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One-Day Trip Itinerary Planning for Visitors to Songkhla City

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Abstract: One-day trip itinerary planning has gained increasing attention in secondary cities such as Songkhla, which is renowned for its rich cultural heritage and natural attractions. However, systematic approaches to designing itineraries under strict time constraints remain limited. This study aims to evaluate the effectiveness of three routing methods for one-day itinerary planning in Songkhla City: (1) Nearest Neighbor Heuristic (NNH), (2) Saving Algorithm (SA), and (3) a mathematical optimization model solved using LINGO software. The analysis utilizes real-world data from ten prominent tourist destinations in Songkhla City. Results indicate that all three methods successfully generated two sub-routes, each constrained to a maximum duration of 360 minutes. Among them, the mathematical model yielded the most optimal solution, minimizing the total travel distance to 56.20 kilometers and total travel time to 619 minutes. The Saving Algorithm (SA) achieved near-optimal results (57.68 kilometers, 625 minutes), while the Nearest Neighbor Heuristic (NNH) method, although slightly less accurate (57.72 kilometers, 671 minutes), proved advantageous in terms of computational efficiency and implementation simplicity. These findings highlight the trade-off between optimality and computational effort, emphasizing the importance of selecting suitable methods based on problem scale and constraints. The study provides strategic insights into developing efficient and sustainable itinerary planning frameworks for tourism in emerging secondary cities.

Keywords: One-day trip; heuristics; mathematical model; itinerary planning

1. Introduction

The tourism industry plays a pivotal role in driving Thailand's economic development, particularly in the southern region, which is endowed with rich natural and cultural resources. Key provinces, such as Phuket, Krabi, and Surat Thani, have emerged as internationally renowned destinations, contributing significantly to the national service sector's gross domestic product [1]. However, the concentration of tourists in these popular areas has exerted pressure on natural resources, while high-potential provinces like Songkhla, Nakhon Si Thammarat, and Trang remain underdeveloped and insufficiently promoted [2]. Songkhla, a coastal province, is notable for its rich historical and cultural heritage, particularly in the Songkhla Old Town area, where Chinese, Thai, and Western architectural styles coexist, reflecting the region's prosperous past [3]. The city also features a variety of attractions that integrate natural and cultural assets, such as Samila Beach with its iconic Golden Mermaid sculpture, Tang Kuan Hill with panoramic city views, and Ko Yo Island, which is home to cultural landmarks and temples situated on the shores of Songkhla Lake.

In 2024, Songkhla recorded more than 6.9 million visitors, representing a 24.53% increase from 2023, and generated over 50 billion baht in tourism revenue. The majority of international visitors originated from Malaysia, Indonesia, Singapore, Laos, and China [4]. Despite the consistent growth in tourist numbers, effective itinerary planning, particularly for one-day trips catering to tourists with limited time, remains underdeveloped. Efficient route sequencing, time management, and the incorporation of time window constraints are critical components that directly affect tourists' experiences. However, there is a noticeable lack of comprehensive research on these aspects specific to Songkhla. Previous studies have predominantly focused on major tourist destinations, such as Phuket or Chiang Mai, utilizing mathematical models and engineering-based approaches, including the traveling salesman problem (TSP) and the vehicle routing problem (VRP), to optimize tourism routes [5, 6]. Nonetheless, these approaches often lack flexibility and fail to address the local context and constraints of secondary cities like Songkhla. Furthermore, the integration of heuristic techniques, such as the Nearest Neighbor Heuristics (NNH) and the Saving Algorithm (SA), which are noted for their computational speed and ease of use with explicit time-based constraints, remains limited, despite their potential in enhancing real-world decision-making for tourists [7-9].

This research article presents a one-day trip itinerary planning framework for exploring Songkhla City, applying both heuristic methods and a mathematical model under time window constraints. The heuristic methods adopted include the Nearest Neighbor Heuristic (NNH) and the Saving Algorithm (SA) Method, which are known for reducing computational time and offering practically efficient routes. The primary objective of this study is to support tourists in planning effective and personalized one-day itineraries in Songkhla that align with both temporal constraints and individual preferences. The findings aim to contribute strategically to the enhancement of tourism management in Songkhla City, ultimately promoting more efficient and sustainable tourism development in the future.

