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# A systematic approach for predicting loyalty behavior of tourist destinations

Ahmad Reza Talae Malmiri, Roxana Norouzi Isfahani, Ahmad BahooToroody and Mohammad Mahdi Abaei

## Abstract

**Purpose** – Destinations to be able to compete with each other need to equip themselves with as many competitive advantages as possible. Tourists' loyalty to a destination is considered as a prominent competitive tool for destinations. Tourists' loyalty manifests itself in recommendation of the destination to others, repeat visit of the destination and willingness to revisit the destination. Although a plethora of studies have tried to define models to show the relation between loyalty and the antecedent factors leading up to it, few of them have tried to integrate these models with mathematical approaches for better understanding of loyalty behavior. The purpose of this paper is to integrate a tourist destination model with Bayesian Network in order to predict the behaviour of destination loyalty and its antecedent factors.

**Design/methodology/approach** – This paper has developed a probability model by the integration of a destination loyalty model with a Bayesian network (BN) which enables to predict and analyze the behavior of loyalty and its influential factors. To demonstrate the application of this framework, Tehran, the capital of Iran, was chosen as a destination case study.

**Findings** – The outcome of this research will assist in identifying the weak key points in the tourist destination area for giving insights to the marketers, businesses and policy makers for making better decisions related to destination loyalty. In the analysis process, the most influential factors were recognized as the travel environment image, natural/historical attractions and, with a lower degree, infrastructure image which help the decision maker to detect and reinforce the weak factors and put more effort in focusing on improving the necessary parts rather than the irrelevant parts.

**Originality/value** – The research identified all critical factors that have the most influence on destination loyalty while driving the associate uncertainty which is significant for the tourism industry. This resulted in better decision-making which is used to identify the impact of tourism destination loyalty.

**Keywords** Destination image optimization, Loyalty prediction, Bayesian network

**Paper type** Research paper

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## Introduction

Tourist loyalty is considered as a competitive advantage for a destination (Almeida-Santana and Moreno-Gil, 2018; Weaver and Lawton, 2011), therefore attracting tourists and making them loyal is of a key concern for destinations managers (Hsu et al., 2009). To increase the number of inbound tourists and in consequence increasing the inbound tourism revenue, marketers should pay more and more attention to tourists' loyalty (Mohamed and Shaker, 2017). In addition, it is of great importance for tourist destination managers and policy makers to find out the elements that incorporate in tourists' loyalty to improve the attractions of a destination and accordingly to introduce better offerings, services and communication strategies that exceed tourists' expectations (Gursoy et al., 2014; Mohamed and Shaker, 2017). Tourist loyalty is also a significant contributor to a destination's success and flourish. Loyal tourists are willing to stay longer in destinations, give positive recommendations to others about the destination and as a result, lower the costs of promotions for the destination (Styliadis et al., 2020). Destinations can be categorized according to the

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area they cover; a destination may be defined as a country, state, region, city or town which is marketed or markets itself as a place for tourists to visit. One of the city destinations that has grown in importance through the recent years is Tehran. The statistics given by Iran's Cultural Heritage, Handicrafts and Tourism Organization show an expansion in the number of inbound tourists coming to Tehran, starting from around three million tourists in 2011 to almost five million in 2017 (CHHTOI, 2018). Tehran's tourism can boast a great potential since it encompasses so many natural and historical attractions like Alborz mountain range in the north and Iran National Museum in the heart of Tehran, yet lack of tourism-related infrastructures, lack of enough endeavor to make a good destination image and lack of strong foreign relationships, and most importantly, lack of a comprehensive domestic model of branding based on new information technology tools have made the city lag behind other tourist destination cities, in spite of its slow progression (Bidhendi *et al.*, 2021; Shafia *et al.*, 2019). Tehran, as a city destination has not integrated a concrete marketing plan for fostering its tourism. Although marketing a destination is quite challenging due to different reasons like the complicated relationships between different stakeholders in a specific destination, the potential contrasts in interests between these stakeholders, and lack of control and ownership of the whole chain of destination product and service supply–demand for tourists (Line and Wang, 2017), destination marketers and destination marketing organizations (DMOs) can cluster all destination-related stakeholders by means of designing a master plan enabling all parts to boost the image, brand and other competitive tools of a specific destination. In this circumstance, word of mouth advertisement and in respect tourists' loyalty to recommend a destination to other people as a competitive advantage may gain importance. Also, the mathematical approach has been applied to struggle with different concerns throughout the tourism sector (Baggio *et al.*, 2010; Smeral, 1988; Tyrrell and Johnston, 2008). One of these concerns being loyalty has been explained and estimated by means of different probabilistic tools (Hsu *et al.*, 2009; Popovic *et al.*, 2018; Chanpariyavatevong *et al.*, 2021). This paper aims to introduce a prediction model based on which it is possible to quantify the uncertainty of a tourist destination loyalty and find the most and least influential factors contributing to it. In this connection, a loyalty model is developed to interconnect qualitative representation of the key factors contributing to destination loyalty in causal inference, quantifying the uncertainty of the influencing parameters that highly affect tourism destinations' loyalty. In particular, to make this model capable of dynamic quantification, a probabilistic modeling tool is implemented to be able to reason under the uncertainty (Assaf and Tsonas, 2015; Hsu *et al.*, 2009, 2012). Among the different probabilistic-prediction models, two models of maximum likelihood estimation (MLE) and Bayesian statistics were found to be recommended by the researchers (Nielsen and Sørensen, 2010). To predict the behavior of factors contributing to a subject, a Bayesian network (BN) is increasingly used due to its advantages over other methods such as fault tree analysis (FTA) as discussed by Friis-Hansen (2000), Khakzad *et al.* (2011) and Straub (2005). There exist three main reasons for the Bayesian method to be superior to other methods. Firstly, it is a promising tool that allows the comprehensive reflection of available knowledge about the process (Abaei *et al.*, 2018; Arzaghi *et al.*, 2018; BahooToroody *et al.*, 2019; Leoni *et al.*, 2019). Secondly, in comparison to other tools such as the analytic hierarchy process (AHP) and factor analysis (FA), BN performs better in quantifying the uncertainty and solving decision-making problems when extended to an influence diagram (Friis-Hansen, 2000; Zwirgmaier *et al.*, 2015). Thirdly, in a Bayesian approach, it is also possible to convert continuous random variables into a discrete space, enabling the inference of more complicated stochastic relationships amongst many parameters (Friis-Hansen, 2000). That means each variable involved in the problem can be analyzed explicitly rather than in a binary space.

