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Experimental Evaluation of an Expert System for Travel Recommender Systems

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Abstract

As the amount of information in the field of tourism becomes abundant, finding the desired information for decision making is increasingly difficult. Therefore, travel recommender systems became significant tools as they offer tourists a convenient opportunity to find a travel package or to make individual travel plans. Today's TRSs need to have more mathematical based and complex back-end systems, to be able to support multiple decision making styles and various customer needs. The prototype system was designed to deal with this, in a manner in which it presents products to consumers and supports non-linear decision making processes. The objective of this research is to evaluate an expert system for travel recommender systems and determine whether the system meets the expectations of potential tourists in supporting the construction of individual travel plans. The evaluation considers aspects such as multi-dimensional coverage, experience, filtering methods and the complexity of a task. The ultimate goal of the research is to realize a quantitative characterization of the performance of the proposed system in terms of its usefulness, effectiveness, efficiency and user satisfaction. This research has found that there is a great potential of the system in helping users in constructing useful travel plans which match their preferences by using a hybrid filtering approach.

Keywords: *Travel Recommender System, expert system, prototype testing*

1. Introduction

The evolution of the Internet over the past years has given destinations and suppliers in the tourism industry a wide range of new possibilities to get into contact with potential visitors [1]. Even though there are many potential advantages associated with the Internet, users are having difficulties dealing with information overload. Recommender systems are one technique to address this problem. They are a popular research area, and have been successfully developed and used by various e-commerce sites [2]. However, for a tourism recommender system, it is hard to define an acceptable approach. This is because of the nature of planning of tourism itineraries, which have been characterized as highly emotional, non-rational, lengthy and revisionist [3].

Given the rapidly rising popularity of on-line tourism decision making and itinerary planning, there is clearly a challenge for the developers of TRSs to manage an experience that is comparable to that of engaging with a retail travel agent. Decrop & Snelders [4] found that the process of holiday planning is ongoing, is not bounded, and it is not rational. It means that today's TRSs need to have more mathematical based and complex back-end systems, to be able to support multiple decision making styles and various customer needs. The prototype system was designed to deal with this, in a manner in which it presents products to consumers and supports non-linear decision making processes. To address these issues, an effective rule

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set that employs a given interest ontology and adopts a hybrid evaluation approach was developed. A typical travel recommender system adopts content-based, knowledge-based or collaborative-based approaches to extract tourism products. This project proposes the adoption of a hybrid approach to the development and implementation of its rule sets. This research evaluated the validity and performance of this hybrid approach, which has not been widely used in the e-commence tourism industry previously.

2. Previous Studies

Previous research in the tourism domain has mainly focused on management-support, destination-oriented and operation functions [5-9] only few have addressed the travel recommender system that incorporates individual needs and interests and the travel decision making process, and only partial solutions have been delivered [10-13]. The lack of comprehensive research efforts regarding the development of a personalized travel recommender system is quite significant [13].

Travel Recommender Systems (TRSs) are a means of providing intending tourists with appropriate product information and assisting them in negotiating the decision making phases of the planning process [2]. They try to minimize the iterative efforts observed in traditional counseling sessions with travel agents [12]. There are an increasing number of commercial websites which have started to cope with travel planning by incorporating Recommender Systems, such as Expedia, Travelocity and Tiscover *etc*. However, theses TRSs focus on a destination selection and do not support the user through personalized interactions.

In addition, research into the effectiveness of expert systems that allow personalized travel planning has not been addressed in previous research. However, Ricci [14] investigated the effectiveness of recommendation capabilities for DieToRecs which is a travel recommendation system developed by IST. The project team conducted experiments with university students rather than real potential tourists. Missier and Ricci [15] noted that tests with real users could show a quite different picture of the system effectiveness because of the GUI impact and the users' behavior.

3. Proposed Prototype

Normally, Recommender Systems use rule sets, which are determined by a combination of content-based filtering technologies, interactive query management, and variations of a collaborative filtering approach or a case based reasoning to rank suggestions, extracted from structured catalogues [16]. For TRS's either a content based approach or a collaborative filtering approach, has been identified as a successful Recommender System technology [5]. Both content- and collaborative-based approaches are normative in suggesting that new travelers will either respond predictably to the patterns of dialogues employed by travel consultants, or will behave according to recognized patterns of choice making employed by other consumers. The main difference with content based technology is that content filtering systems consider "item similarity" whereas collaborative filtering systems use "user similarity" as the basis for a recommendation. In this research, a hybrid approach to Recommender Systems is being proposed as more successful in overcoming some limitations of the collaborative and the content based approach. In the literature, the hybrid approach to Recommender Systems is being proposed as more successful but it has yet to be applied to a real TRS [6, 17].

