along the canal or main river.

Swimming pool would be a bonus but not essential

Near Pratunam Market would be useful (not essential)

BOHEMIAN RATHER THAN CORPORATE

Rooms must have window and balcony would be good too.

Budget £80 per night MAX

Surely not too much to ask :))

Top 10 travel places in Bangkok



<https://www.tourismthailand.org/Destinations/Provinces/Bangkok/219>

DATA

No.	Location	Category	Satisfaction	Time spent	Entrance fee(Thais)	Entrance fee(Foreigners)	Working hour	Working day
0	Sam Yot Station	MRT	4.5	0	0	0	05:30-23:59	Mon-Sun
1	Sanam Chai Station	MRT	4.7	0	0	0	05:30-23:59	Mon-Sun
2	Grand palace	HS	4.4	60	0	500	08:30-15:30	Mon-Sun
3	Wat Pho	WAT	4.6	60	0	300	08:00-19:30	Mon-Sun
4	Bangkok City Pillar Shrine	HS	4.5	30	0	0	06:30-18:00	Mon-Sun
5	Wat Suthat Thepwararam Ratchaworamahawihan	WAT	4.6	60	0	20	08:00-20:00	Mon-Sun
6	Bangkok National Museum	MUS	4.4	60	30	200	08:30-16:00	Wed-Sun
7	Museum Siam	MUS	4.3	60	100	100	10:00-18:00	Tue-Sun
8	Wat Bowonniwet Vihara	WAT	4.6	60	0	0	08:00-17:00	Mon-Sun
9	Wat Ratchanatdaram Worawihan	WAT	4.6	60	0	20	08:00-17:00	Mon-Sun
10	Rattanakosin Exhibition Hall	MUS	4.5	120	70	100	09:00-17:00	Tue-Sun
11	Giant Swing	HS	4.3	30	0	0	00:00-23:59	Mon-Sun



Distance_(km)

WALKING

	0	1	2	3	4	5	6	7	8	9	10	11
0	0	1.1	1.6	1.0	1.4	0.5	2.0	1.0	1.9	1.1	1.2	0.6
1	1.1	0	1.3	0.4	1.0	1.4	1.8	0.065	2.5	2.2	2.3	1.6
2	1.6	1.3	0	0.9	0.3	1.3	0.8	1.1	1.9	1.9	1.8	1.2
3	1.0	0.4	0.9	0	0.9	1.3	1.6	0.3	2.3	2.0	2.1	1.4
4	1.4	1.0	0.3	0.9	0	1.0	0.8	0.9	1.6	1.4	1.5	1.0
5	0.5	1.4	1.3	1.3	1.0	0	1.6	1.3	1.3	0.7	0.8	0.046
6	2.0	1.8	0.8	1.6	0.8	1.6	0	1.6	1.4	1.5	1.4	1.6
7	1.0	0.065	1.1	0.3	0.9	1.3	1.6	0	2.4	2.1	2.1	1.5
8	1.9	2.5	1.9	2.3	1.6	1.3	1.4	2.4	0	1.0	0.9	1.3
9	1.1	2.2	1.9	2.0	1.4	0.7	1.5	2.1	1.0	0	0.2	0.6
10	1.2	2.3	1.8	2.1	1.5	0.8	1.4	2.1	0.9	0.2	0	0.7
11	0.6	1.6	1.2	1.4	1.0	0.046	1.6	1.5	1.3	0.6	0.7	0