The BN as a probabilistic modeling tool has been widely implemented for uncertainty assessment in tourism systems. Hsu *et al.* (2009) merged the BN with the linear structural relation model (LISREL) to consider the factors affecting tourism loyalty and predict the level of the tourists' loyalty. A total of 452 valid samples from tourists with the tour experience of the Toyugi, Taiwan, were accounted for to conduct the proposed methodology. According to the previous conducted research, the established Bayesian ridge regression to a tourism data set in order to treat the biased constant as a parameter of inference. The model proposed to find the optimum solution for the multicollinearity problem as a most important misconception in the tourism research field.

In previous studies related to destination loyalty, different statistical methods have been used. Among these methods, some measures including explanatory and confirmatory factor analysis (Chi and Qu, 2008; Hultman *et al.*, 2015; Sun *et al.*, 2013), structural equation modeling (SEM) (Brida *et al.*, 2012; Prayag and Rayan, 2012; Eusebio and Vieira, 2013) and the logit modeling (Meleddu *et al.*, 2015; Almeida-Santana and Moreno-Gil, 2018) were more widely implemented than others. While these studies have either recognized the strength of relationships between destination loyalty and its antecedent factors or estimated the state of loyalty through regressions, none have analyzed the behavior of loyalty and its influencing factors under different uncertainty scenarios, given new evidence in a prediction model. Moreover, the tourism industry sector for planning effective, sustainable marketing strategies for destination loyalty needs to find an optimum design of sustainable destination loyalty by mapping out destination loyalty on a probabilistic/decision-making model like the BN to help DOMs come up with better plans to make tourists coming to their destinations more loyal.

This paper aims to introduce a systematic approach to analyze the factors contributing to any city destination loyalties and predict their behavior. Tehran, as a potential tourist city to attract more tourists, is introduced as a case study. In this respect, firstly, a qualitative tourist loyalty model is presented to identify casual representative factors; secondly, a survey analysis based on expert's judgment is done to obtain essential data for implementing in the probability model and thirdly, these data are integrated with the BN to predict the loyalty of the city destination. The outcome of this research will assist in identifying the weak critical points in the tourist destination area for giving insights to the marketers, businesses and policy makers in making better decisions related to destination loyalty.

## Tourism loyalty

Based on the conducted research, two aspects of loyalty have been recognized: behavioral and attitudinal (Almeida-Santana and Moreno-Gil, 2017; Baloglu, 2002; Kumar *et al.*, 2006). In behavioral loyalty, revisit intention of a destination and ongoing revisits of a destination is taken into consideration, while attitudinal loyalty manifests tourists' emotions and perceived value toward a destination that results in recommendation of that specific destination and also willingness to revisit it (Almeida-Santana and Moreno-Gil, 2017; Meleddu *et al.*, 2015). In a vast and multidimensional subject like a tourism destination that involves many services such as hotel services, transportation, etc., finding out the proper attributes and factors influencing the tourist's loyalty gains importance (Tasci, 2017). In an early investigation of previous studies, among 17 proposed factors, just three showed significant relation to destination loyalty; safety, different cultural experience, convenient transportation. A blaze of studies have recognized satisfaction as the main factor contributing to tourist loyalty (Almeida-Santana and Moreno-Gil, 2018; Chi and Qu, 2008; Hultman *et al.*, 2015; Rajesh, 2013; Ramseook-Munhurrin *et al.*, 2015; Sun *et al.*, 2013; Velázquez *et al.*, 2011; Yoon and Uysal, 2005). In a study, Rajesh (2013) investigated the impact of tourist perceptions, the destination image and satisfaction on tourist loyalty, and proposed a model to explain the antecedents leading up to destination loyalty. In his model, the travel environment, natural attractions, historical and cultural attractions, accessibility, infrastructure, relaxation, price, and value were introduced as image attributes, and attractions, accessibility, lodging, dining, the environment, shopping, event, and activities as satisfaction attributes, following a research by Chi and Qu (2008). Also, the studies of Sun *et al.* (2013) and Ramseook-Munhurrin *et al.* (2015) suggest both a direct effect and an indirect effect of perceived value through the moderating role of satisfaction on destination loyalty. Service quality also has proven to promote word of mouth and cause repeat purchase (Cole and Illum, 2006; Velázquez *et al.*, 2011). Hsu *et al.* (2009) in an attempt to introduce a framework to predict tourism loyalty using the BN, however, indicate three factors contributing to loyalty: Customer relationship management (CRM), web function and local characteristics. Other factors like novelty seeking, place attachment, information search and demographic characteristics (Almeida-Santana and Moreno-Gil, 2017; Mohamed and Shaker, 2017; Yuksel *et al.*, 2010) also have been mentioned as factors affecting loyalty, but there were

lacks for an uncertainty analysis for evaluating the contribution of each factors to the loyalty and its effect on post-tourism behavior such as likelihood of travelers returnee.