The system was designed to enable customers to specify their needs and preferences by retrieving previously stored data from personal interests profiles or by directly indicating interested areas through an input screen for a specific travel activity (Refer Figure 1).

Customized and personalized travel planning and tour design is possible through the interactive scrapbook which enables customers to specify regions and number of days at the first location, and allows for the design of personalized travel plans by picking, bundling and sequencing chosen destinations, attractions, restaurants and accommodations.

Figure 1. User Interface for Indicating Travel Interests

The rule sets determined for the system were summarized into the following points which make the system distinctive to other existing systems;

- Classification of images and text bytes against the dimensions of a tourism interest ontology
- Determination of suitable combinations of images and textual information objects that may be displayed to reflect the user's interest areas and complement one another
- Refining the user's profile through monitoring actions
- Product set filtering against the emerging user profile
- Maintenance of historic profiles of users' product selection and investigation, without threats to privacy
- Allows direct viewing and modification of user profile
- Extensive rules on the handling of product objects, that provide transparent, comprehensible data capture and support of decision processes

The result of the search is a list of each product from the product database, grouped and ranked in order of relevance, as observed in Figure 2. A user can see what percentage is matching each product with individual preference. The researcher anticipated that the user might assume that the system is more reliable and functional by indicating the match percentage figure for each product.

The results obtained from the query are sorted according to the degree of similarity between found products, satisfying travel preferences, and items contained in past cases. The hybrid expert system finds a small set of interaction sessions performed by similar users using the collaborative filtering system. Then the system computes a double similarity score for each query result, by taking the product of the user similarity and the product similarity. The user similarity takes into account the current user and the similar user, and is calculated using only the collaborative based filtering. The product similarity between the result product and the products of the same type contained in a retrieved product is instead computed on the content based filtering feature. Then, only the items with higher predicted value are presented in decreasing similarity order, as a recommendation, to the user.

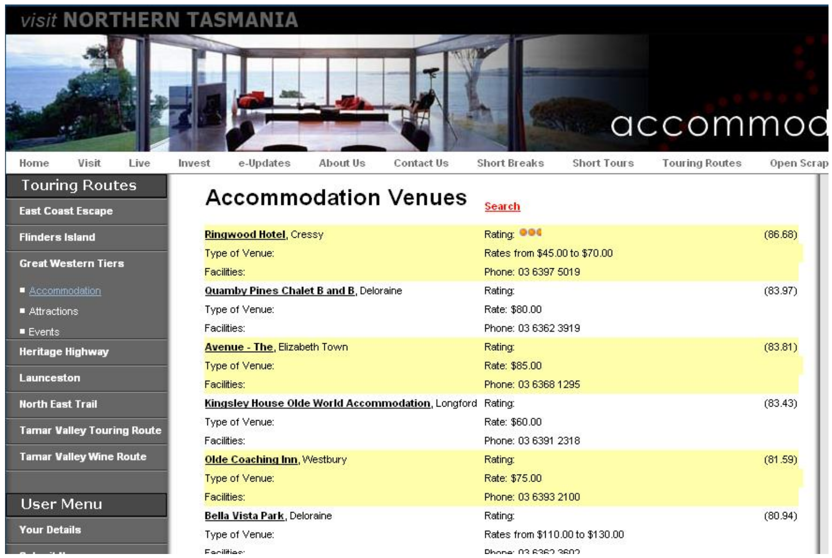
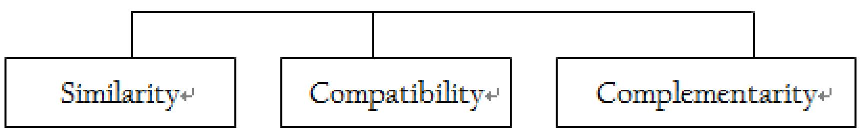


Figure 2. Search Results

The following Figure 3 describes the three dimensions of the filtering system:



* The similarity measure refers to what products have an affinity with individual interest areas
* Compatibility measure refers to what products are compatible with those items that I have configured in my itinerary
* Complementarities refer to what products are complementary to those items that I have placed in my itinerary.

