Constructing a Customized Travel Scheduling Recommendation Service Based on Personal Preference and Special Requirements

Chia-Ling Ho[1]([✉]), Pei-Syuan Li[2], Ying-Ching Wang[2], Peng-Yu Chou[2], Yan-Ling Pan[2], and Shi-Ting Chen[2]

[1] National Taipei University of Nursing and Health Sciences, No. 365, Ming-te Road, Peitou District, 112 Taipei, Taiwan R.O.C.
chialingho@ntunhs.edu.tw
[2] Taipei City University of Science and Technology, No. 2, Xueyuan Road, Beitou, 112 Taipei, Taiwan R.O.C.

Abstract. With the rapid development of the Internet, a variety of Internet services can break national and language boundaries, such as airline ticket booking, hotel booking, Airbnb, ticket booking, car rental service, and travel experience sharing. These online services help self-guided travelers collect data and compare prices or services as they plan their trips, but there still lack a one-stop automated travel planning services on the Internet. The purpose of this study is to design a set of personalized travel itinerary recommendation services based on personal preferences, in the hope that users can save time of data collection and maintain tourism quality when planning their self-guided travel itinerary to foreign countries. The system selects the recommended travel itineraries according to the expert-recommended travel database, personal preference, and travel restrictions, and users can modify the suggested travel itineraries according to personal needs in order to obtain their final travel itineraries.

Keywords: Travel itinerary · Personalized travel itinerary · Personal preferences · Travel restrictions

1 Background

With the gradual improvement of the national living standard, people's demand for tourism has increased year by year. Due to the limited tourism area in Taiwan and low-cost airlines competing in the aviation industry, ticket prices have dropped significantly, leading to a huge increase in the demand for travel to neighboring countries. According to statistics from the Tourism Bureau of MOTC as shown in Fig. 1, in 2018 the number of Taiwanese traveling abroad reached 16.64 million, and the rate of traveling abroad increased year by year from 20.6% in 2012 to 33.9% in 2018, setting a new record.

In terms of destination, as shown in Fig. 2, in 2018 most Taiwanese travelled abroad for short trips. Among them, most of them visited Asian countries (90%), including
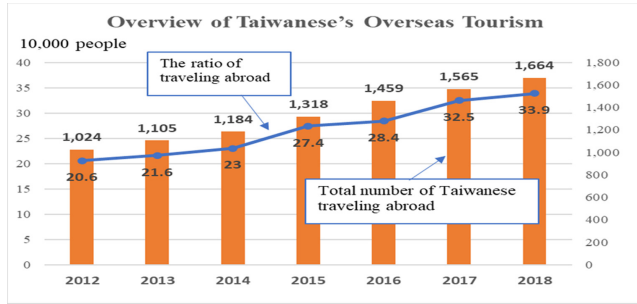
Fig. 1. Statistical chart of the number of people going abroad and ratio of traveling abroad by Taiwanese people over the years Source: National Statistics Report No. 163, Directorate General of Budget, Accounting and Statistics

4.83 million people visited Japan (29%), followed by 4.17 million people visited Mainland China (accounting for 25.1%), and then Hong Kong and Macao (together accounting for 13.8%). Nearly 70% of people visited China, Hong Kong, and Macao. As the most popular destination for Taiwanese to travel abroad is Japan, the simulation model of this study selected the recommended itinerary for Japan's self-guided tour.
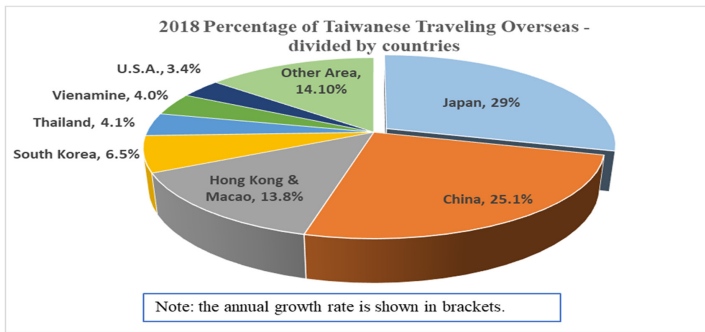

