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Heuristic technique for tour package models

Aida Mauziah Benjamin*, Syariza Abdul Rahman, Engku Md Nazri A. Bakar

School of Quantitative Science, Universiti Utara Malaysia, 06010 Sintok, Malaysia

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Abstract

Tourists can be defined as people who travel to and stay in places outside their usual environment for leisure, business and other purposes. Since they are traveling in a different environment, it is impossible for them to visit all places within limited time and budget. Thus, in this paper tour package models using heuristic approach were proposed with the main objective of covering as many places as possible in a given geographical area particularly in the island of Langkawi. The proposed models considered only one starting point where the tour starts and ends at an identified hotel. The models were developed from a list of 11 restaurants for lunch and dinner and 37 most attractive places in the island. Each hotel/restaurant/place that is to be visited has its own time windows. In addition, we also took into consideration lunch and dinner periods. Tour packages with three different time constraints (1-day, 2-day and 3-day tour packages) were presented. For tour package, two models involving limited and unlimited budget constraint were proposed. The results showed that both models suggested the same number of places to be visited. The only difference between the models was that each model suggested different places to be visited where the limited budget model generated places with less entrance fees compared to the unlimited budget model.

Keywords: tour packages; heuristic; tourist satisfaction, Langkawi island

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1. Introduction

Tourism is a dynamic and competitive industry that requires the ability to constantly adapt to customers' changing needs and desires, as the customer's satisfaction, safety and enjoyment are particularly the focus of tourism businesses. In relation to the tourism industry, tour packaging has a significant association in providing services to the tourists. It has been around since the 1800's, when Thomas Cook began offering continental tours and arranged for his clients to be given discounted hotel rates [1]. In designing appropriate tour packages, it is keys for the tour operators to understand who the visiting markets are.

A tour package is a prearranged tour that includes products and services such as food, activities, accommodation, and transportation, which are sold at a single price [1]. The packages can be sold to an individual person or to a group of people depending on tour operators' preference and the preference of the people they are selling their tour to. They are two types of packages: independent and packaged. An

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* Corresponding author. Tel.: +6049286971; fax: +6049286906.

E-mail address: mauziah@uum.edu.my.

independent tour is when the guests choose from a variety of components offered by the supplier while a packaged tour is one where the components and time table are pre-set. Tour packages can also be separated into two categories: multi-day tour packages and single-day tour packages. A multi-day package is a package that includes a combination of components such as food, activities and overnight stays at one or more locations. Each day is filled with one or more activities, breaks, transportation (if needed), meals, and then sleep at the location. A multi-day package is considered to be two or more planned days. When planning a multi-day package it is important to look at the target market so that the activities, themes and price are correct. On the other hand, a single day tour package, or day trip, includes a combination of components; however, accommodation is something that the guest must reserve and pay for separately. A successful tour package adds value to the goods and services offered. Specifically, in situations where cost is a significant consideration in a tourist's decision to buy, providing the services at a reasonable cost is important to the success of the business [1].

[11] stated that overall convenience and tour economies are the most frequently cited reasons for travelers purchasing a package tour. Travelers normally expect package tours to be the best method of seeing as much as possible combined with comfort, scenery and experienced tour guides [4]. [5] indicated that a package tour is a rational and effective way for tourists to visit the largest number of sites on a trip in a given period, to travel in a relatively safe way to faraway countries with strange cultures, to avoid unreliable transportation and doubtful standards of hygiene, while being usually less expensive than taking an individual trip to the same destination.

The purpose of this paper was therefore to develop tour package models that are able to maximize the total number of sites/attractions visited using heuristic technique while at the same time taking into consideration the budget limitation. The paper is organized as follows. Section 2 discusses a review on tour package factors that affect tourist satisfaction. The scope of the study and the heuristic algorithm used to develop the tour package models are provided in Section 3. Section 4 presents the experimental results of the proposed model and finally Section 5 gives the conclusion of the study.

2. Tour packages and factors influencing tourist satisfaction

A number of studies appeared in the literature discussing tour package services in maximizing tourist total satisfaction. For example, [6] showed the trend of service customization for the package-tour services. The concept of customization that allows consumer to specify the product or service characteristics that they desire is said to increase customer satisfaction. This concept was applied by [10] to develop an interactive system of personalized tourism route that can produce itinerary best suited to the tourists needs.