Figure 3. The Three Dimensions of the Expert System

The relevant similarity measures are:

- Between recommended products and perceived user profiles
- Between the wish list(s) items in the scrapbook (what goes with that?)
- Between the wish list and the actual product details to be confirmed
- The product details to be confirmed and the reality of the experience

This system adopted a revised distance measure:

$$\sum \left| x_i - y_i \right| / N$$

where
x_i is the user's profile,
y_i is the product profile,
i ranges over the N factors in each profile
except for $x_i = 0$ or $y_i = 0$, which are don't care or n/a

The distance measures are normalized on a scale of [0.1], products are displayed in order of decreasing similarity. Unlike with DIETORECS [18, 19], no limitations have been placed on the number of product items displayed, so that the user's choice is not restricted, it is just ranked. The recalculation of the user profile is then to be performed after each significant event. The user profiles contain search behavior, the selected items in the individual scrapbook, the use of the tourism ontology and implicit and explicit feedback based on the actions they perform on the user interface. These user profiles are then transformed into percentage ratings to allow similar matching capabilities with the interest ontology and the content.

4. Experimental Design

4.1. Full Factorial Experiment

For the experiment, the researcher aimed to conduct a full factorial experiment across a stratified sample of Australian tourists, overseas tourists, travel agents and professionals. The full factorial experiments are often used when evaluating complex systems and when a researcher does not know which subset of many decision variables will have the most significant impact on a performance measure [20]. As this research deals with a Recommender System which is known as a very complicated system and the researcher does not know which factor is significantly reflected to the effectiveness of the system [17], a full factorial experiment is the best choice to obtain reliable and validated results. In using a full factorial experimental design, all possible combinations of the levels of the factors can be investigated in each complete trial or replication of the experiment.

To examine the potential of the system, the casual relationship between controlled factors, which are the independent variables, and multiple analyzed responses, which are the dependent variables, were identified and measured. A number of controlled factors were identified that were relevant to the evaluation of an expert system for the TRS. The factors which also can be defined as key components of an expert system are: Multi-Dimensional Coverage, Experience, Filtering Methods and a Complexity of a Task. Each of these factors were set at only two extreme values, a low value (-1) and a high value (+1), as the experimental designs is to test for the significance of main effects and combinations of main effects. Using comparatively few treatment runs, the researcher determined which factor or factors cause significant changes in the performance measure. The degree of system performance was determined by using follow up questionnaire. The responses which would determine the effectiveness of the expert system were; delivering valuable recommendation, facilitating the construction of good travel plan, allowing more efficient search and improving user satisfaction. The components of the responses were adopted from a previous study [21].

To understand the contribution of the factors to user's satisfaction with the system, each factor was controlled using the following methods: The first factor (Complexity of Task) was controlled by giving participants either a complex task which includes limited budget, specific periods and other 4 day scenarios, or a simple task which is only required to make 3 day plans, and see whether complexity of task affect on user perception (the follow-up questionnaire) to the system. For factor 2 (Multi-dimensional Tasks), participants were required to perform either multi dimensional tasks which include various travel activities as well as accommodations, or one dimensional tasks which required to plan only accommodations. The researcher examined whether performing multi dimensional tasks influenced the responses of participants. For factor 3 (filtering method), some variants of the travel recommendation system were developed to test some hypotheses about the performance of each variant on a set of dependent measures. The variants to be tested were:

TRS-1 : Content_based filtering system only
TRS-2 : Hybrid system which combine content_based and collaborative filtering system.

The researcher also asked participants about their degree of previous experience (factor4) with similar TRSs, and compared a set of response between experienced users and non-experience users. The hypotheses to be tested were developed as a tentative statement of the relationship between main independent variables (four controlled factors described above) and the dependent variable (R1: usefulness, R2: effectiveness, R3: efficiency, R4: user satisfaction);

Hypothese1 :[Delivering useful recommendations] is significantly reflect by the combination of complexity of a task(F1), multi-dimensional coverage(F2), filtering method(F3) and experience(F4).
Hypothese2 : [Facilitating the construction of good travel plans effectively] is significantly reflected by the combination of F1,F2,F3 and F4
Hypothese3 : [A more efficient search of the product catalogue] is significantly reflected by the combination of F1,F2,F3 and F4
Hypothese4 : [A satisfaction to the user] is significantly reflected to the combination of F1,F2,F3 and F4

To make the research more authentic, the sample was drawn at random from the identified population, including Australian tourists, overseas tourists, travel agents and tourism professionals. In order to do full factorial analysis without replication, it seemed that a reasonable group size could not be less than 16 (n-16 participants for each group, 64 participants in total). To increase the estimated statistical validity, the researcher aimed to reduce the experimental error through a tighter specification of the tasks and of the experimental procedure, and through a design-based control of some potential nuisance factors such as system expertise, learning and sequence effects.