	0	1	2	3	4	5	6	7	8	9	10	11
0	0	1.2	2.9	1.1	2.9	0.5	2.8	1.1	2.2	1.2	1.4	0.6
1	1.3	0	2.9	0.8	3.0	1.5	2.4	0.065	2.9	2.5	2.6	1.8
2	1.8	1.5	0	1.4	0.041	1.4	3.0	1.4	2.4	2.2	2.4	1.6
3	1.1	0.4	2.8	0	2.8	1.5	1.7	0.3	2.7	2.3	2.4	1.6
4	1.3	1.0	2.2	0.9	0	1.0	2.6	0.9	1.9	1.8	1.9	1.1
5	0.6	1.5	1.8	1.4	1.9	0	3.0	1.3	1.2	0.9	1.0	0.1
6	3.2	2.9	2.9	2.1	3.0	2.8	0	2.4	1.6	3.6	2.5	2.9
7	1.1	0.065	2.8	0.6	2.9	1.4	2.3	0	2.8	2.3	2.5	1.6
8	2.1	2.6	1.5	2.4	1.5	1.7	3.5	2.4	0	2.4	0.9	1.7
9	1.9	3.1	2.0	3.0	2.1	1.4	4.0	3.0	1.4	0	0.5	1.4
10	1.4	2.6	1.5	2.5	1.6	0.8	3.5	2.4	0.9	1.5	0	0.8
11	0.8	1.6	1.8	1.5	1.9	0.011	3.2	1.5	1.2	0.9	1.0	0

TAXI

Time_(min)

WALKING

	0	1	2	3	4	5	6	7	8	9	10	11
0	0	16	23	15	19	7	29	15	27	16	17	9
1	16	0	18	6	15	20	25	1	35	31	32	22
2	23	18	0	12	4	18	11	16	27	26	26	18
3	15	6	12	0	12	19	22	4	33	29	30	20
4	19	15	4	12	0	14	11	13	22	20	22	14
5	7	20	18	19	14	0	23	19	19	10	11	1
6	29	25	11	22	11	23	0	23	21	22	20	23
7	15	1	16	4	13	19	23	0	34	29	30	21
8	27	35	26	33	22	19	21	34	0	15	13	18
9	16	31	26	29	20	10	22	29	15	0	3	9
10	17	32	26	30	22	11	20	30	13	3	0	10
11	9	23	18	20	14	1	23	21	18	9	10	0

	0	1	2	3	4	5	6	7	8	9	10	11
0	0	4	8	4	8	2	9	4	6	4	4	2
1	4	0	8	2	8	5	7	1	8	8	8	5
2	7	6	0	6	1	7	11	6	10	10	9	7
3	4	2	7	0	7	4	5	1	8	8	7	5
4	4	3	7	2	0	3	7	2	6	7	6	4
5	2	5	6	5	6	0	10	4	4	4	3	1
6	10	9	10	6	10	9	0	8	5	13	8	10
7	3	1	7	2	8	4	7	0	8	8	7	5
8	8	8	6	8	6	6	12	8	0	9	3	6
9	7	9	6	9	6	5	13	8	5	0	2	5
10	5	7	4	7	4	3	11	6	3	6	0	3
11	3	5	6	5	6	1	10	5	4	4	3	0

