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Predicting tourism loyalty using an integrated Bayesian network mechanism

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ABSTRACT

For effective Bayesian networks (BN) prediction with prior knowledge, this study proposes an integrated BN mechanism that adopts linear structural relation model (LISREL) to examine the belief or causal relationships which are subsequently used as the BN network structure for predicting tourism loyalty. Four hundred and fifty-two valid samples were collected from tourists with the tour experience of the Toyugi hot spring resort, Taiwan. The proposed mechanism is compared with back-propagation neural networks (BPN) or classification and regression trees (CART) for 10-fold cross-validation. The results indicate that our approach is able to produce effective prediction outcomes.

1. Introduction

With the prevalence of tourism in Taiwan, the development of tourism industry has facilitated local economy and increased the employment opportunity. Thus, tourism becomes an industry that is valued and actively developed by the government. However, when facing a more competitive tourism environment, how to attract the customers and further transform them into loyal ones will be the key for the operation of leisure business. This research seeks to determine the factors that influence tourism loyalty. Moreover, this study proposes an integrated mechanism that combines LISREL (Joreskog & Sorbom, 1993) and BN (Pearl, 1986) to predict a tourist's loyalty level.

Valid samples were collected from 452 tourists with the tour experience of the Toyugi Hot Spring Recreational Village, which is located at the eastern region of Taiwan. The village is managed by Taitung County Farmers Association. With an area of 15 hectare, it is the largest hot spring recreational village in Chihben hot spring area. The village is full of rich ecological resources such as spatial grasslands, varied plants, wild birds and butterflies. Therefore, the village provides the visitors the combined leisure functions such as recreation, conference, experience, education and training by the unique hot spring, landscapes and farm produces. Visitors can enjoy the services, herbs and various agricultural products in hot spring hotels. Besides, the village also provides junior high schools and elementary schools a teaching space for rural village ecology and experience, and the information of agricultural tourism. It is a recreational village with different features.

The data analysis was conducted in two stages: verifying relationships in the research model and predicting the level of tourism loyalty. In the first stage, LISREL was used to verify the belief or causal relationships in the research model of tourism loyalty. LISREL is a structural equation modeling (SEM) technique used to determine whether a research model is valid by examining the goodness-of-fit between the model and raw data. It has been widely applied in social-science research. In the second stage, the supported relationships of the LISREL analysis are used as the BN network structure to predict a tourist's loyalty level. The predicted results were also compared with those generated by BPN and CART.

2. Tourism loyalty

Loyalty refers to the repurchase will of certain products and services (Jones & Sasser, 1997). Fornell, Johnson, Anderson, Cha, and Bryant (1996) suggested that "repurchase possibility" and "repetitive purchase" are two critical factors for loyalty assessment. Sirohi, Mclaughlin, and Wittink (1998) indicated the following as the indexes to assess loyalty: (1) continuous purchase; (2) increase purchase in the future; (3) recommendation for others' purchase. This research defines tourism loyalty as the visitors' will to revisit and recommend the destinations to others after arriving at the tourist attraction. The measurement indexes include continuous revisiting, revisiting will and recommendation to others.

Loyalty is one of the targets of strategic marketing and it allows companies to enhance the competitive advantages (Craft, 1999). The benefits of loyalty include below: (1) customers' repurchase

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and promotion willingness can lead to revenue growth of the firms and the increase of market share; (2) reduction of costs; (3) increase of employees' work satisfaction (Jacoby, 1994). In order to increase the customers' loyalty, companies need positive customer relationship management (CRM). CRM means the enterprises find the customers' real needs with the support of process and technology, and improve the products and services that are devoted to the enhancement of customer loyalty (Kalakota & Robinson, 1999). Spengler (1999) also suggested that CRM integrates planning, marketing and customer service by information technology, and provides customized services to increase customer loyalty and corporate operational benefits. In addition, Hui, Wan, and Ho (2007) indicated the characteristics of tourist attractions, such as interesting cultures, attractive urban sightseeing, interesting night life and attractive natural and scenic aspects might increase customer satisfaction and revisiting will. According to the literature review discussed above, this research proposes three factors which might increase tourism loyalty: customer service, web function with the support of technology and local characteristics.