### Bayesian network

The BN is a graphical model for reasoning under uncertainty that uses causal relationships (represented by directed edges) among components of a system (represented by chance nodes). The BN estimates the joint probability distribution of a set of random variables based on the conditional independencies and the chain rule, as stated in Eq. (2). An extensive review of the BN and probabilistic knowledge elicitation including its applications in uncertainty modeling is provided by Barber (2012).

$$P(X_1, X_2, \dots, X_n) = \prod_{i=1}^n P(X_i | pa(X_i)) \quad (1)$$

where,  $pa(X_i)$  is the parent set of variable  $X_i$ . As an example, the joint probability distribution of the random variables  $X_1$ – $X_4$  shown in Figure 1 is estimated by  $P(X_1, X_2, X_3, X_4) = P(X_1)P(X_2)P(X_3 | X_1, X_2)P(X_4 | X_3, X_2)$

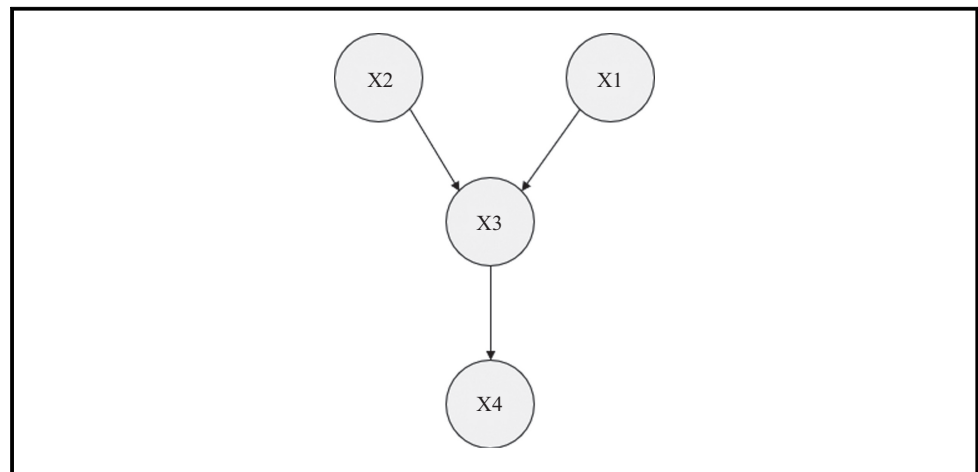
In case new information becomes available for one or more chance nodes, the BN is able to update the joint probability based on the Bayes' theorem:

$$P(X | E) = \frac{P(X, E)}{\sum_x P(X, E)} \quad (2)$$

### Methodology: loyalty prediction tool

In this part, a framework is presented based on which destination loyalty uncertainty can be assessed. To this end, a loyalty model based on the essential influence parameters which best describe destination loyalty attributes is introduced; then a questionnaire based on the proposed conceptual destination loyalty model and answered by experts for obtaining raw data to be fed into the constructed probability network using Bayesian approach is designed. Lastly, the developed loyalty model is set on the BN, and the obtained data from the questionnaire is fed to it to see how different factors have contributed to loyalty uncertainty and how loyalty may perform in the various given scenarios.

**Figure 1** A schematic representation for the BN based on uncertain factors and their hypothetical casual relation



The developed BN has the capacity to evaluate the performance of loyalty in terms of identified influence factors and, in this respect, estimate the most optimum scenario of loyalty destination; thus, it can provide a great opportunity for DMOs and policy makers in the field of tourism to identify the most influential factors contributing to loyalty and plan to focus more on them.

### Qualitative loyalty model and survey analysis

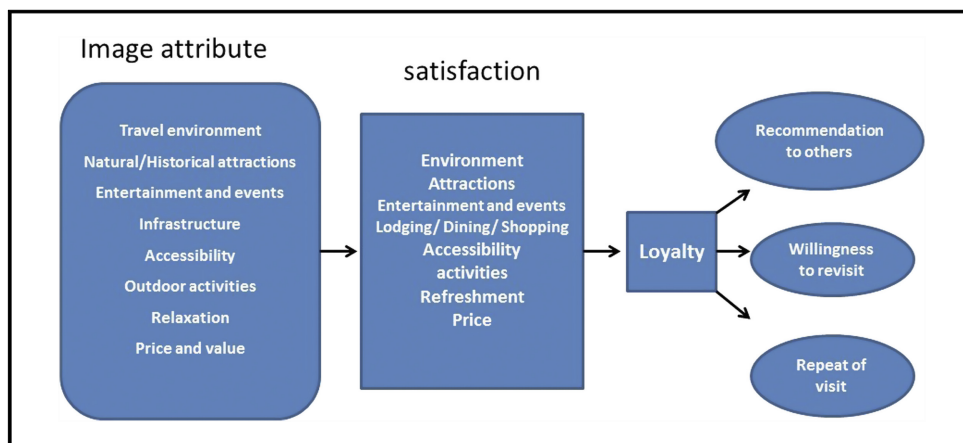
The loyalty model is introduced in a way to focus more on the destination attributes and components. In order to perceive the causal relation between influencing factors in the destination loyalty assessment, a qualitative framework is developed. According to research conducted by [Rajesh \(2013\)](#) and [Chi and Qu \(2008\)](#), a few image attributes and satisfaction attributes were highlighted. However, in this study the imperative factors are observed to form a systematic qualitative loyalty framework that enables integration of the model with the BN for loyalty prediction.

There should be prior knowledge for the BN to run. This prior knowledge is assigned to the independent variables – parent nodes – and, based on this prior knowledge and conditional tables within the BN, the estimation for dependent variables are conducted. In other words, the BN consists of children nodes and parent nodes. For the BN to compile, raw data of parent nodes should be provided and based on conditional relations between different nodes, the state of children nodes (second or third order factors) are estimated. Based on this fact, items of the questionnaire cover only the image factors (IFs) that are considered as parent nodes of the proposed BN. This means that the obtained data for IFs are sufficient for the BN to run. For the prior knowledge in the BN, a questionnaire based on the image attributes connected with satisfaction attributes can be proposed to help generate logical statistical numbers that assist for the third part of the methodology – destination loyalty prediction. The desired questionnaire respondents will be asked to rank from scale 1 to 5 according to their agreement to the statements. The results will be further analyzed for implementation in Bayesian inference. An illustration of the loyalty model and the image parts responsible for constructing the questionnaire items is represented in [Figure 2](#).