Fig. 2. The percentage of Taiwanese going abroad in 2018 – based on the destination Source: National Statistics Report No. 163, Directorate General of Budget, Accounting and Statistics

In terms of the type of tourism, Taiwanese prefer self-guided tours. As shown in Fig. 3, nearly 75% of the people mainly adopt self-guided tours, 25% of the people participate in group tours, and 10% of the people travel in other ways. Therefore, this study focuses on self-guided travel.

For the self-guided travel planning of overseas travel, this study applies the mind map to analyze the websites and Apps used by tourists. As shown in Fig. 4, the online query data about the planning of Taiwanese self-guided overseas travel involves airline tickets, hotels, scenic spots, means of transportation, admission tickets, etc. In addition, to ensure the quality of tourism, people also refer to the advice or instructions of tourism experts or tourism information websites to reduce the risk of incomplete planning before traveling. At present, tourism-related professional websites have been thriving, with
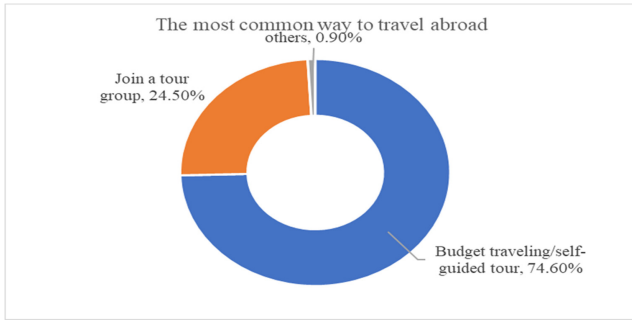
Fig. 3. Percentage chart of the most common ways for Taiwanese to travel abroad Source: Taiwan Trend Research (TTR)

rich data and large-scale diversified choices. However, a self-guided trip requires a lot of information collection before traveling. Air ticket booking, hotel reservations, transportation information, scenic spot information, or ticket booking all require careful planning. The neglect of one link may lead to the decline of tour quality. Therefore, a travel plan that can be completed without too much thought and time is a service that self-guided tourists urgently need. At present, research on self-guided travel itinerary recommendation is still in the initial stage of development.

Fig. 4. Analysis chart of network platforms or Apps for self-guided overseas travel planning

Self-guided travelers have various needs when planning their trips, including accommodation, transportation, attractions, shopping, food, and other activities. Some of these requirements can be met selectively, while others must definitely be met. For example, the requirements on the number of days, number of tourists, and tourist destinations must be met, while the requirements for scenic spots and food can be met according to the situation. This study applies a mind map to analyze the travel itinerary planning needs of Taiwanese for self-guided overseas travel, and there are three items: preferences, restrictions, and special needs, as shown in Fig. 5. Preferences refer to those of self-guided travelers in tourist destinations and places where they will stay. The possible options include shopping, famous scenic spots, and five-star hotels. Preferences are the items that can be possibly reached among the currently available tourism contents and are not necessary conditions for tourism. Restrictions refer to conditions that must be met for the self-guided traveler during the trip. They are necessary conditions of travel, including

possible options such as the limited number of people, region, budget, and climate. Special needs refer to needs that are not generated by ordinary self-guided travelers, such as car rental for the self-guided tour and WiFi hotspots for the query of travel information. Options for winter travel may include ski travel arrangements, clothes rental, vegetarian arrangements, car rental services, and so on. Special needs are those items that can be possibly reached among the current tourism contents available for selection and are not necessary conditions for tourism.
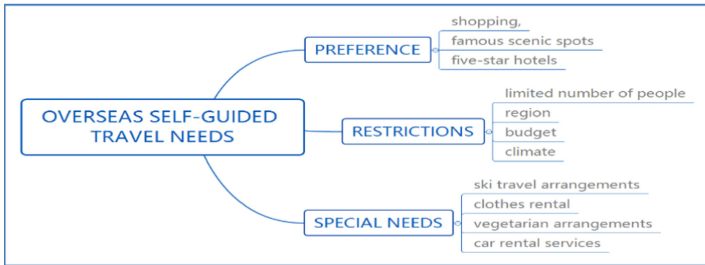