TAXI

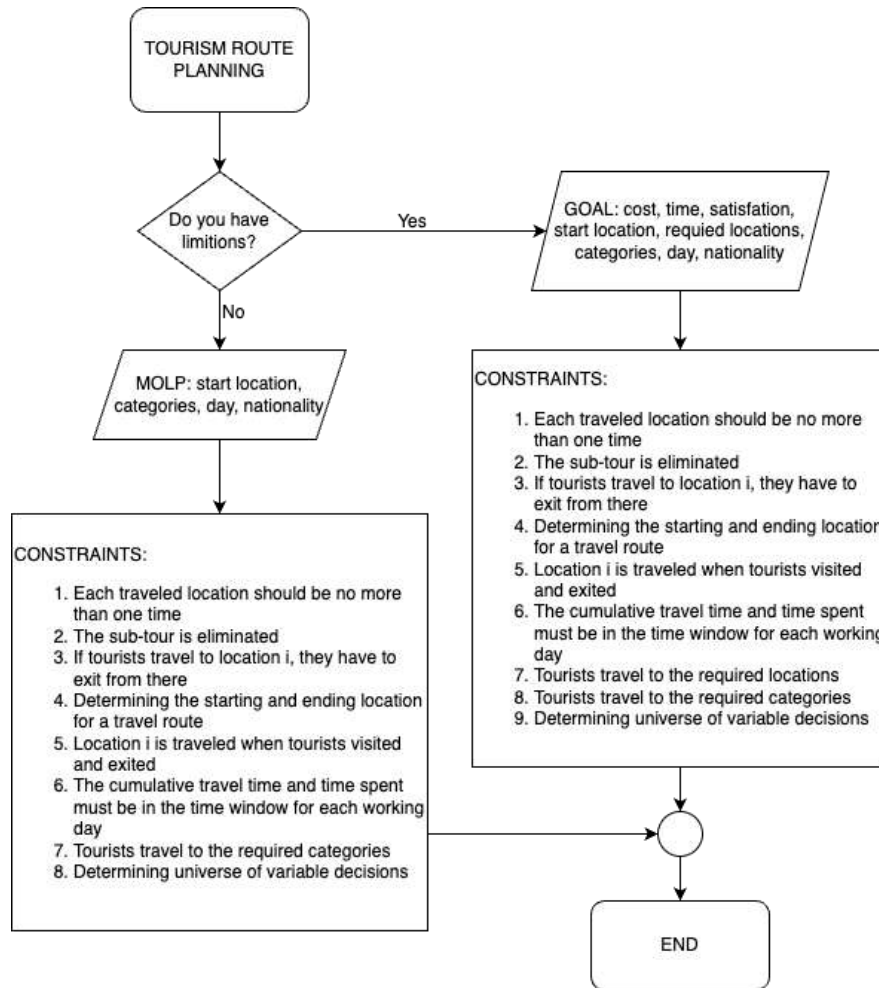
Tourism route planning model

Goals/ Multi-objective

1. Cost
2. Time
3. Satisfaction

Constraints

1. Each traveled location should be no more than one time
2. The sub-tour is eliminated
3. If tourists travel to location i , they have to exit from there
4. Determining the starting and ending location for a travel route
5. Location i is traveled when tourists visited and exited
6. The cumulative travel time and time spent must be in the time window for each working day
7. Tourists travel to the required locations
8. Tourists travel to the required categories
9. Determining universe of variable decisions



MATH MODEL FOR GOAL PROGRAMMING



Parameters

- N = the number of locations,
 C = the category for each location,
 L = set of locations,
 S = set of sub-tour; $S \subset L$
 M = set of transportation modes, i.e. walking, taxi
 SE_i = 1 if tourists start at location i (MRT station) or 0 otherwise; $i \in L$,
 NSE_i = 0 if tourists don't start at location i (MRT station) or 1 otherwise; $i \in L$,
 Cat_i^c = 1 if tourists travel location i that is in the required category or 0 otherwise; $i \in L, c \in C$,
 α_{ijk} = the unit cost of traveling one unit from location i to location j by transportation mode k
; $i, j \in L, k \in M$,
 D_{ijk} = distance from location i to location j by transportation mode k ; $i, j \in L, k \in M$,
 T_{ijk} = travel time from location i to location j by transportation mode k ; $i, j \in L, k \in M$,
 $T_{ijk} = \alpha_{ijk}D_{ijk}$,
 C_{ijk} = cost from location i to location j by transportation mode k ; $i, j \in L, k \in M$,
 SP_i = time spent at location i ; $i \in L$,
 E_i = entrance fee of location i ; $i \in L$,
 ST_i = satisfaction of location i ; $i \in L$,
 TT_{ijk} = total time from location i to location j by transportation mode k ; $i, j \in L, k \in M$,
 $TT_{ijk} = T_{ijk} + SP_i$,
 TC_{ijk} = total cost from location i to location j by transportation mode k ; $i, j \in L, k \in M$,
 $TC_{ijk} = C_{ijk} + E_i$,
 a_i = time window open of location i ; $i \in L$,
 b_i = time window end of location i ; $i \in L$,
 MT_{ij} = large value for time window from location i to location j ; $i, j \in L$,
 $MT_{ij} = \{b_i + TT_{ij} - a_j, 0\}$,

Parameter(Cont.)

a_i = time window open of location i ; $i \in L$,

b_i = time window end of location i ; $i \in L$,

MT_{ij} = large value for time window; $MT_{ij} = \{b_i + TT_{ij} - a_j, 0\}$; $i, j \in L$,