### Questionnaire design for image factors

IFs have been considered parent nodes in the proposed BN and therefore needed to be fed by prior knowledge. In this study, the required data for IFs have been obtained through questionnaires that the field experts responded to. Experts who were asked to answer the questionnaire were among experienced tour guides and prolific academicians. These experts were chosen as they have a good knowledge of inbound tourists' attitudes traveling to Iran. The questionnaire items

**Figure 2** Determining influencing factors and their causal relationship for elaborating loyalty of the destination city



were adopted from [Chi and Qu \(2008\)](#) and [Rajesh's \(2013\)](#) studies. As illustrated in [Figure 2](#), the travel environment, natural/historical attractions, entertainment and events, infrastructure, accessibility, outdoor activities, relaxation, price and value were the factors that have been addressed in the questionnaire. The items of the questionnaire related to each IF are illustrated in [Figure 3](#).

In the next step, the constructed questionnaires are distributed to experts. These experts are asked to rank each item based on a five-point scale, indicating how much they agree to the statements: 1 being strongly disagree and 5 being strongly agree. As subjectivity and variability of expert judgment could influence the data obtained, Dempster–Shafer theory is implemented on the data to reduce the conflict of judgments. The basic probability assignment (BPA) for each individual IF is obtained from the expert judgment. As the IF is assigned to five different possibilities – strongly agree, agree, undecided, disagree and strongly disagree – the BPA is assigned by an expert for each of these states and expresses the degree of expert opinion. The BPA is represented by  $m(p_i)$  and can be characterized by the following equation:

$$m(p_i) \rightarrow [0, 1]; \quad m(\varphi) = 0; \quad \sum_{p_i \in \mathcal{P}} m(p_i) = 1 \quad (3)$$

The DST combination rule is then used to accumulate the different knowledge sources according to individual expert degrees of belief. If there are  $n$  different knowledge sources that are to be combined, the orthogonal sum combination rule will be as shown in the following [Eq. \(4\)](#):

$$m_{1-n} = m_1 \oplus m_2 \oplus \dots \oplus m_n \quad (4)$$

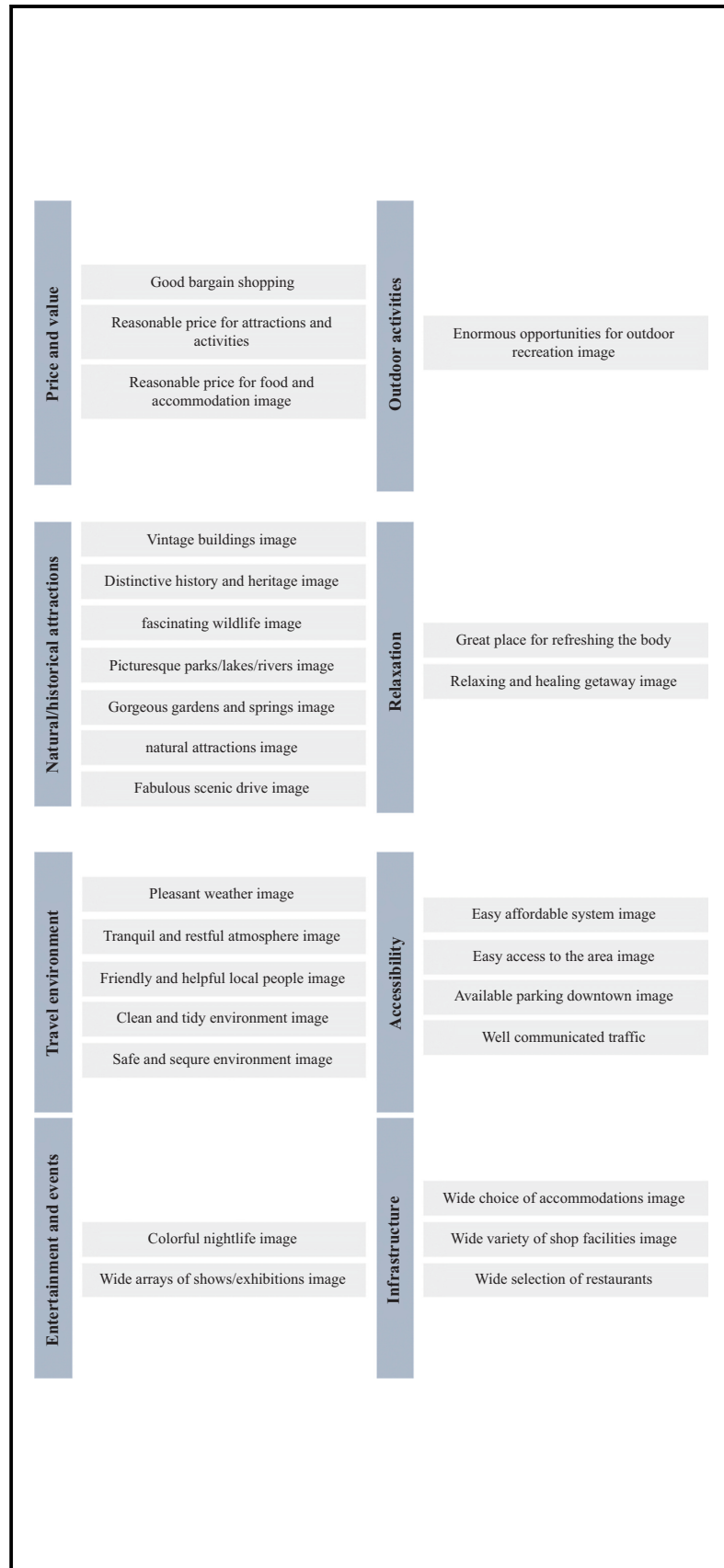
The DST combination rule by implementing a normalizing factor  $(1 - k)$  creates a consistency among the multiple knowledge sources and disregards all conflicting evidence through normalization. Considering all knowledge sources independent, the DST combination rule uses AND-type operators. For example, if  $m_1(p_a)$  and  $m_2(p_b)$  are two sets of evidence for the same event collected from two different sources; the DST combination rule uses the relation in [Eq. \(3\)](#) to combine the evidence:

$$[m_1 \oplus m_2](p_i) \begin{cases} 0 & \text{for } p_i = \varphi \\ \frac{\sum_{p_a \cap p_b = p_i} m_1(p_a) m_2(p_b)}{1 - k} & \text{for } p_i \neq \varphi \end{cases} \quad (5)$$