Fig. 5. Analysis chart of itinerary planning demand of self-guided overseas travel

To sum up, the number of Taiwan people traveling abroad has reached new highs, and the demand for self-guided travel-related services is increasing. At present, the relevant services available on the Internet mostly belong to a certain professional field, such as airline tickets, hotels, and admission tickets, showing a lack of integrated self-guided travel services. In addition, the planning of self-guided overseas travel is laborious, and foreign languages and unfamiliar environments increase the risk of self-guided travel. Therefore, a set of services with fewer risks and planning time that meet the needs of personal self-guided travel and can automatically generate or modify the itinerary is an urgent need for self-guided travelers. The purpose of this study is to design a set of self-guided travel itinerary recommendation services according to the necessary or non-necessary conditions of personal self-guided tourism, so as to reduce the time required for planning and tourism risks and improve tourism quality.

2   Related Work

As for the existing products, according to the research, as shown in Table 1, there are tourism websites/Apps in Taiwan that provide tourism planning services, such as TripPacker, KKDAY, Trip Case, Trip Hugger, Pintogo, and Good Luck Trip Japan.
KKDAY and TripCase are widely known, have rich service content, and see quite a lot of users. TripCase also has the function of sharing itineraries. Trip Packer is moderately known and has recommended itineraries for users. While Good Luck Trip Japan, Trip Hugger, and Funliday are not used as much as the three Apps mentioned above, they have features such as offering coupons and sharing articles. One can use Funliday to share a travel itinerary with friends and plan a travel destination. Although the above Apps have their own features and strengths, none of them can arrange travel itineraries according

to personal preferences and provide customized travel services. Therefore, this study designs a set of services for self-guided tourists when planning their trips, and these services can help automatically generate customized itineraries according to personal preferences or needs, so as to reduce the time and energy consumed of self-guided tourists in planning their itineraries.

Many researchers have published papers related to the Personalized Travel Itinerary Recommendation. The research literature on route scheduling algorithm includes [1–5], and the research literature about automatic travel planning covers [6–8]. The route algorithm originated from a study of the salesman travel problem and gradually developed into the study of travel route optimization, including such factors as limited budget, location, arrival time, and stay time. However, these studies did not take into account the personal preferences of tourists, such as shopping itineraries, skiing itineraries, and experience itineraries. These factors seriously affect the quality of self-guided travel. In addition, most of the studies on automatic travel planning still focus on point-of-interest. Few studies have included the personal preferences of tourists. Therefore, personal preferences are incorporated into the considerations for the travel itinerary recommendation in this study.

3   System Framework

Because compared with other destination countries, a higher proportion of Taiwanese people travel to Japan when travelling independently, this study used independent travel in Japan as the basis for developing a service system that can automatically generate independent travel itineraries to reduce the time and effort required to plan independent travel in Japan.

3.1   Procedure of the Personalized Travel Itinerary Recommendation Service

The research framework of this study is displayed in Fig. 6. Itinerary recommendation comprises two offline stages. In the first stage, preliminary recommendation routes are produced, and in the second stage, the primary recommendation routes are produced. Subsequently, users revise the itineraries to generate the final itinerary recommendation. In the first screening stage, the system compares the screening constraints specified by the user with the expert-recommended itinerary database and accommodation level database. Itineraries and accommodation locations that match the screening constraints are added to the preliminary recommendation routes. In the second screening stage, the preliminary recommendation routes corresponding to the user input preferences are further screened to generate primary recommendation routes. Finally, the user adjusts the primary recommendation routes, and the remaining recommendation routes are output as the final itinerary recommendation results.