4.2. Experimental Procedure

The experimental design for this research was based on a standard method of factor analysis [22] to ensure that users could interact on a realistic level with the prototype system, it could then be evaluated to what extent the expert system assisted the users in constructing travel plans within 10 minutes. The process begins starting from pre treatment questionnaires, through to mid treatment set activities and then the follow-up questionnaires. All processes were to be conducted in the same experimental setting. The total experiment was designed to be conducted over a 25 minute period. This 25 minute duration was kept to as closely as possible because extra time may have affected results.

Table 2. Experimental Process

Procedure	Duration
Introduction	2 mins
Initial questionnaires	3 mins
System training, Familiarization	5 mins
Treatment (Performing task)	10 mins
Follow-up questionnaires	5 mins
Total Duration	**25 mins**

The pre-treatment questionnaire was conducted to establish the subject’s basic profile data and to determine personality categories, buyer behavior categories, in association with, previous experience and user expectation of TRS. The participants were then asked to perform one of a series of tasks (refer Table 3), which aligned with the specific scenario specifications. The follow-up questionnaire was designed to measure the dependent variable (responses) after the treatment has been introduced into the experimental situation and to evaluate the effectiveness of the treatment in facilitating the solution to the proposed filtering problems. A slightly modified version1 of the IBM Post-Study System Usability Questionnaire (PSSUQ)[23] was used to make it more complete and suitable to the evaluation of the system under investigation.

Table 3. Task Scenarios

Task	Scenario
Task 1 : Simple(F1 : -1) , One dimension (F2 : -1)	Imagine you have been nominated for 3 days and 2 night's accommodation in Northern Tasmania. Please organize 2nights accommodation in two distinct area, which best suits your interests.
Task 2 : Complex (F1 : +1) , One dimension (F2 : -1)	Imagine that you have a total budget of $600 for the trip for two people, and you cannot exceed that budget. This budget needs to cover all accommodations and attractions on the trip. Now, it is your task to plan your trip using the TRS. The trip is only restricted to last for 4 days, with 3 nights accommodation in 3 different towns, and can be taken any time between September and November.
Task 3 : Simple (F1 : -1) , Multi dimension (F2 : +1)	Imagine you have been nominated 3 days and 2 night's accommodation in Northern Tasmania. Please organize 2nights accommodation and 2 attractions in two distinct area, which best suits your interests.
Task 4 : Complex (F1 : +1) , Multi dimension (F2 : +1)	Imagine that you have a total budget of $600 for the trip for two people, and you cannot exceed that budget. This budget needs to cover all accommodation and attractions on the trip. Now, it is your task to plan your trip using the TRS. The trip is only restricted to last for 4 days, with 3 nights accommodation and 3 attractions in 3 different towns, and can be taken any time between September and November.

4.3 Data Analysis

Descriptive and inferential statistics were used to analyse the results of 64 evaluations. In addition, the Analysis of Variance (ANOVA) was used to test the level of significance of the main and compounded effects. The factor analysis of the follow-up questionnaire was performed to quantify to what degree each controlled factor contributed to the creation of a travel itinerary using the system. Ratings of the items selected by the users were collected.

The analysis of the relationship between one particular response and the four main factors can be formulated as follows. The formulae represent interactions between each factor, and the regression model of the four-factorial experiment [22]. The regression equations determined in this research for each sample and for each survey question;

$$\mathbf{Y_1 = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_{12}x_1x_2 + \beta_{13}x_1x_3 + \beta_{14}x_1x_4 + \beta_{23}x_2x_3 + \beta_{24}x_2x_4 + \beta_{34}x_3x_4 + \beta_{123}x_1x_2x_3 + \beta_{124}x_1x_2x_4 + \beta_{134}x_1x_3x_4 + \beta_{234}x_2x_3x_4 + \beta_{1234}x_1x_2x_3x_4 + e}$$

R_1 means one of responses(Response 1)
x_1 means (Factor 1)
β_0 means total effects (average level of effects)
β_1 means main effects of factor 1
e means error terms

where Y is the response, the **β's** are parameters whose values are to be determined, x_1 is a variable that represents factor 1, x_2 is a variable that represents factor 2, and e is a random error term. The variables x_1 and x_x are defined on a coded scale from -1 to +1(the low and high levels of facotr1 and factor2), and x_1 x_2 represents the interaction between x_1 and x_2. The parameter estimates in this regression model turn out to be related to the effect estimates.

