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Assessing the performance of tourism supply chains by using the hybrid network data envelopment analysis model

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HIGHLIGHTS

- Proposing the hybrid network DEA model, which evaluates the overall and divisional efficiency in a single DEA implementation.
- Variable and semifixed inputs are respectively measured using radial and nonradial assumptions in mathematical plan programming.
- Providing an integrated efficiency index to measure the overall efficiency of a tourism supply chain.
- Providing the measurement that reveals inefficiency sources by resolving the slacks and radial ratios.

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ABSTRACT

Although the importance of cooperation and coordination in tourism supply chains has been emphasized in previous research, studies continue to focus purely on the performance of a particular division within a given tourism supply chain. The primary aim of this study was to establish a hybrid network data envelopment analysis (DEA) model for measuring integrated and divisional performance within the supply chain. The main factor distinguishing the DEA model from previous network models is the assumption of input types; variable and semifixed inputs are respectively measured using radial and nonradial assumptions in mathematical plan programming. Another significant difference between the hybrid network DEA model and previous supply chain efficiency models is that the hybrid model contains a measurement defining the overall efficiency of tourism supply chains. To test the proposed model, the performance of the tourism supply chain across 30 regions in China was evaluated. The empirical results provide several practical insights for tourism supply chain management.

1. Introduction

In competitive market environments, network cooperation between manufacturers and service providers characterizes an advantageous partnership that can increase revenues while reducing costs (Ferguson, 2000). Supply chains represent a network structure that includes suppliers, producers, and distributors. Raw materials can be processed into final goods and services and be delivered to customers through supply chain processing (Tavana, Mirzagoltabar, Mirhedayatian, Saen, & Azadi, 2013). According to Bowersox, Closs, and Helferich (1996), supply chain management includes all activities involving the transformation and flow of goods and services. Attendant information flows from sources of materials to end users are also considered in supply chain processing. Creating seamless coordination across the functions of sourcing, production, and distribution is the primary objective of supply chain management (Li, Rao, Ragu-Nathan, & Ragu-Nathan, 2005). Moreover, supply chain processing also generates various advantages in the manufacturing industry, such as reduced cycle times, inventory costs, and logistics costs (Prasad & Selven, 2010).

The main components of a tourism supply chain are products, distributors, and resources. Examples include accommodation, which is a primary tourism service product, and travel agencies, which can be regarded as a mode of delivery or distributor of a service product (Huang, Song, & Zhang, 2010; Sigala, 2008; Yilmaz & Bititci, 2006). Tourism education, which can be regarded as a producer (or supplier) of a trained workforce (Chang, Chung, & Hsu, 2012), is an example of a resource in the supply chain. Regarding the performance of tourism supply chains, Page (2011) stated that tourist destinations, as the final component in the supply chain, are the most representative indicator of the effectiveness of tourism service flow.

Tourism supply chain management can be defined as a set of

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approaches used to more efficiently manage the operators in a chain to ensure that they meet tourist needs (Zhang, Song, & Huang, 2009). The primary concern in tourism supply chain management pertains not only to the performance of individual sections but also that of the integrated system of tourism operators (Ţigu and Calareţu, 2013). The importance of integration between different components in a tourism supply chain has been discussed in many studies (e.g., Guo, Ling, Dong, & Liang, 2013; Huang et al., 2010; Yang, Huang, Song, & Liang, 2009; Zhang et al., 2009). Enterprises could cooperate or coordinate in information sharing, marketing, decision synchronization, and incentive alignment to enhance the overall competitiveness of each component in the supply chain (Sigala, 2008). Most findings indicate that the effective integration of components in a tourism supply chain can benefit the tourism industry as a whole by lowering costs, and it can enhance tourism sustainability (Carey, Gountas, & Gilbert, 1997; Hilletofth, 2011; Theuvsen, 2004; Tseng, Chiu, & Vo, 2011; Zhang & Murphy, 2009). Furthermore, appropriate integration in tourism supply chains is advantageous for promoting innovations in business reconstruction, strategic union, and value-added services (Chen, 2009).

Despite emphasis on the importance of cooperation and coordination in tourism supply chains, studies remain mainly focused on the performance of a particular division within tourism supply chains, such as tourist hotels (Assaf, 2012; Huang, Ting, Lin, & Lin, 2013; Ting & Huang, 2012), travel agencies (Assaf, 2012; Fuentes, 2011; Koksal & Aksu, 2007; Qi & Junhai, 2011), and tourist destination efficiency (Perez, Guerrero, González, Pérez, & Caballero, 2013; Tsionas & Assaf, 2014; Wu, Lan, & Lee, 2012). Shafiee, Lotfi, and Saleh (2014) suggested that an integral indicator, which is used to measure the overall performance, should consider all components of a tourism supply chain, but studies assessing the efficiency of the entire frame of tourism supply chains remain scant. Because integration is vital to tourism supply chain management, providing a measure for assessing overall performance should be considered imperative.