G_g = goal g assigned by tourists; $g \in G$,

Wd_g^+ = weighted of positive deviation variable of goal g ; $g \in G$,

Wd_g^- = weighted of negative deviation variable of goal g ; $g \in G$,

Decision variables

x_{ijk} = 1; if tourists travel from location i to j by transportation mode k ; $i, j \in L, k \in M$,
0; otherwise,

y_i = 1; if tourists travel from location i ; $i \in L$,
0; otherwise,

z_i = time instant that starts at location i ; $i \in L$,

d_g^+ = positive deviation variable of goal g ; $g \in G$,

d_g^- = negative deviation variable of goal g ; $g \in G$,

Objective

$$\text{Min} \sum_{g \in G} \frac{d_g^+}{G_g} Wd_g^+ + \sum_{g \in G} \frac{d_g^-}{G_g} Wd_g^-$$

Constraints

$$\sum_{k \in M} \sum_{i \in L, i \neq j} x_{ijk} \leq 1; \forall j \in L \quad (1a)$$

$$\sum_{k \in M} \sum_{j \in L, i \neq j} x_{ijk} \leq 1; \forall i \in L \quad (1b)$$

$$\sum_{k \in M} \sum_{i, j \in S} x_{ijk} \leq |S| - 1; \forall S \subset L \quad (2)$$

$$\sum_{k \in M} \sum_{j \in L} x_{ijk} = \sum_{k \in M} \sum_{j \in L} x_{jik}; \forall i \in L \quad (3)$$

$$\sum_{k \in M} \sum_{j \in L} x_{ijk} \geq SE_i; \forall i \in L \quad (4a)$$

$$\sum_{k \in M} \sum_{j \in L} x_{jik} \geq SE_i; \forall i \in L \quad (4b)$$

$$y_i \leq NSE_i; \forall i \in L \quad (4c)$$

$$\sum_{k \in M} \sum_{j \in L} x_{ijk} + \sum_{k \in M} \sum_{j \in L} x_{jik} = 2y_i; \forall i \in L \quad (5)$$

$$z_i + TT_{ijk} - MT_{ij}(1 - x_{ijk}) \leq z_j; \forall i, j \in L \forall k \in M \quad (6a)$$

$$a_i \leq z_i \leq b_i; \forall i \in L \quad (6b)$$

$$y_i \geq R_i; \forall i \in L \quad (7)$$

$$y_i \geq Cat_i^c; \forall i \in L \quad (8)$$

$$x_{ijk}, y_i \in \{0, 1\}; \forall i, j \in L \forall k \in M \quad (9a)$$

$$z_i \geq 0; \forall i \in L \quad (9b)$$

Constraints(Cont.)

$$\sum_{i \in L} \sum_{j \in L} \sum_{k \in M} TC_{ijk} x_{ijk} + d_{cost}^+ - d_{cost}^- = G_{cost} \quad (10)$$

$$\sum_{i \in L} \sum_{j \in L} \sum_{k \in M} TT_{ijk} x_{ijk} + d_{time}^+ - d_{time}^- = G_{time} \quad (11)$$

$$\sum_{i \in L} ST_i y_i + d_{satisfaction}^+ - d_{satisfaction}^- = G_{satisfaction} \sum_{i \in L} y_i \quad (12)$$

$$d_g^+, d_g^- \geq 0; \forall g \in G \quad (13)$$

MATH MODEL FOR MULTI-OBJECTIVE LINEAR PROGRAMMING



Parameter

- N = the number of locations,
 C = the category for each location,
 L = set of locations,
 S = set of sub-tour; $S \subset L$,
 M = set of transportation modes; i.e. $M = \{\text{walking, taxi}\}$,
 G = set of goals; i.e. $G = \{\text{cost, time, satisfaction}\}$,
 SE_i = 1 if tourists start at location i (MRT station); $i \in L$,
0; otherwise,
 NSE_i = 0 if tourists don't start at location i (MRT station); $i \in L$,
1; otherwise,
 Cat_i^c = 1 if tourists travel location i that is in the required category; $i \in L, c \in C$,
0; otherwise,
- D_{ijk} = distance from location i to location j by transportation mode k ; $i, j \in L, k \in M$,
 T_{ijk} = travel time from location i to location j by transportation mode k ; $i, j \in L, k \in M$,
 C_{ijk} = cost from location i to location j by transportation mode k ; $i, j \in L, k \in M$,
- SP_i = time spent in location i ; $i \in L$,
 E_i = entrance fee of location i ; $i \in L$,
 ST_i = satisfaction of location i ; $i \in L$,
- TT_{ijk} = total time from location i to location j ; $i, j \in L, k \in M, TT_{ijk} = T_{ijk} + SP_i$,
 TC_{ijk} = total cost from location i to location j ; $i, j \in L, k \in M, TC_{ijk} = C_{ijk} + E_i$,

