Tourism Management Perspectives 20 (2016) 55–65

Contents lists available at ScienceDirect

Tourism Management Perspectives

journal homepage: www.elsevier.com/locate/tmp

Optimizing customer searching experience of online hotel booking by sequencing hotel choices and selecting online reviews: A mathematical model approach

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ARTICLE INFO

Article history:
Received 3 March 2016
Received in revised form 10 July 2016
Accepted 13 July 2016
Available online xxxx

Keywords:
Mathematical model
Multi-attribute user preferences
Online hotel booking
Online review
Sequential searching
Stochastic programming

ABSTRACT

A two-stage stochastic programming model to determine an optimal sequencing of hotels, with the online review selection provided by online travel agencies (OTAs), is developed. The multi-attributes of hotels and online reviews containing various indicators (e.g., location and service) are all incorporated in a booking decision. To determine the optimal stopping search step for customers, a sequential search behavior is assumed. The objective of model is to minimize the expected number of search steps to reach a hotel of which all characteristics satisfy customer expectations under optimal search behavior. The effectiveness of the proposed model is confirmed in a case study using real data from an OTA. The contribution of this paper is to propose a new model that OTAs could practically adopt to generate an optimal sequence of hotels with a selection of online reviews to shorten search time for customers and yield a high number of booked rooms.

1. Introduction

The emergence of the Internet has dramatically transformed the hospitality and tourism industry. For example, aiming to expand their distribution channels, a number of hotels started cooperating with online travel agencies (OTAs) (Guo, Ling, Dong, & Liang, 2013). The popularity of cooperating with a growing number of OTAs increases the number of hotel bookings done online. Recently, OTAs have become a major source of online hotel bookings. They provide travelers with a superior experience in regard to accessing hotel information while allowing them to share opinions freely and make bookings conveniently (Hao, Yu, Law, & Fong, 2015; Amaro & Duarte, 2015).

The growing number of hotels and the availability of online reviews of OTAs increase choices, but incur considerable search effort on the part of an online customer (Konstan & Riedl, 2012). Searching all available hotels randomly might not reflect the actual search behavior of a customer. Accordingly, online users are calling for an efficient approach for evaluating thousands of hotels and online reviews in a short time. In addition, today's society is more concerned with search cost and search time. Full utilization of a large amount of information is expected to provide an interesting insight into the relationship between customer satisfaction and hotel attributes. The development of a recommendation system and a filtering mechanism is a pressing issue for many researchers. These mechanisms are necessary to avoid unnecessary information that does not fit a customer's criteria and to facilitate the searching process for a potential customer. To understand precisely what a customer needs, the criteria involved in hotel selection, effect of online reviews, and customer search behavior should be incorporated in the search mechanisms. However, certain challenges arise when facing the complexity of tourism products, multi-criteria decisions, and uncertainty of customers. With the aim of helping a customer make better decisions with lower search effort, an optimal sequencing of hotels with selected online reviews is investigated in the present study. In particular, the decisions are made on the basis of customer-defined criteria and sequential search behavior.

Understanding a customer's decision plays a major role in determining a successful business. The criteria for hotel selection and customer satisfaction have been extensively investigated by many researchers in tourism. It was found that hotel attributes (e.g., star rating, convenience, and facilities) drive customer-satisfaction level, but they contribute differently across different types of customers (Radojevic, Stanisic, & Stanic, 2015). Specifically, one survey result revealed that a solo traveler has a higher baseline satisfaction level than a family traveler. Also, American tourists consider cleanliness and value for money, but they concentrate on security when they travel overseas (Shanahan & Hyman, 2007). Although hotel attributes (e.g., safety, food, convenience, non-smoking rooms, cleanliness, and price) contribute to a traveler's satisfaction level, they are differently perceived across destinations or countries. Several frameworks for studying customer satisfaction concerning hotels have

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http://dx.doi.org/10.1016/j.tmp.2016.07.003
2211-9736/

been devised (Deng, Yeh, & Sung, 2013; Kim & Perdue, 2013; Ren, Qiu, Wang, & Lin, 2016; Subramanian, Gunasekaran, & Gao, 2016).

Online reviews have become a source of travel information that most online travelers adopt to reduce perceived risk and make a booking decision (Gretzel & Yoo, 2008). Different types of travelers concentrate on the indicators mentioned in online reviews (e.g., cleanliness, location, value for money, room condition, service, and sleep quality) in different ways (Korfiatis & Poulos, 2013). Similarly, the indicators mentioned in online reviews to identify customer expectations concerning different trip modes were analyzed by Liu, Law, Rong, Li, and Hall (2013). It was also found that the availability of online reviews influences online sales and the popularity of hotels. A model that determines the influence of online reviews on online hotel sales was proposed (Ye, Law, & Gu, 2009). Moreover, it was found that review rating, overall hotel ranking, and the number of online reviews determine the number of online bookings and hotel revenues (Torres, Singh, & Robertson-Ring, 2015). The characteristics of a hotel and online reviews (e.g., number of positive reviews), compared with hotel performance, were examined (Phillips, Zigan, Silva, & Schegg, 2015). Moreover, online-review attributes (e.g., perceived usefulness, enjoyment, and understandability) influence the trust and intentions of online customers (Elwalda, Lü, & Ali, 2016).

Developing a recommendation system for online shopping, which alleviates information overload on online customers, has become a pressing issue. To address that issue, several approaches for predicting customer preferences have been developed; in particular, the most common recommendation systems are based on user-generated content (e.g., social media and online reviews) and collaborative filtering (Ghose, Ipeirotis, & Li, 2012; Konstan & Riedl, 2012). In regard to research on tourism, indicators used in online reviews (e.g., cleanliness, location, and service) were found to differ across traveler types (Korfiatis & Poulos, 2013). In that research, a "demographic recommendation system" based on user-defined preference criteria was proposed. To enhance the predictive accuracy of such hotel-recommendation systems, multi-criteria collaborative-filtering techniques were incorporated (Nilashi, Ibrahim, Ithnin, & Sarmin, 2015).