Another factor that contributes to the total tourist satisfaction is popularity of sites to be visited. This has been shown by [2], [9], [7], [3] and [8]. [2] and [9] solved a time constrained routing problem by scheduling the visit of a tourist to a given geographical area in order to maximize tourist satisfaction degree whilst respecting time windows restrictions using LP-based heuristic. [7] and [3] considered the one-period bus touring problem (BTP) to maximize the total attractiveness of the tour by selecting a subset of sites to be visited and scenic routes to be traveled. [8] employed the BTP with time windows (BTPTW) to maximize the total attractiveness of the tour by selecting a subset of sites to be visited and scenic routes to be traveled while observing time windows associated to each of the network items (tourist sites and scenic road segments).

Based on the discussion above, factors that affect the tourist satisfaction are tourist personal preferences, popularity of sites and economic tour package. However, [5] indicated that a package tour that covers the largest number of sites on a trip in a given period also plays an important role to the tourist satisfaction.

3. Methodology

Most of the studies in the literature focused on the popularity of sites to be visited. However, this study aimed to propose a tour package that could cover as many places as possible in a limited time. The tour package was meant for a group of tourist. Two assumptions were made:

i. The entire group members stay at the same hotel, which also serves as the starting and ending location for the tour.
ii. The places that were considered in this study are the most popular places in a given geographical area and they were assumed to have equal popularity.

In coming up with the tour package, the following data were gathered:

i. The hotel where the tourists are staying.
ii. The potential places/sites to be visited and cost of visiting each place.
iii. The potential suitable restaurants/eateries.
iv. Traveling time between each pair of places/sites/restaurants.
v. The time spent at each place/site/restaurant.
vi. The budget allocated by the tourists.

The formulation of the heuristic algorithm was as follows:

3.1. Notation

Let $\boldsymbol{P}$ be the set of places and $\boldsymbol{R}$ be the set of restaurants. To represent the hotel, places and restaurants we indexed them such that 0 is the hotel, 1, 2, …, $|R|$ are the restaurants and $|R|+1$, $|R|+2$, …, $|R|+|P|$ are the places. We denoted the travel time between i and j by $\boldsymbol{t_{ij}}$ and the distance between them by $\boldsymbol{d_{ij}}$ (where i and j may be the hotel, restaurants or places). The notation was conveniently structured as that relating to the tour package or places/restaurants/hotel. For the tour package we let:

- $\boldsymbol{K}$ be the number of days of the tour package, so a number of K-day itineraries would be developed.
- $\boldsymbol{C}$ be the maximum budget of the tour package.
- $\boldsymbol{[l_1,l_2]}$ be the lunch time window so that the lunch period must start at some time within this period, the lunch duration being $\boldsymbol{l_3}$.
- $\boldsymbol{[d_1,d_2]}$ be the dinner time window so that the dinner period must start at some time within this period, the dinner duration being $\boldsymbol{d_3}$

For the places/restaurants/hotel we let:

- $\boldsymbol{F_i}$ be the entrance fee of place $i \in P$
- $\boldsymbol{S_i}$ be the time spent for $i \in P$ such that the visit to i (for place) takes this (fixed) time
- $\boldsymbol{G}$ be the fixed cost of the tourist guide per person/day
- $\boldsymbol{B}$ be the fixed cost of the tour bus per person/day
- $\boldsymbol{[E_i,L_i]}$ be the time window for $i \in P \cup R \cup \{0\}$ such that the visit to $i \in P \cup R$ must start within this time period and the tour must start/return to the hotel within $\boldsymbol{[E_0,L_0]}$

3.2. Heuristic Algorithm

Initialise

Set:

$\boldsymbol{K_{total}}$ **= 1** is the total number of itinerary that has been developed.
$\boldsymbol{C_{total} = (B + G) \times K}$ is the total (fixed) cost of K days of a tour package.
$\boldsymbol{V=P}$ is a working set of places that still can be visited.
$\boldsymbol{Z}$ **= 0** is the total number of places that has been visited.

Step 1

If $\boldsymbol{K_{total} \leq K}$ (there is still itinerary to be developed) and $\boldsymbol{C_{total} \leq C}$ (there is still available budget to be spent) and $\boldsymbol{|V| \neq 0}$ (there are still places that could be visited) **then** starts a tour route at time $\mathbf{E_0}$

$T=E_0$	T is the current time.
r=0	r is the place at the end of the current emerging tour route.
lunch=0	*lunch* is 1 if the tour has had its lunch period, else 0.
dinner=0	*dinner* is 1 if the tour has had its dinner period, else 0.

else

tour package's itinerary is completed, so **stop.**

end if

Step 2

Check for the lunch and dinner period – here we started the lunch/dinner period as soon as practicable