5. Results

The beta values obtained from the factor regressions were summarized into Table 4, separating the positive contribution and the negative contributions of the factor rotation against the dependent variables measured in the research. The results of the factor regressions highlight the strong positive contribution of Factor 3 (Filtering method) against all dependent variables across the four different cohorts. Factor 4 (experience of a user) is a negatively correlated factor that impacts on all four cohorts with all four dependent variables (responses). Factor 1 (complexity of a task) appeared as a negative correlation for the overseas potential tourist cohort with four dependent variables. However, Factor 2 (dimensionality of a task) when regressed does not have statistically significant impacts on any areas in any cohorts.

Table 4. Factor Regressions

Response (Dependent Variable)	**Questions**	**Regressions SS Total SS Error**	**Positive Factor (beta value)**	**Negative Factor (beta value)**
Usefulness	Q6	13.8 6.9	F2(0) F3(+0.25)	F3(-0.13) F4(-0.38)
	Q7	12.0 6.0	F3(0) **F3(+0.50)**	F2(-0.13) F4(-0.38)
	Q8	8.9 4.5	F3(+0.31)	F3(-0.19) F2(-0.19) F4(-0.44)
	Q9	15.8 7.9	F2(+0.13) **F3(+0.63)**	F3(-0.13) F4(-0.13)
	Q10	8.9 4.5	F2(+0.19) **F3(+0.56)** F4(+0.06)	F3(-0.31)
Effectiveness	Q11	6.4 3.2	F2(+0.25) **F3(+0.63)**	F1(-0.31) F4(-0.38)
	Q12	14.0 7.0	F2(+0.31) **F3(+0.69)**	F1(-0.19) F4(-0.31)
	Q13	12.9 6.5	**F3(+0.81)**	**F1(-0.56)** F2(-0.06) F4(-0.19)
	Q14	15.8 7.9	F3(+0.69)	F1(-0.44) F2(-0.31) F4(-0.31)
	Q15	12.9 6.5	F2(+0.06) **F3(+0.56)**	F1(-0.44) F4(-0.06)
Efficiency	Q16	19.8 9.9	F2(0) **F3(+0.75)**	F1(-0.38) F4(-0.13)
	Q17	11.8 5.9	F2(+0.06) **F3(+0.81)**	F1(-0.44) F4(-0.19)
	Q18	15.4 7.7	F2(0) **F3(+0.63)**	**F1(-0.50)** **F4(-0.63)**
	Q19	25.0	**F3(+0.69)**	F1(-0.31)

		12.5		F2(-0.19) F4(-0.44)
	Q20	14.9 7.5	**F3(+0.75)**	**F1(-0.63)** F2(-0.13)
User Satisfaction	Q1	16.0 8.0	F2(0) **F3(+0.75)**	**F1(-0.50)** F4(-0.38)
	Q2	15.8 7.9	F2(0) **F3(+0.50)**	F1(-0.38) **F4(-0.63)**
	Q3	20.9 10.5	**F3(+0.87)**	F1(-0.33) F2(-0.33) F4(-0.47)
	Q4	19.0 9.5	F2(+0.06) **F3(+0.69)**	**F1(-0.56)** F4(-0.31)
	Q5	16.9 8.5	**F3(+0.75)**	**F1(-0.50)** F2(-0.13) **F4(-0.50)**

The Australian potential tourist cohort tended to evaluate the effectiveness of the system very positively compared with other cohorts. However, the travel agent cohort and tourism professionals evaluated the system negatively as they had a very good knowledge of tourism products in Northern Tasmania, compared with potential tourists. With the travel agent cohort Q14 had a negative main effect with respect to the effectiveness of the system in formulating travel plans. In particular the travel agent cohort had a low average response level to question 14. The researcher observed that the travel agent participants tended to see the system as a competitor to their business as opposed to a complementary tool. There were 15 hypotheses related with this research question. All hypotheses relating to effectiveness of the system except hypothesis 2-3 for the tourism professional cohort and the null hypothesis 2-10 for the travel agent cohort as follows;.