2. Application of Heuristics Method and Mathematical Models

Efficient tourism route planning is a crucial factor in enhancing tourist satisfaction, particularly in the context of one-day trips, which are constrained by limited time. The application of heuristic techniques and mathematical models has gained popularity as an effective approach to solving tourism routing problems, as these methods can provide high-quality solutions within a limited timeframe [10].

2.1 Nearest Neighbor Heuristics (NNH) Method

The NNH is a widely used technique in tourism route planning due to its simplicity and efficiency in generating initial solutions. Although it does not guarantee the optimal solution, it serves as a practical starting point for itinerary design [11]. The procedure for applying the NNH method to tourism route planning consists of the following steps:

(1) Begin by defining the starting point of the trip, which serves as the reference location for searching nearby attractions. This starting point may be a hotel, bus terminal, airport, or any other relevant location. Identify the tourist attraction that is closest to the reference point.

(2) Select the nearest tourist attraction and add it to the main route. Then, update this attraction as the new reference point for future searches.

(3) Identify the next unvisited tourist attraction that is closest to the current reference point. Estimate the cumulative travel and visit time if this attraction is added to the route. If the total time does not exceed the allowed trip duration, include the selected attraction in the main route.

(4) If the cumulative time exceeds the trip duration, terminate the current route. Then, check whether there are any remaining unvisited attractions. If so, repeat steps 1 to 3 until all attractions are assigned to one or more feasible routes.

2.2 Saving Algorithm (SA) Method

The SA method, originally proposed by Clarke and Wright [12], is one of the most widely adopted heuristic techniques used for minimizing travel distances and transportation costs. This approach is based on the concept of calculating savings generated by merging travel routes between pairs of tourist attractions. The methodology can be described in the following steps [11–13]:

(1) Select a starting point or reference location for the tour. Initially, this results in separate routes from the starting point to each tourist attraction.

(2) Calculate the travel time, distance, and cost savings (referred to as the saving value) using Equation (1):

$$S_{ij} = D_{0i} + D_{0j} - D_{ij} \quad (1)$$

Where:

i, j denote the tourist attractions

0 represents the starting point or reference location

S_{ij} is the distance saved by combining the routes to i and j

D_{0i} is the distance from the starting point to attraction i

D_{oj} is the distance from the starting point to attraction j

D_{ij} is the distance between attractions i and j

(3) Sort the values of S_{ij} in descending order.

(4) Construct tourism routes by pairing attractions i and j that yield the highest saving values.

(5) Repeat the process iteratively until all tourist attractions are included in the route(s), subject to travel constraints such as the total tour duration, which must not exceed the maximum allowable time as defined in the itinerary plan. The concept of savings is illustrated in Figure 1. The SA is a well-established theoretical framework in tourism route planning. Its logic is straightforward, and its implementation is relatively simple. The saving value (S_{ij}) represents the potential reduction in travel distance between two attractions. A higher saving value indicates a greater potential to reduce the total route distance.

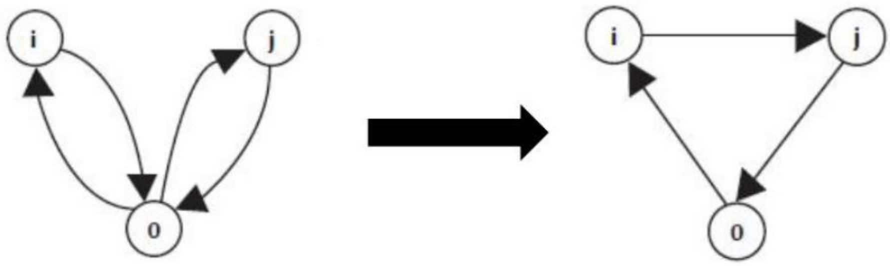


Figure 1. Conceptual of savings value. [11]