3.2   User Input Item

This study divided travelers' needs into conditions that must be satisfied and conditions that can be optionally satisfied. The conditions that must be satisfied are the screening

Table 1. Analysis of travel service websites/Apps

Name	Number of downloads	Feature	Service	Marketing
KKDAY	1 million times	The conversion of various languages	Charter cars, booking air tickets, and other services	TV ads, websites
Trip Case	1 million times	1. You can keep track of the travel status at any time 2. You can share the itinerary with others. 3. You can edit your personal information after logging into the website	1. If you input the reservation code and last name, you can search automatically 2. You can quickly switch the use function	Websites
Trip Packer	500,000 times	It provides scenic spots and itineraries recommended by users	Charter cars, book air tickets, and other services	Websites
Good Luck Trip Japan	100,000 times	1. You can add the content of Notes to My Favorite, browse, and share posts 2. The content can also be displayed offline	Currency exchange rate conversion	Websites
Japani	100,000 times	1. You can easily search popular scenic spots and shops 2. You can check other people's comments on sellers as a travel reference	Coupons of the most popular local stores	Websites
Funliday	100,000 times	You can create, share, and edit your own itinerary	Itinerary sharing	Websites

Table 1. (*continued*)

Name	Number of downloads	Feature	Service	Marketing
Trip Hugger	1000 times	1. You can make friends. 2. There is a voting function in the app, and you can choose where you want to go	1. It can be used offline 2. It provides a tourist map	Websites

Source: Compiled by this study.

constraints of the proposed system. By contrast, the conditions that can be optionally satisfied are considered during itinerary planning when suitable options are available in the itinerary after the screening constraints have been satisfied. Therefore, the screening constraints are higher priority than the optional conditions. Screening constraints include days of travel (i.e., travel duration), accommodation conditions, and travel destination. In the first screening stage, the screening constraints must be applied. For example, the days of travel must be a positive integer greater than 1. Accommodation level is classified into luxury, mid-range, and budget. The travel destinations are Hokkaido, Honshu, Shikoku, Kyushu, and other islands. Among the constraints, days of travel is the only item that must be input; accommodation level and travel destination are optional input items. Conditions that can be optionally satisfied in the second screening stage are user preferences such as points of interests and types of activities. The points of interest are renowned attractions in a region, and the user can select multiple attractions. Types of activities include nature and ecology, sports and recreation, culture and the arts, shopping, and gourmet. The user can select multiple items in this condition. Input of these two conditions is optional. The user can input the conditions depending on their personal preferences.

3.3 Expert-Recommended Itinerary Database

The expert-recommended itinerary database was established to mitigate difficulty in itinerary searching. The database also aims to improve the quality of tourism. Some independent travelers share their travel itinerary on the Internet, but the quality of these itineraries is not guaranteed. Some challenges may have been encountered in the travel process, but the travelers may not mention them when sharing their itinerary. To minimize the uncertainty in travel quality, this study proposed an expert-recommended itinerary database detailing attractions recommended by many major travel agencies and tourism associations to ensure the quality of travel. Expert-recommended itineraries are provided according to the input tourism region and days of travel. A greater number of days of travel results in more travel destinations.
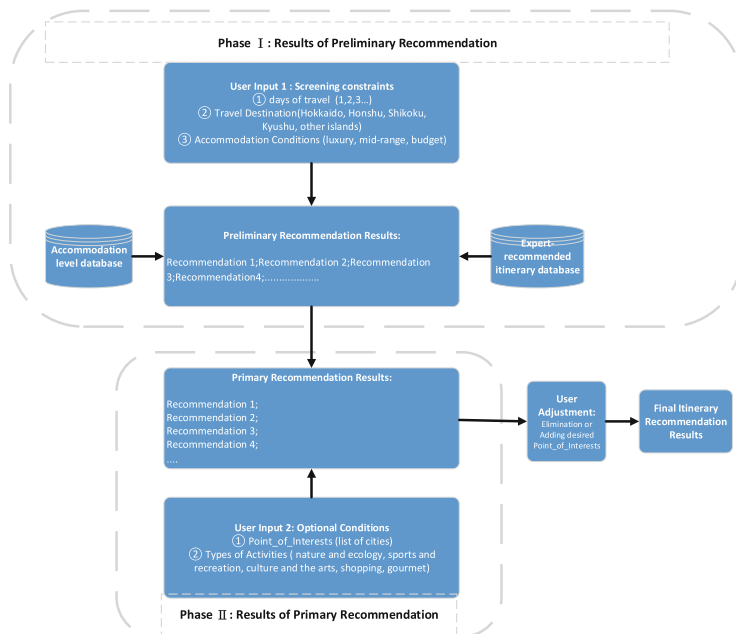
Fig. 6. Architecture of an automatic travel itinerary recommendation system