Table 5. Summary of Hypotheses for Effectiveness of the System

Effectiveness(R2)	Hypotheses	Factor	F-statistic	Fcrit	Coefficient in regression equation
Travel Agent					
Q15	2-10H0	F3&F4	5.94	5.32	-0.81
Tourism Professional					
Q11	2-3H0	F3	5.88	5.32	+0.63
Q12	2-3H0	F3	6.56	5.32	+0.69
Q13	2-3H0	F3	5.46	5.32	+0.81

Hypothesis 2-3, "[Effectively facilitating the construction of appropriate travel plans (R2)] is significantly dependent on the [Filtering method of the system (F3)]". This is accepted in Q11, Q12 and Q13 for the tourism professional cohort. It appeared that the hybrid filtering method had a positive effect on the responses of Q11, Q12 and Q13. There was a 37% variation on the response of Q11, 41% variation on the response of Q12 and 34% variation on the response Q3, due to the difference in filtering method of the expert system. These results indicated that the effectiveness of the system was significantly enhanced by the hybrid filtering method. Interestingly, there was a 37% variation on the response of the travel agent cohort for Q15 due to the interaction of the different filtering methods (Factor 3) used and the user experience (Factor 4). This result may be due to the strong effect that the experience of the participant played. An increase in the experience factor of the travel agent cohort tended to have a negative effect on the assessment of the system by the participants, even with the hybrid filtering system, but this finding needs further investigation

Table 6. Summary of Hypotheses for Usefulness of the System

Usefulness(R1)	Hypotheses	Factor	F-statistic	Fcrit	Coefficient in regression equation
Australian Potential Tourists					
Q7	1-3H0	F3	5.33	5.32	+0.50
Q8	1-4H0	F4	5.48	5.32	-0.44
Q9	1-3H0	F3	6.35	5.32	+0.63
Q10	1-3H0	F3	9.06	5.32	+0.56
Overseas tourists					
Q6	1-4H0	F4	7.27	5.32	-0.63
Q8	1-1H0	F1	6.56	5.32	-0.50
Travel Agents					
Q7	1-4H0	F4	5.61	5.32	-0.56
Q8	1-4H0	F4	6.86	5.32	-0.75

Questions 6, 7, 8, 9 and 10 in the follow-up questionnaire asked to evaluate usefulness of the system as shown in the Table 6. Hypothesis 1-3, "[Delivering useful recommendations (R1)] is significantly dependent on the level of [Filtering method of the system (F3)]", was accepted in the responses to Q7, Q9 and Q10 across all the cohorts. It appeared that the hybrid filtering method had a strong positive effect on the response of all questions regarding the usefulness of the system. There was 33% variation on the response of Q7, 40% variation on the response of Q9, and 57% variations on the response Q10 for Australian tourist cohort, due to the difference in filtering method of the expert system. These results indicated that the perceived usefulness of the system was significantly enhanced by the use of the hybrid filtering method. Hypothesis 1-4, "[Delivering useful recommendations (R1)] is significantly dependent on the level of [experience of a user (F4)]" was accepted on the responses of Q8 for The Australian potential tourist cohort, of Q6 for the overseas potential tourist cohort and of Q7 and Q8 for the travel agent cohort. There were 34% variations on the Australian tourists' responses of Q8, 45% variations on the overseas tourists' responses of Q6 and 35% and 43% variations on the travel agents' responses of Q7 and Q8 respectively. These results indicated that the perceived usefulness of the system was significantly enhanced by the experience level of a user. Interestingly, there was a 41% variation on the response of the overseas potential tourist cohort for Q8 due to the effect of complexity of a task. The result may be due to language difficulties of overseas tourists as they tended to struggle to understand complex tasks.

Questions 1, 2, 3, 4 and 5 in the follow-up questionnaire evaluate whether the expert system employing a hybrid filtering process provide a discemable level of satisfaction in product retrieval to the user. It appeared that the hybrid filtering method had a relatively moderate positive effect on the response to the user satisfaction to the system. There were 40% variations on the response of Q2 for Australian potential tourist cohort, and 54% variations on the response of Q4 for travel agent cohort, due to the difference in filtering method of the expert system. These results indicated that the user satisfaction with the system was significantly enhanced by the hybrid filtering method. Hypothesis 4-1, "[Providing a discernable level of satisfaction to the user (R4)] is significantly dependent on [Complexity of a task (F1)]" was accepted on the responses of Q2 and Q5 for the overseas potential tourist cohort. There were 38% and 35% variations on the Australian tourists' responses of Q2 and Q5 respectively. These results indicated that the user satisfaction of the system was significantly decreased by complexity level of a task.