Three factors influence travelers' tourism loyalty are proposed based on a literature review, including (1) Customer Service (CS): the service consumers received from employees; (2) Web Function (WF): the functions providing by the tour web site; (3) Local Characteristics (LC): the consumer's perception of the local tourism characteristics; and Tourism Loyalty (TL): the loyal degree regarding a tourist revisit a destination. This study suggests that the greater the degree to which a tourist perceived regarding customer service, web function and local characteristics of the destination, the greater is his/her tourism loyalty, which refers to repeat of visit, willing to revisit and recommend to others. Therefore, H1–H3 is established as below:

H1: Customer service positively influences tourism loyalty.
H2: Web function positively influences tourism loyalty.
H3: Local characteristics positively influences tourism loyalty.

All questionnaire items are shown in Table 1. Each tourist was asked to rate on a scale of 1–5 his or her degree of agreement with each item.

3. The integrated Bayesian network mechanism

To overcome the difficulty of constructing a BN structure when learning from data, this study proposes a novel approach that combines LISREL and BN to predict a tourist's loyalty level. LISREL is an advanced statistical technique in the social and behavioral sciences to verify the hypothesized relationships, but it is seldom combined with other machine-learning algorithms. This study uses LISREL to aid BN in discovering a suitable network architecture for prediction.

Table 1
The questionnaire items.

Factor	Item	Content
Customer service	CS1	Quick response to customers' suggestions
	CS2	Fluent service flow
	CS3	Understanding customers' need
	CS4	Quickly solving customers' problems
	CS5	Listening to customers' complaint
Web function	WF1	Web information attracted people
	WF2	Ease of use
	WF3	Web site security
Local characteristics	LC1	Farm products have local characteristics
	LC2	The brand and image of farmers' association is relieved
	LC3	Service and produce have geographic features
Tourism loyalty	TL1	Repeat of visit
	TL2	Revisiting will
	TL3	Recommendation to others

3.1. LISREL

LISREL is one SEM technique which combines the concepts of both factor analysis and path analysis. It is especially appropriate to use LISREL to analyze the data in social and behavioral research fields. While multiple regression can estimate the parameters of only one linear equation at a time, LISREL can simultaneously process multiple sets of variable relationships to estimate the parameters in an entire system of linear equations in a model. The LISREL model and equations are shown in Fig. 1 in which E is disturbance; η is the vector of endogenous latent variable; α is intercept; B is the matrix of regression coefficient for endogenous latent variable; Γ is the matrix of regression coefficient for exogenous latent variable; ξ is the vector of exogenous latent variable; and ζ is the vector of latent disturbance. The analysis consists of two steps: (1) measurement model analysis, which aims to analyze the loading relationships between latent variables and their corresponding observable variables, and (2) structural model analysis, which aims to analyze the hypotheses relationships among latent variables.

3.2. BN

A BN is a graphical model of variables and their relationships based on probability theory. It is also called a belief network or causal network. A BN uses prior probabilities and probabilities in sample space to estimate posterior probabilities. In a BN graph, arrows between nodes are used to represent a directed acyclic graph (DAG) (Niedermayer, 1998). Each parent node represents the cause of an event, a child node represents the outcome, and an arrow represents the causal relation. As shown in Fig. 2, the set of parent nodes of a node TL is denoted by *parents(TL)* and the joint distribution of the node values can be written as the product of the local distributions of each node and its parents.

Advantages of BN include the ability to analyze problems with incomplete data and to combine domain knowledge and data (Hackerman & Wellman, 1995). However, without prior understanding or knowledge about the problem domain, the required significant computational effort of an NP-hard task in exploring a

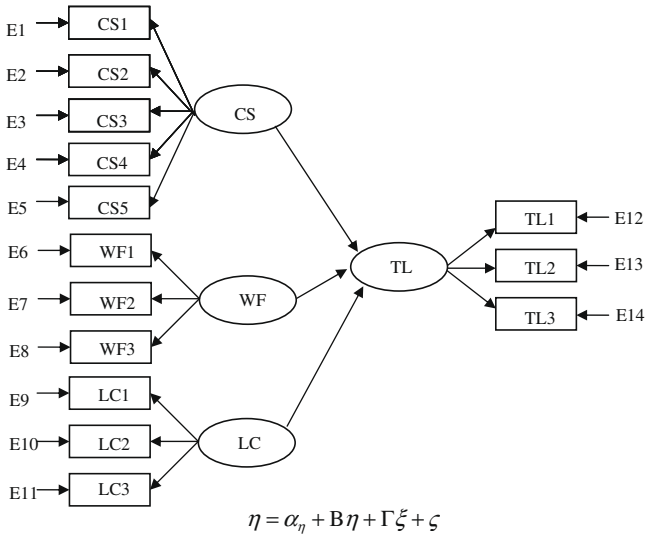

Fig. 1. LISREL: verifying the believe relationships.