If ***lunch=0*** (the tour has not had a lunch period) and $\boldsymbol{T \in [l_1, l_2]}$ **then:**

the tour now has its lunch period

lunch=1	update *lunch*
$T=T+t_{i,restaurant}+l_3$	update the current time
r= restaurant	update the current place at the end of the route

go to step 2

end if

If ***dinner=0*** (the tour has not had a dinner period) and ***lunch=1*** (the tour already had a lunch period) and $\boldsymbol{T \in [d_1, d_2]}$ **then:**

the tour now has its dinner period and after finish, return to the hotel

dinner=1	update *dinner*
$T=T+t_{i,restaurant}+d_3+ t_{restaurant,0}$	update the current time
r= restaurant	update the current place at the end of the route

go to step 1

end if

Step 3

The next place to be visited on the current emerging route is that place $i \in V$ such that

$$\boldsymbol{i=\arg\min[S_j \mid j \in V,\ T+t_{rj}+0.1(t_{rj}) \in [E_j, L_j],\ C_{total}+F_j+0.1(F_j) \leq C,\ \theta=T+t_{rj}+0.1(t_{rj})+}$$

$S_j + t_{j,restaurant} + 0.1(t_{j,restaurant})$ so if lunch=0 then $\theta \leq l_2$, if lunch=1 and dinner=0 then $\theta + d_3 + t_{restaurant,0} + 0.1(t_{restaurant,0}) \leq L_0$

This place *i*, has the minimum time spent and it also has the shortest travel time from the place r at the current end of the tour route, provided i satisfies the conditions seen above. This expression is relatively complex. Here we considered only those places *j* such that when the tour arrives at *j* (at time $T+t_{rj}$) it will be possible to visit the places as the visit will fall in its time window $[E_j,L_j]$ and the total cost we have spent (including the entrance fee of *j*) is within the budget. In the above expression θ is the time at which the tour travels to *j* (t_{rj}), and spending time at *j* (S_j), then the tour travels to the nearest open restaurant, taking time $t_{j,restaurant}$. Thus, the place *j* has to be such that if the tour has not yet had its lunch period (lunch=0) there is still time after visiting *j* for the lunch period to be started ($\theta \leq l_2$) at the nearest restaurant to *j*. Or if the tour already had its lunch period, *j* also has to be a place such that if *j* is visited there is time for the tour to have dinner to the nearest restaurant to *j*, where dinner takes time d_3, and then the tour returns to the hotel taking time $t_{restaurant,0}$, arriving before L_0. In addition, our model also takes into consideration of contingency cost and travel time. For example, 10% of the entrance fee is included every time the total cost that we have spent, $\boldsymbol{C_{total}}$ is updated, and 10% of the travel time is included when current time, $\boldsymbol{T}$ is updated.

If there is a place *i* satisfying the above expression that we could add to the end of the emerging route then:

the tour travels to *i*	
$T=T+t_{ri}+S_i$	update the current time
$r=i$	update the current place at the end of the route
$C_{total}=C_{total}+F_i$	update the total cost has spent
$V=V-\{i\}$	update the set of customers *B* by removing *i* from it
Z=Z+1	update the total number of places that have been visited
go to step 2	

else (when we have not found a place to add to the end of the emerging route)

$T=T+t_{r0}$	return to the hotel and update the current time
$K_{total}= K_{total}+1$	update the number of itinerary to be developed
go to step 1	

end if

In step 1, we started a new tour route and initialised the various counters. We needed to keep track of the tour package limitations. In step 2 we attempted to schedule the lunch and dinner periods. In step 3 we added a place to the end of the emerging route such that it is feasible to add the place in terms of the available budget and the time windows of the place, restaurant and the hotel. The above procedure terminated when one of the tour package limitations in the step 1 was violated.

4. Experiment and Results

The algorithm was tested to propose a multi-day packaged tour that could give suggestions to the customers on the tour plan for predefined days while aiming for their total satisfaction of the suggested plan.

For this, the island of Langkawi, one of Malaysia best worldwide tourist attractions was chosen. Langkawi is a suitable choice since it has many categories of attractions for the tourists such as forests, beaches and sun, historical and cultural sites as well as tax-free shopping.

Two types of models were proposed. The first model considered unlimited budget and the second model considered budget limitation for producing the tour package. The aim was to maximize the number of places to be visited within time window by considering opening time of each place, lunch time and dinner time. For each model, three different number of days were proposed which are K = 1, 2, or 3.

In generating the tour packages the fixed cost of transportation and tour guide were included in the overall cost. Each potential place to be visited was also allocated a reasonable spending time. For example, time spent for a day cruise is half of the day due to a fixed departure and arrival time. On the other hand, spending time at a museum lasts for an hour. The spending time for lunch and dinner is one hour each. The tour starts and ends at the same hotel.