### **Bayesian network framework**

In this part, a Bayesian framework based on the proposed qualitative loyalty is projected. The image attributes are considered prior information in the framework, as they directly affect the satisfaction attributes. Based on the expert judgment points derived from the designed questionnaire, a set of IFs identified as  $IF = [A1, B1, C1, D1, E1, F1, G1, H1]$  has a potential contribution for varying the tourism satisfaction factors (SFs) according to the set of  $SF = [A2, B2, C2, D2, E2, F2, G2, H2]$  in a target destination (see [Table 1](#)). For this reason, there are conditional links from each array of IFs to all member of SFs in the network as depicted in [Figure 4](#). Accordingly, the uncertainty of destination loyalty is modeled by the influence link derived from the set of SF members. Regarding the attributes of loyalty ([Almeida-Santana and Moreno-Gil, 2017](#); [Meleddu et al., 2015](#)), three factors are considered in the network for the direct conditional influence of the destination loyalty; these factors represent the most important characteristics of loyalty to a destination and are estimated by three modes of returnee, intention and recommendation. The developed network will be able to analyze the behavior of destination loyalty and its antecedent factors. In one common analysis, the state of loyalty is improved to its optimum state, therefore estimating the most effective IFs of the considered destination and alleviating the associated uncertainty regarding IFs leading to destination loyalty. The description of the nodes in the developed BN is abbreviated according to [Table 1](#).

**Figure 3** The structure of the questionnaire for survey analysis regarding destination loyalty assessment

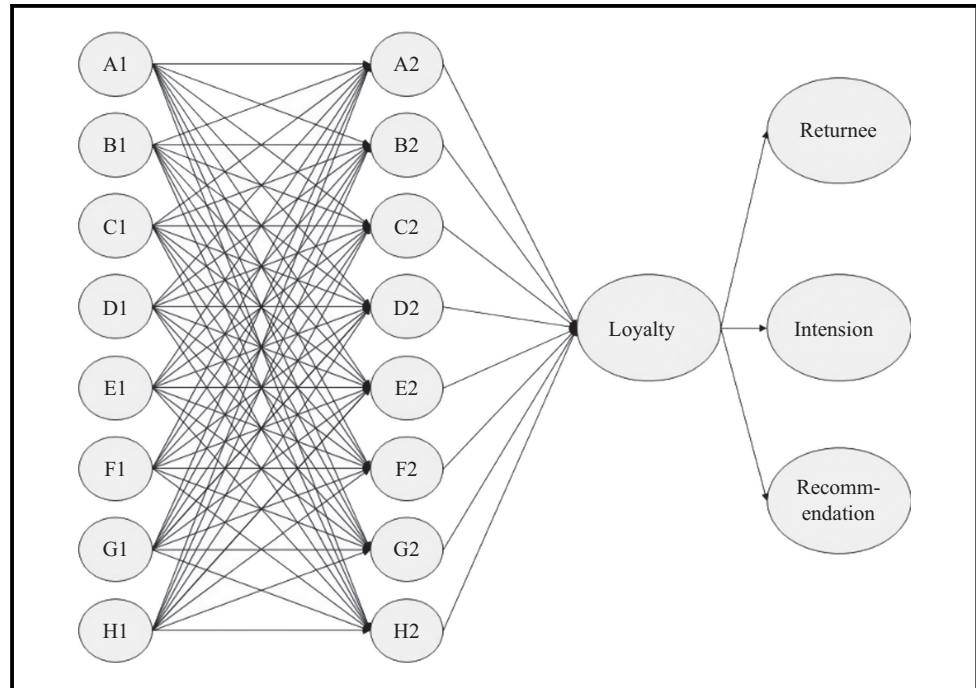




**Table 1** The definition of the IF and SF sets that were considered in the developed network

Travel environment image	A1	Environment satisfaction	A2
Natural/historical attractions image	B1	Attractions satisfaction	B2
Entertainment and events image	C1	Activities and events satisfaction	C2
Infrastructure image	D1	Shopping/lodging/dining satisfaction	D2
Accessibility image	E1	Accessibility satisfaction	E2
Relaxation image	F1	Refreshment satisfaction	F2
Outdoor activities image	G1	Activities satisfaction	G2
Price and value image	H1	Price satisfaction	H2

**Figure 4** Developed BN for prediction loyalty of tourist destination respect to essential influencing factors



### Application of the framework: a case study

To demonstrate the application of the methodology, a case study is adopted for loyalty prediction of tourists coming to Tehran. Tehran has high potential in attracting tourists, as it has untouched historical, cultural and natural attractions. However, there is still need to optimize the marketing and policy making approaches for this destination. To achieve this objective, the proposed framework is developed to help improve the condition of destination loyalty in Tehran. The remaining of this section will describe the loyalty behavior of Tehran as a newly noticed destination regarding the associated uncertainty factors.