Most existing approaches concerning a hotel-recommendation system concentrate on multi-selection criteria and propose a utility or satisfaction model for predicting a good hotel. Online reviews are a major source for indicating preferences of similar types of customers. However, these approaches have two limitations: (i) fixed sample size in the case of sequential search behavior with optimal stopping time, and (ii) room availability under an uncertain arrival of customers. Moreover, the high volume of unnecessary online reviews confuses online customers in regard to evaluating the best product. A mechanism for selecting useful online reviews among the unnecessary ones on the basis of user-preference criteria is necessary and a few have been developed. While the main characteristics of useful online reviews have been analyzed extensively (for example, by Liu & Park, 2015), only one mechanism for ranking online reviews has been proposed (Ghose & Ipeirotis, 2007). However, this mechanism ignores user-preference criteria in the online-tourism context.

Using an optimization model is a common practice in e-commerce, which can be found in literature. Cooperation between a hotel and a third-party company is very common in practice. Papers have presented an application of the optimization model to derive optimal pricing decisions and revenue management. Using a pricing game model, Ling, Guo, and Yang (2014) derived the optimal decision on the unit commission for a hotel that cooperates with OTAs to maximize profit. Guo, Zheng, Ling, and Yang (2014) presented economic game analysis to determine the unit commission fee on OTAs, and cash back value for a customer so that profit of OTAs was maximized. Moreover, many studies on dual-channel distribution systems investigated optimal decisions on pricing and service level to maximize the revenue. For example, Lu and Liu (2013) proposed modelling competition for a supplier selling a product through conventional and e-commerce channels. The pricing and profit of a retailer and a supplier were analyzed with several key factors (e.g., efficiency of e-channel). Lau, Jiang, Ip, and Wang (2010) developed a fuzzy location model to optimize the distribution system design in B2C e-commerce under fuzzy variables (e.g., supply and demand). Furthermore, many approaches for a recommendation system were developed using an optimization model based on analysis of online reviews to find the best product for a customer (Nilashi et al., 2015). The maximum utility gained from a product was studied in an online hotel recommender system by Ghose et al. (2012). Kamiński and Szufel (2015) proposed an algorithm for the optimization of a simulation execution in the Amazon Elastic Compute Cloud (Amazon EC2) with a spot pricing mechanism. Using the proposed algorithm, the bidding strategy was analyzed to minimize the computation cost and time for running simulations on the system. This algorithm is ready for the application of real life simulations executed on Amazon EC2.

Promoted by many research forums concerning marketing and human behavior, search theory has made theoretical contributions to understanding customer behavior. A search is a major activity before making a purchase decision. "Non-sequential search model" and "sequential search model" are commonly used to deal with a customer's choice and search problem. The assumptions of each model have advantages and limitations. In the assumptions of "non-sequential search model", a searcher fixes the sample size, screens the samples, and decides the best sample for a certain period (Grosfeld-Nir, Sarne, & Spiegler, 2009; Stigler, 1961; Ghose et al., 2012). The problem is determining the optimal sample size at the minimum cost of a linear search. A searcher can achieve a best-choice decision with the highest expected utility (or search offer). However, this model has limitations in a realistic search problem, especially when search cost is expensive, or when a searcher faces a time constraint for decisions (e.g., Ommeren & Russo, 2014; Morgan, 1983; Krishnan, 2007). Thus, the sequential search model is more appropriate, as it makes an optimal decision on the balance of search cost (including time) and utility (search offer), based on each curriculum (Feinberg & Johnson, 1977; Lippman & McCall, 1976). Also, in an online hotel booking, some customers may not observe all available hotels on the website and expect the best hotel with the highest expected utility, but simply make a satisficing decision under constraint of time (e.g., business traveler). In this case, the search behavior matches the sequential search used by this model.

The assumptions of "sequential search model" are commonly assumed in most search problems, such as shopping online (Chhabra, Das, & Sarne, 2014; Zwick, Rapoport, Lo, & Muthukrishnan, 2003; Grosfeld-Nir et al., 2009), job search (Lippman & McCall, 1976), residential search (Phipps & Laverty, 1983), choosing a mate (Cheng, Seubert, & Wiegmann, 2014), and other search problems (Müller, 2000; Mak, Rapoport, & Seale, 2014). Accordingly, the use of these assumptions has justification, commonly discussed by mathematical theorems. Under these assumptions, a searcher can flexibly decide either to accept a choice or continue searching, using a personal optimal stopping policy (Lippman & McCall, 1976). This approach determines an optimal control limit for an optimal stopping rule (e.g., reservation value). In practical terms, typical customers have different constraints of time and expectation level from a hotel, and thus, they perform different searching processes. Using an experimental methodology for analysis of the actual search behavior in the job search and apartment search problems, the results revealed that most of respondents tended to search sequentially in the same optimal way as the search theory (Braunstein & Schotter, 1982; Phipps & Laverty, 1983). These results strongly support the consistency of sequential search assumptions and actual search behavior. Feinberg and Johnson (1977) examined the superiority of "sequential search" over "non-sequential search" based on the distribution of search cost. The findings show the superiority of sequential search in terms of net expected return, especially in the middle range of search cost. Furthermore, the sequential search can simplify the model, and lead to an optimal decision within an acceptable computation time. These are the main reasons that the sequential search model has been adopted in many applications.