4.1. Experimental Results

In this study we considered only one starting point where we start and end the tour at an identified hotel. 11 restaurants for lunch and dinner and 37 most attractive places in Langkawi were identified as candidate places to be visited. A suitable site identification (ID) was given to every site (hotel, restaurants and places) as shown in Table 1.

Table 1. ID of every site.

Site_ID	**Site**
0	Hotel
1 to 11	Restaurants
12 to 48	Attractive places

Table 2 provides experimental results with three different time constraint (K=1, 2, and 3). The results of the unlimited and limited budget constraint were compared for every K. The aim was to produce tour packages with maximum number of place to be visited within the time constraint. As can be seen, the proposed tour packages can cover many places with variety of places within the time window of the places. The numbers in Table 2 represents the ID of the proposed site.

Table 2. Itinerary for K = {1, 2, 3} day(s) with unlimited and limited budget constraint.

	K =1		K = 2				K = 3					
	Unlimited budget	Limited budget (RM50)	Unlimited budget		Limited budget (RM100)		Unlimited budget			Limited budget (RM150)		
	Day 1	Day 1	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
	0	0	0	0	0	0	0	0	0	0	0	0
	46	46	46	35	46	35	46	35	20	46	35	20
	36	3 6	36	26	36	26	36	26	22	36	26	22
	45	45	45	25	45	25	45	25	**42**	45	25	31
	43	43	43	5	43	5	43	5	4	43	5	7
	6	6	6	23	6	23	6	23	31	6	23	30
	29	29	29	21	29	21	29	21	30	29	21	**48**

	33	33	33	24	33	24	33	24	27	33	24	19
	32	28	32	**44**	32	**27**	32	**44**	19	32	27	**38**
	28	18	28	7	28	7	28	7	8	28	7	3
	18	8	18	0	18	0	18	0	0	18	0	0
	8	0	8		8		8			8		
	0		0		0		0			0		
No. of proposed sites	9	8	16		16		23			23		
Total cost (RM)	50.30	45.90	143.50		88.50		223.50			148.70		

Based on Table 2, for a day trip (K=1) it can be seen that with unlimited budget the proposed tour package is able to cover nine places with a total cost of RM50.30 per person. On the other hand, the proposed tour package with limited budget (RM50) can cover only eight places with the cost of RM45.90 per person. The difference between these two packages is that the unlimited budget constraints tour is able to visit site **32** (as highlighted in the table) while, this place is not included in the limited budget tour. Since the entrance fee for site 32 is RM4 and the contingency cost is RM0.40 (10% of the entrance fee), adding this place to the limited budget tour model would result in a total budget that exceeds RM50 (45.90+4+0.40=50.30).

Nevertheless, the total number of places that can be visited under limited and unlimited budget for K=2 and K=3 are similar which are 16 and 23 locations, respectively. However, the entrance fee to some of the locations affected the results whereby, the proposed places in the limited budget tour involve locations with cheaper entrance fee compared to the proposed places in the unlimited budget tour. For example, for K=2 with unlimited budget, 16 places can be visited with a total cost of RM143.50, while with the limited budget tour (RM100) only RM88.50 cost per person is required. The other difference between these two packages is that the unlimited budget tour suggests site **44** to be visited on the second day, whereas the limited budget tour suggests site **27**. The entrance fee for site 44 is RM50 and the contingency cost is RM5 (10% of the entrance fee). Adding this place to the tour package will violate the budget of RM100 (RM88.50+50+5=143.50). Thus for limited budget tour, the available place after visiting site 24 is site **27** (with no entrance fee), and not site **44** (as highlighted in the table).

The same goes for K=3. Even though the number of places to be visited are similar for both limited and unlimited budget tours, but each tour covers different places. For example, unlimited budget tour suggests site **44** (entrance fee is RM50) and site **42** (entrance fee is RM38) whereas limited budget tour suggests site **48** (entrance fee is RM20) and site **38** (no entrance fee) as highlighted in Table 2.

5. Conclusion

The heuristic algorithm presented in this paper was used to develop tour package models with the objective of maximizing the number of attractive places to be visited in the island of Langkawi Island. Experimental results of two models were compared (unlimited budget and limited budget tours) with three different time constraints (K=1, 2, and 3). The main criterion of both models for choosing the places to be visited was the time spent at each place. However, the results showed that the time spent at each site did not affect the final results in terms of the total locations to be visited. However, the entrance fee to each place played a determining factor in the choice of locations to be visited. To enhance the model, we suggest other objectives such as the group preference to be included in the model.

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