2.3 Mathematical Model

A mathematical model is a structured approach for solving allocation and resource optimization problems that involve relationships among multiple variables. The primary objective is to identify the optimal solution or the most beneficial course of action for a given system, considering the specified constraints or limitations. The standard components of a mathematical model include [13]: (1) decision variables and parameters, (2) constraints or restrictions, and (3) an objective function. In this research, the proposed mathematical model is formulated as a time-constrained tourism routing problem, also known as the time-window constrained traveling problem. The route starts and ends at the exact location, involving a visit to 10 tourist attractions within Songkhla City. The model is designed to reflect real-world scenarios of one-day tourism, where all selected attractions must be visited within a limited time frame and under predefined time windows [14]. Currently, various software tools are available for solving linear programming problems, such as Excel Solver and LINGO. This study employs LINGO software to solve the proposed model [15]. LINGO, developed by LINDO Systems in the United States, enables users to input mathematical expressions directly or define models using conventional mathematical notation. In the latter case, all variables and parameters must be declared explicitly, followed by the formulation of the objective function and constraints in LINGO syntax to obtain the optimal solution. This study presents a one-day trip itinerary planning approach for visiting Songkhla City, employing a mathematical modeling framework to identify the optimal solution under constraints of time and distance. The primary objective of the model is to minimize the total travel distance while ensuring that all selected tourist attractions are accessible within the designated time window. The model is designed to capture the essential decision-making components of the routing problem and incorporates the following elements:

(1) Decision variables

X_{ijk} = 1 if the route travels from node i to j in route k

X_{ijk} = 0 otherwise

Y_{ik} = 1 if tourist attraction i is visited in route k

Y_{ik} = 0 otherwise

U_i ≥ 0 : auxiliary variable used for subtour elimination (miller-tucker-zemlin (MTZ) formulation)

(2) Parameters

D_{ij} : distance between node i and node j (km)

t_i : visiting time at node i (minutes), with:

t_0 = 0 (Start and end at node Ho)

t_1 = 120, t_2 = 40, t_3 = 30, t_4 = 90, t_5 = 30,

t_6 = 30, t_7 = 30, t_8 = 30, t_9 = 40, t_{10} = 120

v = 60 km/h = 1 km/min

T_{max} = 360 minutes (maximum time per route)

N = 10: number of tourist attraction

M = 2: number of available routes

Index sets: i, j ∈ {0, 1, …, N}, k ∈ {1, 2}

(3) Objective function

minimize the total travel distance across both routes: using Equation (2)

$$\text{Min} \quad \sum_{i=0}^{N}\sum_{j=0}^{N}\sum_{k=1}^{M} D_{ij} X_{ijk} \tag{2}$$

(4) Constraints

(4.1) Coverage constraint: each tourist attraction must be visited exactly once in one of the two routes: using Equation (3)

$$\sum_{i=1}^{M} Y_{ij} = 1 \qquad \forall i \in \{1, \ldots, N\} \tag{3}$$

(4.2) Flow conservation: for every node in a route, the number of incoming and outgoing edges must match: using Equation (4) and (5)

$$\sum_{j=0}^{N} X_{ijk} = Y_{ik} \qquad \forall i \in \{1, \ldots, N\}, \forall k \in \{1, 2\} \tag{4}$$

$$\sum_{i=0}^{N} X_{ijk} = Y_{jk} \qquad \forall j \in \{1, \ldots, N\}, \forall k \in \{1, 2\} \tag{5}$$

(4.3) Start and end at depot (node 0): each route must start and end at the depot node (Ho): using Equation (6) and (7)

$$\sum_{j=1}^{N} X_{0jk} = 1 \qquad \forall k \in \{1, 2\} \tag{6}$$

$$\sum_{i=1}^{N} X_{i0k} = 1 \qquad \forall k \in \{1, 2\} \tag{7}$$

(4.4) Time constraint: total time (travel time + visiting time) must not exceed the maximum allowed time per route: using Equation (8)

$$\sum_{i=0}^{N}\sum_{j=0}^{N} \frac{D_{ij}}{v}.X_{ijk} + \sum_{i=1}^{N} t_i.Y_{ik} \le T_{max} \qquad \forall k \in \{1, 2\} \tag{8}$$

(4.5) Subtour elimination (MTZ constraints): using Equation (9)

$$U_i - U_j + N \,.\, X_{ijk} \le N\text{-}1 \qquad \forall i \ne j \in \{1, \ldots, N\}, \forall k \in \{1, 2\} \tag{9}$$

(5) Variable conditions: using Equation (10-12)

$$X_{ijk} \in \{0, 1\} \qquad \forall i,j \in \{0, \ldots, N\}, \forall k \in \{1, 2\} \tag{10}$$

$$Y_{ik} \in \{0, 1\} \qquad \forall i \in \{1, \ldots, N\}, \forall k \in \{1, 2\} \tag{11}$$

$$U_i \ge 0 \qquad \forall i \in \{1, \ldots, N\} \tag{12}$$

The one-day trip itinerary planning for visiting Songkhla City was conducted using a mathematical model developed and solved through Lingo software. The primary objective was to determine the most efficient travel plan in terms of minimizing the total travel distance, while simultaneously satisfying time constraints and ensuring that all designated tourist attractions were visited.