Parameter(Cont.)

a_i = time window open of location i ; $i \in L$,

b_i = time window end of location i ; $i \in L$,

MT_{ij} = large value for time window; $MT_{ij} = \{b_i + TT_{ij} - a_j, 0\}$; $i, j \in L$,

Decision variables

x_{ijk} = 1; if tourists travel from location i to j by transportation mode k ; $i, j \in L, k \in M$,
0; otherwise,

y_i = 1; if tourists travel from location i ; $i \in L$,
0; otherwise,

z_i = time instant that starts at location i ; $i \in L$,

Objectives

$$\text{Min} \sum_{i \in L} \sum_{j \in L} \sum_{k \in M} TC_{ijk} x_{ijk}$$

$$\text{Min} \sum_{i \in L} \sum_{j \in L} \sum_{k \in M} TT_{ijk} x_{ijk}$$

$$\text{Max} \sum_{i \in L} ST_i y_i$$

Constraints

$$\sum_{k \in M} \sum_{i \in L, i \neq j} x_{ijk} \leq 1; \forall j \in L \quad (1a)$$

$$\sum_{k \in M} \sum_{j \in L, i \neq j} x_{ijk} \leq 1; \forall i \in L \quad (1b)$$

$$\sum_{k \in M} \sum_{i, j \in S} x_{ijk} \leq |S| - 1; \forall S \subset L \quad (2)$$

$$\sum_{k \in M} \sum_{j \in L} x_{ijk} = \sum_{k \in M} \sum_{j \in L} x_{jik}; \forall i \in L \quad (3)$$

$$\sum_{k \in M} \sum_{j \in L} x_{ijk} \geq SE_i; \forall i \in L \quad (4a)$$

$$\sum_{k \in M} \sum_{j \in L} x_{jik} \geq SE_i; \forall i \in L \quad (4b)$$

$$y_i \leq NSE_i; \forall i \in L \quad (4c)$$

$$\sum_{k \in M} \sum_{j \in L} x_{ijk} + \sum_{k \in M} \sum_{j \in L} x_{jik} = 2y_i; \forall i \in L \quad (5)$$

$$z_i + TT_{ijk} - MT_{ij}(1 - x_{ijk}) \leq z_j; \forall i, j \in L \forall k \in M \quad (6a)$$

$$a_i \leq z_i \leq b_i; \forall i \in L \quad (6b)$$

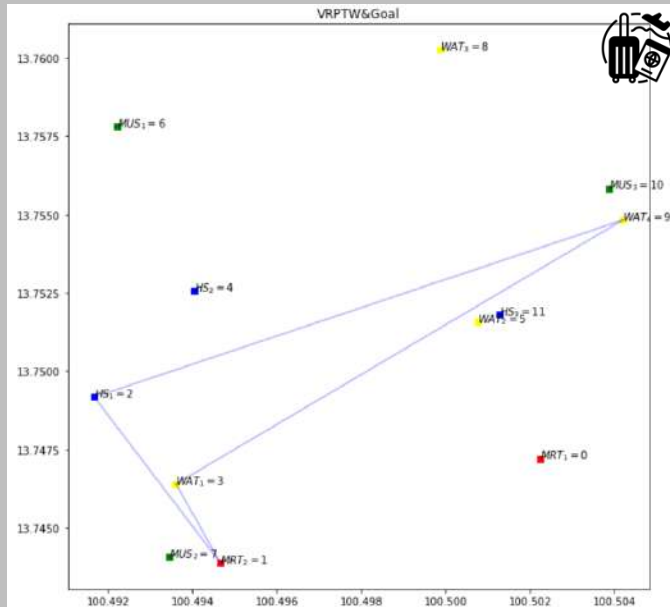
$$y_i \geq Cat_i^c; \forall i \in L \quad (7)$$