3.4 Accommodation Level Database

Excellent accommodation considerably contributes traveler satisfaction with a travel itinerary. Thus, this study used accommodation level as a screening constraint. To help screen accommodation sites suitable for the user, an accommodation level database was established. For each hotel included in the database, their accommodation levels are luxury, mid-range, or budget. Luxury hotels are those with four or more stars. Hotels with 2.5–3.5 stars are ranked as mid-range. Hotels with two or fewer stars, including hostels and private lodges, are considered budget hotels. Budget hotels that have received numerous negative reviews are not listed in recommendations. Regarding the selection of hotel location, the system prioritizes selection of a hotel near the final attraction of the day to save time spent on driving to the hotel.

3.5 User Adjustment Items

At the end of the second stage, the primary recommendation routes are generated. The recommended content may not necessarily satisfy the user. For example, the user may have been to some of the recommended attractions or hotels or want to leave blanks in the itinerary, visit some unrecommended attractions, adjust the times at which they visit the attractions, arrange accommodation independently, or adjust, cancel, or add to the itinerary abruptly for other reasons. Many factors can cause the user to adjust the recommended itinerary. To ensure user satisfaction with the recommended itineraries, the itinerary settings must be flexible. Therefore, the proposed system includes a step in

which the user can adjust the recommended itinerary according to their personal needs or preferences. This step mainly comprises four options: cancel attraction, add attraction, cancel hotel, and add hotel. When the user selects any of these adjustment options, the system responses are as follows:

Cancel Attraction. Independent travel differs from group travel because it has customizable itineraries. The proposed system provides flexible functions allowing the user to delete part of an itinerary according to their stamina and preferences, thereby facilitating the goal of recreational travel. The user cancels one attraction at a time. Upon cancellation of an attraction, the system asks the user if a new attraction should be added. If the user replies "yes," the system lists attractions near the straight line between the attractions before and after the cancelled attraction. After the user has selected a new attraction, the system rearranges the day's itinerary. If the user replies "no," the system displays the itinerary after the attraction cancellation.

Add Attraction. If the user adds a new attraction to a recommended itinerary without removing any of the recommended attractions, the quality of the itinerary may be affected. Because the recommended itinerary is the optimal combination recommended by experts, arbitrary addition of new attractions not only leads to an overly packed itinerary but also puts on a burden on the traveler, affecting the overall tourism quality. Therefore, the proposed system does not permit addition of an attraction without removal of an attraction. Once the user has canceled an attraction, the system lists attractions near the straight line between the attractions before and after the cancelled attraction. After the user has selected a new attraction, the system rearranges the day's itinerary.

Cancel Hotel. The user may stay in a different hotel every day or in one hotel for consecutive days. If the user dislikes a recommended hotel stay on consecutive days, they can cancel it. If the user is not satisfied with the hotels in the recommended itinerary, they can cancel them. After cancellation of a hotel, the system displays a message to add a hotel. The user must select a new hotel; otherwise, the user may forget to add a hotel and have nowhere to stay. The system requires the user to add a new hotel whenever they cancel a hotel.