3. Results and Discussion

3.1 Data Collection

This study focuses on developing a one-day trip itinerary for visiting the city of Songkhla, incorporating ten popular tourist attractions. Private vehicles or rental cars were assumed to be the primary mode of transportation, with an average travel speed of 60 km/h. The researcher collected the geographic coordinates of major tourist sites in Songkhla for routing purposes. The BP Samila Beach and Resort (Ho) was selected as both the starting and ending point of the trip, as it is a popular accommodation choice among tourists. This location is situated at a latitude of 7.2140266 and a longitude of 100.5968600, according to Google Maps.

Table 1. Coordinates and visiting times for tourist attractions in Songkhla City.

Code	Tourist attraction	Coordinates (Latitude, Longitude)	Visiting time (minutes)
TA1	Koh Yo	7.1625439264314630, 100.54359928526166	120
TA2	General Prem Tinsulanonda Historical Park	7.1490522083543380, 100.56137037928802	40
TA3	Khao Kao Seng (Khao Kao Seng Temple)	7.1830935997878465, 100.61764270196703	30
TA4	Chalatat Beach-Samila Beach	7.2151756617667290, 100.59531766011072	90
TA5	Songkha City Park	7.2125770570205600, 100.59687456627293	30
TA6	Song Thale Park	7.2278169984735910, 100.57749037521063	30
TA7	Tangkuan Hill	7.2112713194156230, 100.58933755176975	30
TA8	Khao Noi	7.2109748113266940, 100.59274018229340	30
TA9	Songkhla National Museum	7.2025028068605340, 100.58850537794254	40
TA10	Songkhla Old Town	7.1953756321492170, 100.58999283805554	120

The coordinates and estimated visiting times for each tourist attraction are presented in Table 1. These data were used to evaluate the most appropriate travel routes, considering both the distances between tourist attractions and the distance from each attraction to the starting point. The pairwise distance matrix is provided in Table 2, which supports the optimal determination of routes.

Table 2. Distance matrix between tourist attractions (unit: kilometers).

Point	Ho	TA1	TA 2	TA 3	TA4	TA5	TA6	TA7	TA8	TA9	TA10
Ho	0.00	19.85	16.95	4.74	1.24	0.49	3.51	1.46	0.95	2.42	3.16
TA1	19.85	0.00	5.29	17.31	19.05	18.50	12.24	18.30	18.29	17.63	16.87
TA2	16.95	5.29	0.00	14.24	15.98	15.43	17.76	15.24	15.22	14.56	9.91
TA3	4.74	17.31	14.24	0.00	5.61	4.50	7.80	5.71	5.32	4.95	4.32
TA4	1.24	19.05	15.98	5.61	0.00	0.63	3.22	1.17	0.66	2.39	2.97
TA5	0.49	18.50	15.43	4.50	0.63	0.00	3.47	1.42	0.91	2.37	3.23
TA6	3.51	12.24	17.76	7.80	3.22	3.47	0.00	2.68	2.91	3.30	4.75
TA7	1.46	18.30	15.24	5.71	1.17	1.42	2.68	0.00	0.54	1.35	2.23
TA8	0.95	18.29	15.22	5.32	0.66	0.91	2.91	0.54	0.00	1.34	2.21
TA9	2.42	17.63	14.56	4.95	2.39	2.37	3.30	1.35	1.34	0.00	0.96
TA10	3.16	16.87	9.91	4.32	2.97	3.23	4.75	2.23	2.21	0.96	0.00