The primary data for the BN were obtained through the process described in the questionnaire design section. In the questionnaire for each item related to IFs, five options from strongly agree to strongly disagree, and weighted from 1 to 5 exist. According to the weights given by experts to each item of the questionnaire and normalization of data based on Dempster–Shafer theory, the results were, then, further described in percentage and summarized in Table 2. In the questionnaire the travel environment image is assessed using five items, natural/historical attractions image using seven items, entertainment and event image using two items, infrastructure image using three items, accessibility image with four items, relaxation image with two items, outdoor activities image

**Table 2** Contribution of the responders to the IFs according to the questioner items

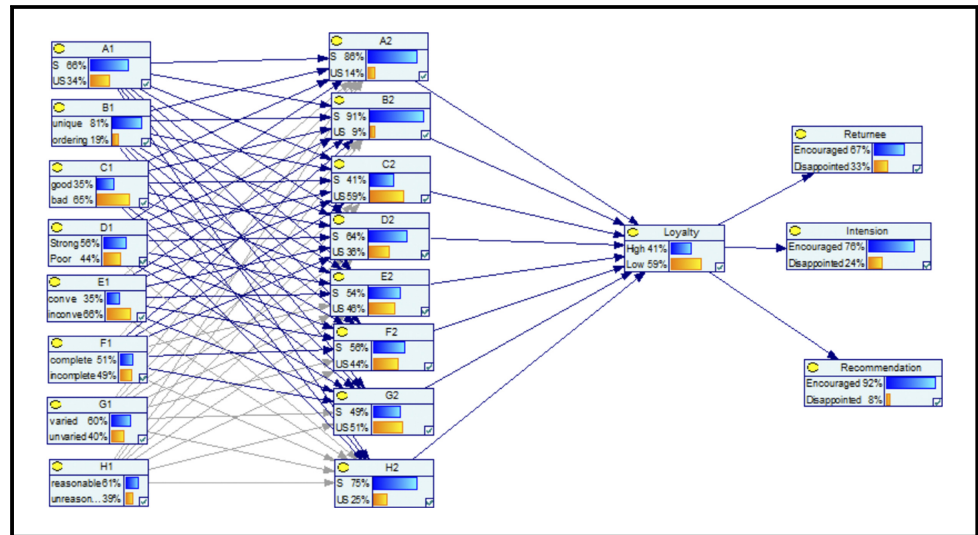
Travel environment 65.6%	Safe and secure environment image	46%
	Clean and tidy environment image	52%
	Friendly and helpful local people image	95%
	Tranquil and restful atmosphere image	60%
	Pleasant weather image	75%
Natural/historical attractions 81.5%	Fabulous scenic drive image	90%
	Breathtaking scenery and natural attractions image	90%
	Gorgeous historical gardens image	85%
	Picturesque parks/lakes/rivers image	80%
	Unspoiled wilderness and fascinating wildlife image	70%
	Distinctive history and heritage image	90%
	Vintage buildings and sites image	94%
Entertainment and events 35%	Wide arrays of shows/exhibitions image	45%
	Colorful nightlife image	25%
Infrastructure 56%	Wide selection of restaurants/cuisine image	62%
	Wide variety of shop facilities image	50%
	Wide choice of accommodations image	56%
Accessibility 34.5%	Well communicated traffic flow and parking information image	30%
	Available parking downtown image	30%
	Easy access to the area image	46%
	Easy-to-use and affordable trolley system image	32%
Relaxation 51%	Relaxing day spa and healing getaway image	46%
	Great place for soothing the mind and refreshing the body image	56%
	Enormous opportunities for outdoor recreation image	60%
Outdoor activities 60%	Reasonable price for food and accommodation image	60%
	Reasonable price for attractions and activities	70%
	Good bargain shopping	52%
	Price and value 60.6%	

with one item, and price and value image with three items. The number of items for each contribution was defined based on the expert opinions and their concern for the image contributions to loyalty perception. These judgments were made based on the compatibility of the items with Tehran as a destination.

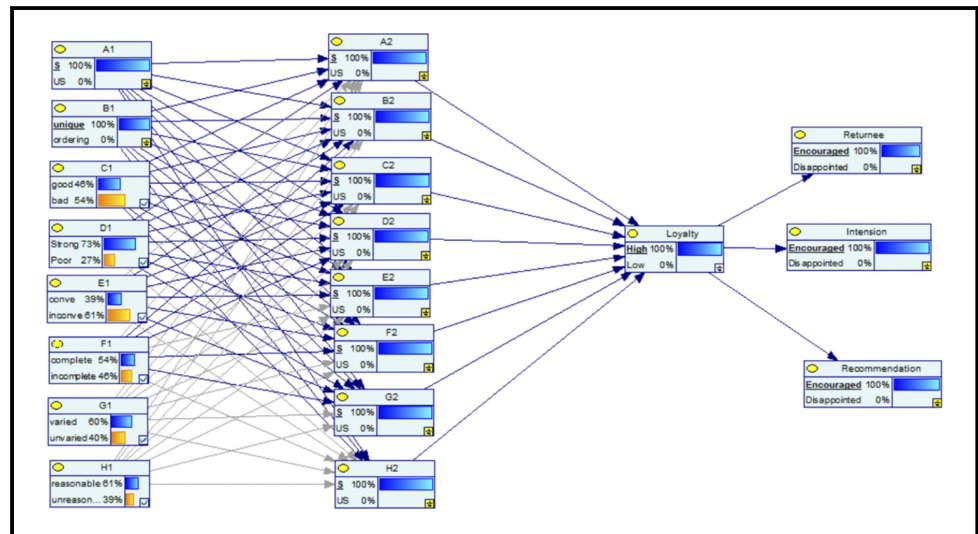
In order to perform loyalty estimation with the developed BN, the root nodes of the network for IFs are fed by prior knowledge obtained from experts. Then, to consider the conditional dependency of the satisfaction factors with the images, the logic value of zeros (not satisfied) and ones (satisfied) are considered according to the expert judgment perception on the contribution of satisfaction on the loyalty of the destinations. This concept was previously suggested by Friis-Hansen (2000) to fill up the conditional probability tables (CPTs) and to start the Bayesian inference. This will cause the first compile of the network to find the joint probability of satisfaction nodes as perceived by expert judgments. Finally, the CPT of the loyalty node and consequences nodes of loyalty attributes are filled by the “And-gate” concept (Khakzad *et al.*, 2011) to find the most critical scenario that helps estimate better tourist loyalty observance. Given the information fed into the BN, Tehran’s anticipated loyalty as a destination is 41% based on the prior knowledge collected from survey observations. The loyalty attributes percentage of contribution are all calculated through the network. The returnee repeat visit stands as 67% encouraged, the intention to revisit stands as 76%, and recommendation to others as 92%, being the most influential attribute of Tehran destination loyalty. The results are shown in Figure 5.