Add Hotel. In the itinerary, one hotel per day is reserved. To avoid more than one hotel being reserved for one day, the system limits the user to select only one hotel for one day in the itinerary. The "add hotel" function is only presented when the user cancels a hotel. Thus, the "add hotel" function is not visible in the menu. After the function is revealed, the user must select a hotel for accommodation; if they do not, the original hotel cannot be cancelled. Two methods are available for selection of a new hotel: First, a hotel of comparable level to the cancelled hotel is selected from the area near the cancelled hotel. Second, a hotel near the straight line between the final attraction of the day and first attraction of the next day is selected. The first method has higher priority than the second method. If the user is unsatisfied with the hotel recommended through the two methods, they can link to other dedicated hotel websites to select a hotel. The "add hotel" function also provides the option to allow the user to stay in a friend or relative's house to satisfy the requirement of flexibility in independent travel itineraries.

4 Simulation Model

The goal of the system proposed by the present study is to help independent travelers save time and effort on planning independent travel itineraries and improve the overall quality of independent travel. To achieve these goals, the quality of the core expert-recommended itinerary database is the key to success. In preliminary planning, the system is associated with professional travel agencies, who provide recommendations regarding itinerary planning, to ensure the quality and size of the expert-recommended itinerary database. In the following simulation model, the expert-recommended itinerary database is constructed for a single city, and the recommendations of hotels and attractions are limited to this city.

The flow of mobile application use is shown in Fig. 7. The user is asked to first provide personal information. Subsequently, the travel constraints and personal preference items can be input. The system then generates recommended itineraries. The user can customize a recommended itinerary before finalizing it. The user interface for adjusting the recommendation itinerary is displayed in Fig. 8. The system requires a hotel to be canceled before a new hotel is added; therefore, the "add hotel" function is only presented after hotel cancellation. No "add hotel" item is available in the itinerary adjustment stage. Once the user has adjusted the itinerary, they must confirm the itinerary; consequently, the final travel itinerary customized by the user is generated.

Fig. 7. Explanation of the flow of mobile application use.

Fig. 8. User interface for adjustment of the recommended itinerary.

5 Conclusion

Thanks to the Internet and low-cost airlines, the number of Taiwanese traveling to neighboring countries has reached a record high year by year. Japan is the top destination for

Taiwanese, followed by the Chinese mainland, and then Hong Kong and Macao. Self-guided tourism is the main method when Taiwanese travel abroad, accounting for nearly 3/4 of all travel modes. Because the largest number of Taiwanese travel to Japan, there is a growing demand for services related to travel planning to Japan. However, due to the limitation of national boundaries and language, self-guided overseas travel often leads to the decline of tourism quality or the increase of risks due to many uncertainties. While there are many travel-related websites or Apps that offer a single professional service, such as air ticket booking and hotel booking, there are few professional services for travel itinerary planning. Planning an overseas trip is not easy. In addition to language barriers, airline ticket booking, hotel booking, admission ticket booking, car rental, scenic spot selection, route planning, transportation planning, food, and other factors test the patience and carefulness of self-guided travelers. They are afraid that one of the links may be overlooked and ruin their overseas travel.

The purpose of this study is to provide a set of travel planning services for self-guided tourists to Japan. According to users' preferences and travel restrictions, this service selects high-quality and flexible travel itineraries recommended by experts. Its feature is that users can quickly complete travel planning without spending time collecting travel-related information, and that it can meet the needs of individuals in travel itineraries. The system can provide a travel itinerary recommended by experts, because of the establishment of a database regarding travel itinerary recommended by experts. The more perfect the database is, the higher the quality of the recommended travel itinerary will be. However, due to the limitation of research funds, the simulation model established in this study can only provide tourism suggestions for people who plan to go to Japanese metropolises and cannot provide travel itinerary suggestions of all Japanese cities for tourists. In the future, we plan to add special needs to the screening conditions, so as to better meet the demands of self-guided tourists in planning itineraries.

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