Note: Ho = BP Samila Beach and Resort

3.2 Nearest Neighbor Heuristics (NNH)

The NNH method was applied to plan a one-day tourism route for visiting the city of Songkhla. This approach constructs a travel route by iteratively selecting the next unvisited tourist attraction that is closest in distance to the current location. The process begins at the starting point (Ho) and continues until all designated destinations have been visited, concluding with a return to the origin. Based on the implementation results, as shown in Table 3, the itinerary was effectively divided into two main routes. Route 1 includes visits to seven attractions: TA5, TA4, TA8, TA7, TA9, TA6, and TA3, resulting in a total travel distance of 19.51 kilometers and an overall duration of 325 minutes. Route 2 covers three attractions: TA10, TA2, and TA1, with a total distance of 38.21 kilometers and a total travel time of 5 hours and 46 minutes. Both routes were designed to comply with the one-day travel constraint of a maximum of 360 minutes per route, thereby demonstrating the feasibility of using the NNH method for time-constrained tourism planning.

Table 3. Tourism route results using the NNH method.

Route	Tourist Attractions Visited	Distance (km)	Time (minutes)
1	Ho - TA_5 - TA_4 - TA_8 - TA_7 - TA_9 - TA_6 - TA_3 - Ho	19.51	325
2	Ho - TA_{10} - TA_2 - TA_1 - Ho	38.21	346

3.3 Saving Algorithm (SA)

The one-day tourism route planning for visiting Songkhla City was conducted using the SA method, which aims to determine an efficient sequence of travel that minimizes both the total travel distance and duration. This optimization is subject to a time constraint of no more than 360 minutes per route. The outcome of the implementation was divided into two main routes, as detailed in Table 4. Route 1 consists of visits to seven tourist attractions: TA9, TA6, TA7, TA8, TA4, TA5, and TA3. This route starts and ends at the origin point (Ho), covering a total distance of 19.47 kilometers and requiring a total travel time of 4 hours and 39 minutes. Route 2 includes three tourist attractions: TA1, TA2, and TA10, and also starts and ends at Ho. This route has a total distance of 38.21 kilometers and a total travel time of 5 hours and 46 minutes. Both routes fully comply with the 360-minute time constraint, ensuring feasibility for a one-day trip itinerary.

Table 4. Tourism route results using the SA method.

Route	Tourist Attractions Visited	Distance (km)	Time (minutes)
1	Ho - TA_9 - TA_6 - TA_7 - TA_8 - TA_4 – TA_5 - TA_3 - Ho	19.47	279
2	Ho - TA_1 – TA_2 – TA_{10} - Ho	38.21	346

3.4 Mathematical Model

The results obtained from solving the mathematical model with LINGO are presented in Table 5. The model generated two feasible travel routes. The first route starts from the origin (Ho), continues through tourist attractions TA6, TA1, TA2, and TA10, and returns to the origin. This route covers a total distance of 34.11 kilometers and takes 277 minutes. The second route begins at Ho, proceeds through TA3, TA9, TA7, TA8, TA4, and TA5, and returns to Ho, covering a distance of 13.36 kilometers in 342 minutes.

Table 5. Results of tourism route planning using the mathematical model with Lingo software

Route	Tourist Attractions Visited	Distance (km)	Time (minutes)
1	Ho - TA_6 - TA_1 – TA_2 - TA_{10} - Ho	34.11	277
2	Ho – TA_3 – TA_9 - TA_7 - TA_8- TA_4- TA_5 - Ho	13.36	342

These results demonstrate the model's capability to generate effective travel plans under real-world constraints, specifically time limitations and comprehensive coverage of all attractions. This highlights the potential of mathematical modeling as a robust tool for addressing tourism-related route optimization problems within a logistics context.