Table 7. Summary of Hypotheses for User Satisfaction of the System

User Satisfaction(R4)	Hypotheses	Factor	F-statistic	Fcrit	Coefficient in regression equation
Australian Potential Tourists					
Q2	4-3H0	F3	6.35	5.32	+0.63
Overseas Tourist					
Q2	4-1H0	F1	6.06	5.32	-0.75
Q5	4-1H0	F1	5.63	5.32	-0.63
Travel Agents					
Q4	4-3H0	F3	8.69	5.32	+0.63

6. Conclusions

The findings assessed the factors that were related to the overall evaluation of the users' perceptions of the travel recommender system. These factors allowed the researcher to measure how effectively and efficiently an expert system (using the proposed hybrid filtering system) was able to deal with complex tasks, multi-dimensional tasks, and to interact with highly experienced users over four different cohorts.

The results of the empirical evaluation showed the effectiveness of the proposed hybrid approaches for travel consultants, especially for potential tourists and overseas tourists as well as travel agents and tourism professionals. However, the travel recommender system was not of value for those people with a comprehensive knowledge of tourist destinations. It was also found that the recommender systems produced valuable, individualized recommendations in the form of ranked lists of products and guided the users in a personalized manner, based on the perceived users' interests.

The objectives of this research were achieved. The results showed that the average overall evaluation rating, given by the users towards matching tourism products to consumer needs in itinerary planning, was relatively high in the potential tourist cohort (4.06) and the overseas tourist cohort (3.56); was relatively moderate in the travel agent cohort (3.38) and the tourism professionals (3.19). The findings identified the factors related to the overall evaluation ratings. These factors allowed the researcher to measure how effective and efficient an expert system (that used a hybrid filtering system) was able to deal with complex tasks, multi-dimensional tasks, and to interact with highly experienced users over the four different cohorts.

The factor analysis showed that the hybrid filtering method had a strong positive effect on the overall evaluation of the system by the users. However, this research found that an increase in the experience level of a user and an increase in the complexity level of a task were negatively related with the overall evaluation of users for several of the cohorts. Moreover, the dimensionality of a task was not related to the overall evaluation by users, and hence the system seemed to have capabilities that allowed multi dimensional tasks to be performed.

The full factorial experimental methodology conducted in this research enabled the researcher to understand empirical relationships amongst several factors influencing the users' evaluation ratings. The major findings were; 1) More experienced retail agent saw less relevance of the recommender system, 2) Comments and observations indicated these participants preferred to seek products by name because of their level of familiarity with the product set and did not see immediate value of the filtering system, 3) Both Australian potential tourists and other tourism professionals saw value in the recommender system, especially the adoptive nature of the expert system, 4) The overseas potential tourists reacted to the lack of helpful process information for complex tasks, and also were less satisfied with the system if they had greater experience with other on-line systems.

The travel recommender system which adopted a hybrid approach in an expert system can be considered to add value to tourism development since the system has the potential to attract visitors to their local area. Most importantly the system assists the potential visitors to make better and faster decisions in making a travel itinerary by effectively filtering travel products which match user preferences and interest areas. The system allowed users to shorten the customer's time spent researching their destination and to spend more time examining interested products.

The limitations of the sample size and mode of selection are acknowledged. Only 16 evaluations were conducted for each group (in total 64 evaluations) and only one subject was allocated into each interaction of the factors. Therefore, it is hard to generalize the result of the research into other fields of study. This evaluation is preliminary research in the form of a screening design to gain an indication of which factors may be significant in the use of this system.

This paper has presented a hybrid approach and a tourism ontology to a travel recommendation system. There seems to be a capability to support users, but it did not previously have clear evidence to support this. This research has found that there is a great potential of the system in helping users in constructing useful travel plans which match their preferences by using a hybrid approach. The development of optimal travel recommender system is a time and cost-intensive issue [24] as users will have different kinds of needs and the systems that do not meet their needs or provide weak functionalities might be rejected. This research is valuable since such empirical evaluation research before its commercialization to discover strengths and weaknesses is able to provide the best and effective system possible.

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