$$x_{ijk}, y_i \in \{0,1\}; \forall i, j \in L \forall k \in M \quad (8a)$$

$$z_i \geq 0; \forall i \in L \quad (8b)$$

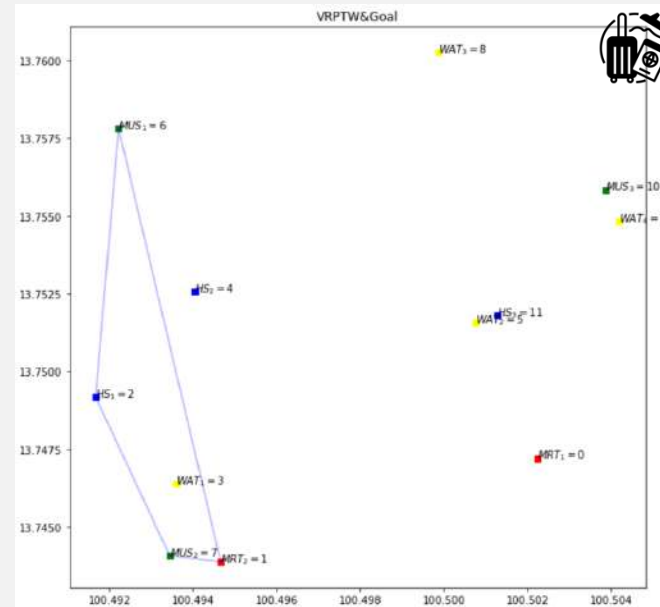
RESULT

Priority	Goal	Target value	Actual value
1	Cost(Baht)	1000	1000
2	Time(Minute)	200	202
3	Satisfaction	4.5	4.5



Priority	Goal	Target value	Actual value
1	Cost(Baht)	1000	998
2	Time(Minute)	200	208
3	Satisfaction	4.5	4.567

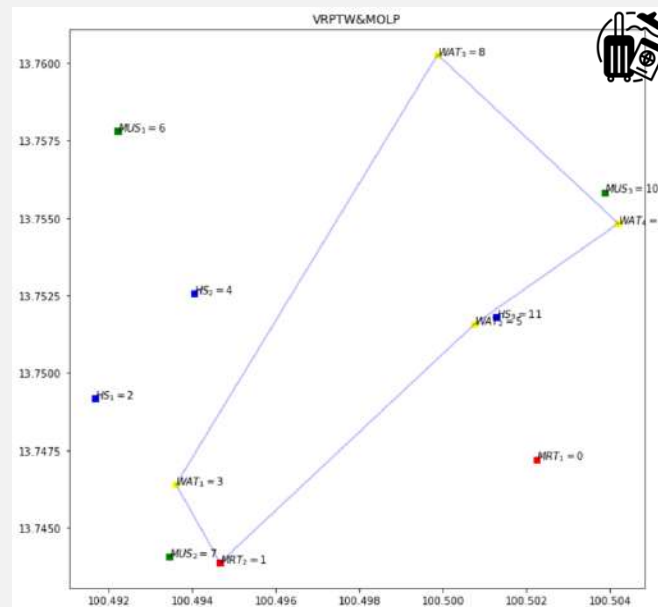
With the requirement to travel Bangkok National Museum



RESULT

No.	Objective	Actual value
1	Cost(Baht)	340
2	Time(Minute)	324
3	Satisfaction	4.59

Multi-objective with the requirement to travel to temple



The image features a white background with the text 'THANK YOU' centered in a bold, dark teal font. In the top-right and bottom-left corners, there are decorative geometric shapes. These shapes are composed of teal and orange colors, with a white diagonal line running through them. The teal shapes are larger and more prominent, while the orange shapes are smaller and positioned within the teal shapes.

THANK YOU