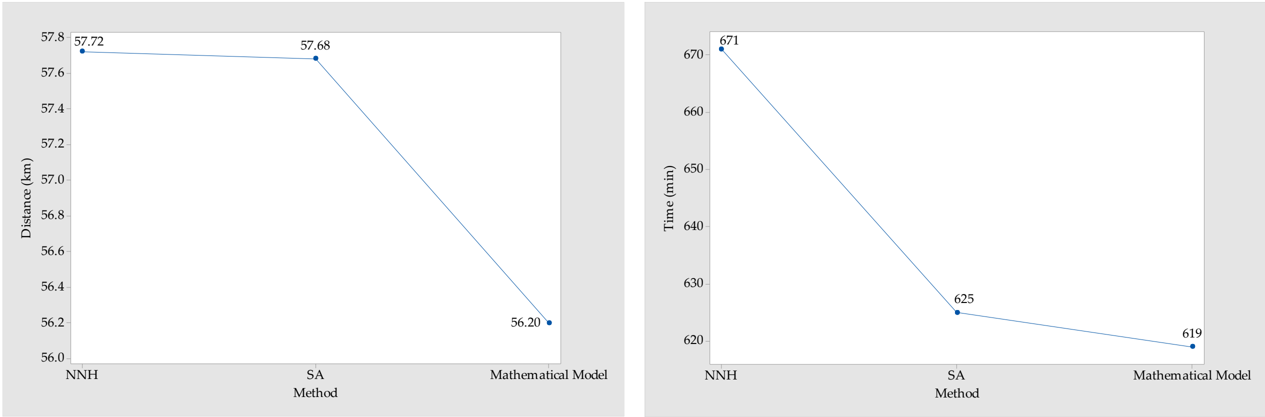
In summary, the mathematical model executed via Lingo software yielded the optimal solution for this small-scale problem. It can serve as a benchmark for comparison with heuristic methods in subsequent analyses or in studies involving larger and more complex problem instances.

3.5 Comparative Results of Route Planning Methods

This study applied three different methods to develop a one-day tourism itinerary for visiting Songkhla City: (1) Nearest Neighbor Heuristics (NNH), (2) the Saving Algorithm (SA), and (3) a mathematical model implemented using LINGO software. The outcomes derived from each method are summarized and compared in Table 6 and Figure 2.

Table 6. Comparison of tourism route planning results.

Method	Route	Tourist attractions	Distance (km)	Total Distance (km)	Time (min)	Total Time (min)
Nearest Neighbor Heuristics (NNH)	1	Ho - TA_5 - TA_4 - TA_8 - TA_7 - TA_9 - TA_6 - TA_3 - Ho	19.51	57.72	325	671
	2	Ho - TA_{10} - TA_2 - TA_1 - Ho	38.21		346	
Saving Algorithm (SA)	1	Ho - TA_9 - TA_6 - TA_7 - TA_8 - TA_4 - TA_5 - TA_3 - Ho	19.47	57.68	279	625
	2	Ho - TA_1 - TA_2 - TA_{10} - Ho	38.21		346	
Mathematical Model	1	Ho - TA_3 - TA_9 - TA_6 - TA_7 - TA_8 - TA_4 - TA_5 - Ho	17.99	56.2	277	619
	2	Ho - TA_1 - TA_2 - TA_{10} - Ho	38.21		342	



(a) Comparison of total distance per method. (b) Comparison of total time per method.

Figure 2. Comparison of results for each method.

According to Table 6, the mathematical model solved with LINGO provided the most optimal results in terms of both travel distance and total time. Based on the analysis in Figure 2(a), the mathematical model yielded the optimal result, with the shortest total travel distance of 56.20 kilometers. In contrast, the two heuristic methods produced similar but higher results: the SA recorded a near-optimal total distance of 57.68 kilometers, while the NNH had the highest total distance at 57.72 kilometers. This result clearly indicates that for the small-scale problem under consideration, the mathematical model can accurately determine the optimal solution in terms of distance. In terms of total time (Figure 2(b)), the mathematical model again yielded the best result, with the shortest total time of 619 minutes. The SA followed closely at 625 minutes, exhibiting performance remarkably similar to that of the mathematical model. In contrast, the NNH had a significantly higher total time of 671 minutes. Although NNH is the simplest and quickest method for computation, it proved to be the least efficient in terms of total travel time and visiting time. These comparative results confirm that the mathematical model can provide the optimal solution for small-scale routing problems, serving as a benchmark against which other methods can be compared. However, the heuristic methods demonstrated their practical value, particularly the SA, which delivered near-optimal results for both distance and time. Although the mathematical model provides a perfect solution, it comes at the cost of higher processing time, which may be impractical for large-scale problems. Conversely, while heuristic methods do not guarantee optimality, they offer greater speed and flexibility, making them a highly suitable alternative for large-scale problems or real-time planning. Therefore, the choice of method depends on the problem's context and the trade-off between the demand for accuracy and the constraints of computational resources. Therefore, as the problem size increases (e.g., more tourist sites or complex constraints), the mathematical model may become less practical due to time and resource limitations. In such contexts, heuristic methods become more suitable in practice. A high-level conceptual comparison of each method is summarized in Table 7.