In a back-propagation analysis, given that it is aimed to reach a hundred percent loyal travelers, the most important and influential IFs that contribute to a hundred percent loyalty, are recognized. As illustrated in Figure 6, which shows the back-propagated Tehran loyalty BN, A1 (travel environment) and B1 (natural/historical attractions) are considered as the most prominent factors leading to high percentage of loyalty to Tehran as a tourist destination. C1, D1, E1 and F1 contribute to loyalty optimization much less, and G1 and H1 have no contribution at all. To analyze

**Figure 5** BN for loyalty to Tehran as a tourist destination according to the prior knowledge of the traveler deductions for selecting Iran as a tourism destination

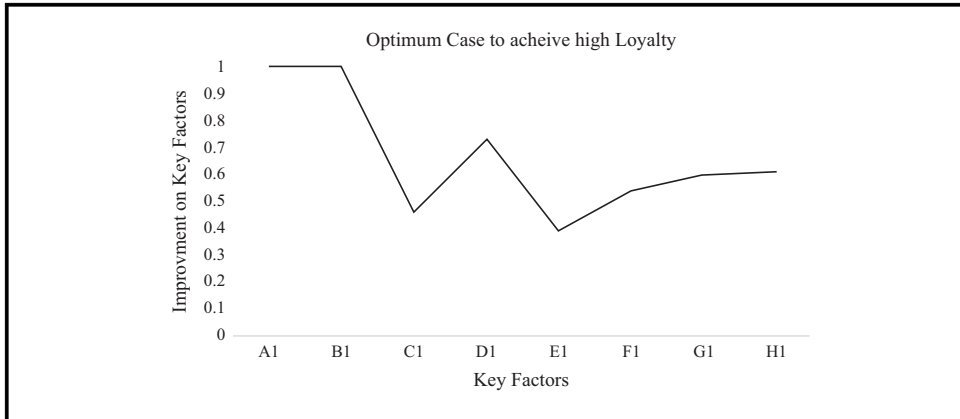


**Figure 6** The back-propagation analysis for estimating optimized improvement of tourism loyalty



the results better and to give a clearer representation of the back-propagated BN result, the states of IFs in the back-propagated BN are mapped out on a line graph, represented in Figure 7. As represented in this line graph, A1(travel environment), B1(natural/historical attractions) and D1(infrastructure) contribute the most in raising the state of loyalty to its optimum level. This graph also informs that for optimization of the loyalty, it is not necessary to consider every IF influential, and there is no need for every IF to be in its most optimized state. In other words, it is possible to define a scenario for IFs' behaviors when the optimum state of destination loyalty is given as new evidence in the BN. As a result of this analysis, the IFs that have the most contribution to improvement of Tehran destination loyalty will stand out.

**Figure 7** IFs optimization achieved from the BN

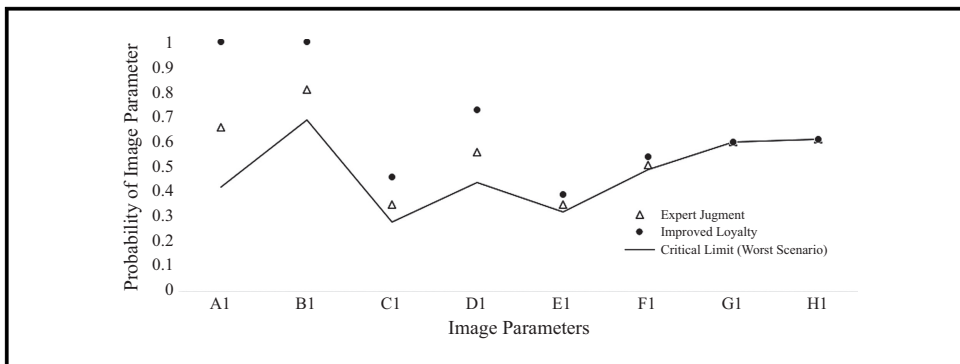


To compare this optimized state of IFs with experts' judgments and also to point out the critical limit of these factors, another graph is rendered in Figure 8. In this plot, the improved IFs contributing to improved loyalty, deducted from back-propagation analysis, are shown with black dots; also, experts' judgments speculations before improvement are depicted with small triangles and the worst-case scenario of the loyalty status, drawn from another back-propagation analysis of the BN where destination loyalty is considered to be zero percent for the selected destination city, is shown with a straight line. The worst-case scenario of Tehran destination loyalty is, in fact, an illustration of the critical condition that would result in no satisfaction for travelers.