The main aim of this study was to develop a hybrid network data envelopment analysis (DEA) model for measuring the integrated and divisional performance of tourism supply chains. The main difference between previous network models and the present model is the assumptions of input types; variable and semifixed inputs are respectively measured using radial and nonradial assumptions in mathematical plan programming. In previous network DEA models, many studies (e.g., Huang, Ho, & Chiu, 2014; Kao & Hwang, 2008; Kwon & Lee, 2015; Ma, 2015; Yu & Lin, 2008) have assumed all inputs and outputs as radial factors, which can change proportionally. Other studies (e.g., Liu, Zhou, Ma, Liu, & Shen, 2015; Tone & Tsutsui, 2009; Wang, Huang, Wu, & Liu, 2014; Yu, 2010) have assumed inputs and outputs to be entirely nonradial factors, which can change nonproportionally. However, conventional network DEA models do not consider the difference of changeability between variable and semifixed factors. Few researchers have attempted to incorporate this difference into DEA models and apply a mixed approach involving radial and nonradial (i.e., hybrid measure) factors. For instance, automatic banking facilities and marketing inputs have been defined as nonradial inputs by Huang, Chiu, Lin, and Liu (2012) and Huang, Chiu, Ting, and Lin (2012). In the present study, we also adopted the mixed approach and developed a hybrid network DEA, in which variable inputs, such as labor, which can be rapidly changed with variations in scale, are assumed to be radial factors; and semifixed inputs, such as assets, which cannot be adjusted rapidly or do not need to change proportionally with variation in scale, can be considered nonradial factors.

The other notable difference between the hybrid network DEA model and previous supply chain efficiency models is the measurement that defines the overall efficiency of a tourism supply chain. Various calculation approaches are reported in the literature as to how this measurement can be calculated. For instance, overall efficiency has been calculated by summing the scores of divisional efficiency (Azadi, Jafarian, Saen, & Mirhedayatian, 2015), averaging the scores of divisional efficiency (Khodakarami, Shabani, Saen, & Azadi, 2015; Saranga & Moser, 2010), or by using a convex linear combination of divisional efficiencies to define the overall efficiency (Cook, Zhu, Bi, & Yang, 2010; Shafiee et al., 2014). However, because the aforementioned modes have computed overall efficiency mostly by using a sum or weighted average rather than structuring an index for all excess input utilizations and all output deficits in every division, the sum of divisional scores cannot represent the overall efficiency though a ratio. Furthermore, using weighted averages is liable to have inconsistent benchmarking targets because of multiple independent DEA implementations (Chiu & Huang, 2011; Huang, Chiu, Fang, & Shen, 2014). Chen and Yan (2011) developed a supply chain efficiency model that measures overall efficiency as a ratio through a single DEA process, but their approach does not specifically measure the efficiency of individual divisions The model developed in the current study simultaneously evaluates the overall and divisional efficiency in a single DEA implementation, and the efficiency scores are calculated on the basis of the slacks of nonradial variables and the radial ratios of benchmarks to actual values. Furthermore, the efficiency measurement can reveal inefficiency sources by resolving the slacks and radial ratios.

The remaining sections are organized as follows: Section 2 reviews the literature on tourism supply chains, and Section 3 describes the hybrid network DEA model. Empirical results are reported in Section 4, and the conclusions of the present study and recommendations for future research are given in Section 5.

2. Literature

Tourism supply chain management is a developing academic topic in the tourism industry, primarily because of the rising popularity of package tours and trends in globalized tourism. The components of a typical package tour are transportation, accommodation, dining, and tourist attractions. Furthermore, a package tour involves various service providers including hoteliers, travel agencies, transportation companies, and restaurants. Therefore, coordination and cooperation between tourism service providers within the supply chain is a crucial element in creating a seamless experience (Lambert & Cooper, 2000). Effective supply chain management is a strategic area of focus for deriving and enhancing competitive advantages (Zhang et al., 2009). For the firms in a supply chain, collaboration between service suppliers and product channels is essential for reducing marketing costs and increasing sales (Huang et al., 2010).

Researchers have mostly focused on defining the structure of tourism supply chains, defining them as including accommodation suppliers, tour operators, travel agencies, and customers (Kaukal, Hopken, & Werthner, 2000); theme parks, accommodation providers, and tour operators (Huang et al., 2010); goods and service suppliers and delivery firms (Tapper & Font, 2004); and food and lodging suppliers, tour operators, and travel agencies that specialize in the resale of package tours (Ţigu and Calareţu, 2013).

Research investigating supply chain performance in the tourism industry is limited. In assessing the performance of supply chain operations, most related studies have observed manufacturers such as petrochemical firms (Azadi et al., 2015); automobile, energy, high-tech, and construction companies (Saranga & Moser, 2010); food manufacturers (Shafiee et al., 2014); the semiconductor manufacturers (Tavana et al., 2013); and chemical firms (Khodakarami et al., 2015); and studies have established new