Table 7. Conceptual comparison of routing methods.

Comparison criteria	Mathematical model	Nearest Neighbor Heuristics	Saving Algorithm
Method type	Exact (mathematical)	Heuristic	Heuristic
Solution quality	Optimal	Suboptimal	Near-optimal
Computational time	High	Very low	Low
Suitability for small problems	High	Moderate	High
Suitability for large problems	Low (time-intensive)	High	High
Ease of development/use	Moderate to difficult	Very easy	Moderate

In conclusion, for small-scale problems where high accuracy is critical, the mathematical model is the most appropriate choice. However, for large-scale scenarios or applications requiring real-time responsiveness, heuristic methods such as NNH or SA are more practical alternatives.

3.6 Discussion

The findings of this study present a comparative analysis of three routing approaches: NNH, the SA, and a mathematical model solved via LINGO for a one-day trip itinerary for visitors in Songkhla City under time window constraints. Among the three methods, the mathematical model yielded the optimal results in terms of minimizing both total travel distance (56.2 kilometers) and total travel time (619 minutes), aligning with previous studies [6, 11] suggesting that exact methods are well-suited for small-scale, constraint-intensive routing problems [14]. However, heuristic approaches offer significant advantages in terms of computational speed and ease of implementation. The SA, in particular, produced near-optimal results (57.68 kilometers, 625 minutes), demonstrating its effectiveness in consolidating routes based on the principle of distance savings. Meanwhile, the NNH, though providing a slightly less optimal outcome (57.72 kilometers, 671 minutes), was the fastest and simplest method, making it highly suitable for real-time applications or large-scale systems [13, 15]. These findings underscore the inherent trade-off between accuracy and efficiency. While mathematical models can guarantee optimality, heuristic methods provide the flexibility and practicality needed in scenarios constrained by time or computational resources. This hybrid analysis provides strategic insights into tourism route planning, particularly in secondary cities like Songkhla, where both logistical efficiency and feasibility of implementation must be considered. Moreover, this research contributes to bridging existing gaps in the literature and supports the advancement of sustainable tourism by promoting improved accessibility and equitable distribution of tourist flows across urban areas [7]. The integration of mathematical and heuristic approaches presents a balanced framework for optimizing travel itineraries in real-world tourism contexts.

4. Conclusions

This study focused on planning one-day trip itineraries for visitors to Songkhla City. Songkhla is a secondary city in Thailand with significant tourism potential but lacks efficient routing strategies, particularly under time window constraints. The research aimed to compare the performance of three primary route planning methods: (1) the Nearest Neighbor Heuristic (NNH), (2) the Saving Algorithm (SA), and (3) a mathematical model developed and solved using LINGO software. The findings revealed that the mathematical model provided the most accurate and optimal solution for small-scale problems, yielding the shortest total travel distance (56.20 kilometers) and travel time (619 minutes), while satisfying the time constraint of no more than 360 minutes per route. Meanwhile, both heuristic methods demonstrated rapid computation and practical applicability, particularly in cases involving a larger number of tourist attractions or where real-time planning is required. Although heuristic methods do not guarantee optimality, they offer substantial benefits in flexibility and efficiency. Specifically, the comparative evaluation showed that: (1) the mathematical model delivered the most precise results but required the longest computation time, (2) Nearest Neighbor Heuristics (NNH) offered the most straightforward implementation and the lowest processing time but yielded suboptimal solutions, and (3) the Saving Algorithm (SA) achieved near-optimal performance, closely approximating the results of the mathematical model while maintaining low computation time. In summary, the choice of routing method should be guided by the problem context. For small-scale problems that demand high accuracy, the mathematical model is the most suitable. In contrast, for large-scale problems requiring rapid decision-making, heuristic methods offer a more practical solution. This research contributes to the development of strategic frameworks for tourism route planning in secondary cities such as Songkhla and provides a foundation for more efficient and sustainable tourism management in the future.

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