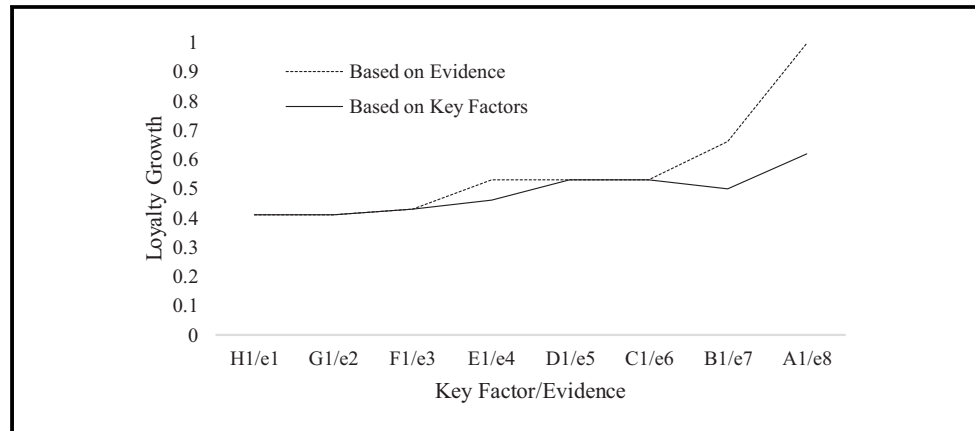
Figure 9 represents a line graph showing results inferred from forward propagation analysis of the BN. On the Y-axis the state of loyalty is shown according to the X axis for two different conditions (1) the contribution of each IF in its best improved condition and (2) the influence of cumulative evidence on progressive improvement of series of image parameters for the destination loyalty. The unbroken line shows the growth of loyalty when only each factor separately is taken into consideration as it is the best condition in the BN, each being individually one hundred percent effective on satisfaction and in return on loyalty. These key factors' influences are shown by H1 to A1 on the graph. The broken line from e1 to e8 show the influence of factors cumulatively, which means e8 is the successive addition of H1 to A1. This graph shows how important the evidence e6 to e8 are for optimization of Tehran's destination loyalty.

Finally, to demonstrate the most influential factors on loyalty attributes – recommendation, intention to revisit, repeat of visit – each factor is optimized to a 100% state in order to check the changes happening to these attributes. The results were further represented in a line graph (Figure 10). As it

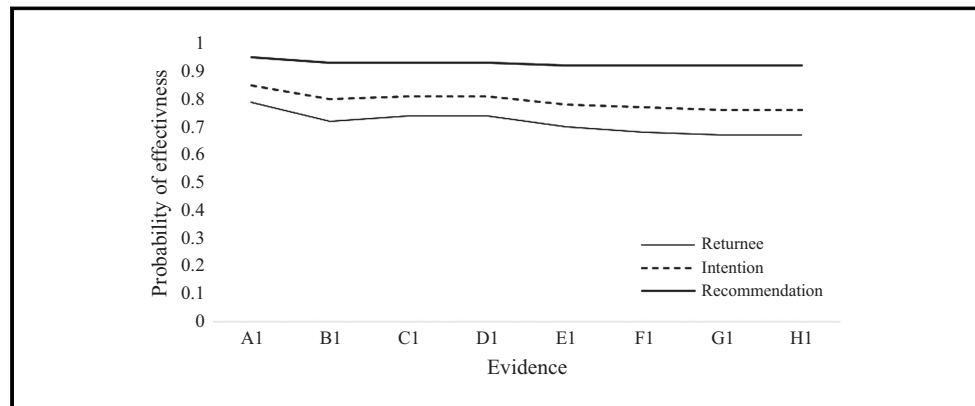
**Figure 8** Comparison study for evaluation of possible scenarios for improving loyalty of Tehran as a destination of tourism



**Figure 9** Effect of individual key factors and cumulative evidence on destination loyalty growth



**Figure 10** Effective analysis of royalty attributes improvement



is shown in the graph, the travel environment image proved to be the most influential factor. In its optimized state, it makes the probability of repeat of visit stand at 79%, intention to revisit at 85% and recommendation to others at 95%. The entertainment/event image along with the infrastructure image also showed high influence on loyalty attributes. In a 100% optimized state of the entertainment/event image, the probability of repeat of visit stands at 74%, intention to revisit at 81% and recommendation to others at 93%. For the 100% optimized infrastructure image, the result is the same as that of the entertainment/event image. This result is very important for decision makers in the field of tourism showing them where to focus when they want to increase the rate of destination loyalty.

### Conclusion

An important part in tourism marketing is destination marketing. Destination marketing has proved to be complicated due to the fact that many tourist stakeholders are entangled in it, some of which may even have conflicting interest. As a result, the role of destination policy makers to introduce a comprehensive plan considering all destination stakeholders becomes more prominent. In this regard, destination loyalty as an important marketing tool and a competitive advantage for destinations comes into attention.

High destination loyalty is considered a strong competitive advantage tool for organizations, companies and destinations; so recognizing the most influential factors in shaping high loyalty and predicting its behavior play an important role in tourism marketing. This paper attempts to provide a framework through which explaining the behavior of a destination loyalty and its antecedents would be possible.

Although many articles have tried to find out a model describing factors contributing to loyalty, very few have tried to analyze its behavior given probabilistic conditions.

This paper first introduces a loyalty model in which the destination image and traveler satisfaction are involved in shaping loyalty. After that, this loyalty model is mapped out on a probabilistic tool, namely the BN. The image attributes in the network are considered the prior knowledge in the network and are fed with the data obtained from the questionnaire survey. Tehran also has been selected as a case study destination. The results pertaining to Tehran's destination loyalty obtained from the BN show that Tehran's destination loyalty stands as 41%. In a backward analysis approach, to predict the behavior of its antecedents' factors, destination loyalty was set to the 100% state. In this analysis, the most influential factors were recognized as the travel environment image, natural/historical attractions image and, to a lower extent, the infrastructure image.

## Managerial implications

This study, besides providing academic contributions, has insightful implications for practitioners in the tourism sector. Given the low state of tourist destination loyalty toward Tehran, the most influential factors to improve this loyalty were estimated. In the backward analysis of the constructed BN, the results showed that in the scenario of a hundred percent destination loyalty of Tehran, two IFs of the travel environment image and natural/historical attractions image were the most contributing and influential factors for improving loyalty state to its optimum level. Also the critical limits of IFs were estimated seeing another scenario in the BN where the state of loyalty was put at its lowest level which is zero. This finding can, alongside the previous finding, help different tourism stakeholders and policy makers in Tehran to find a balanced plan to focus more on most influential IFs to improve these factors and also work on other IFs to the extent needed for an optimum destination loyalty level.

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