Low-carbon tourism supply chain

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Contributor: Lu Zhang

Low-carbon tourism is a kind of way to reduce the "carbon" tourism, that is, in the tourism activities, tourists try to reduce the carbon dioxide emissions. That is, green travel based on low energy consumption and low pollution, advocating the minimum reduction of carbon footprint and carbon dioxide emissions during travel, is also a deep-seated performance of environmental tourism. This paper integrates a low-carbon tourism supply chain consisting of a low-carbon tourist attraction (LTA) providing a low-carbon service and an online travel agency (OTA) responsible for big data marketing. Consumers may also encounter sudden crisis events that occur in the tourist attraction during their visit, and the occurrence of crisis events can damage the low-carbon goodwill of the tourist attraction to the detriment of the sustainable development of the supply chain. Therefore, this paper aims to investigate how tourism firms can develop dynamic strategies in the pre-crisis environment if they envision the occurrence of a crisis event and how crisis events affect interfirm cooperation. Our findings provide important managerial insights for enterprises in the tourism supply chain and suggest that they need to not only become aware of the tourist attraction crisis events, but also, more importantly, they need to adjust their appropriate input strategies based on the degree of anticipation of the crisis.

Keywords: low-carbon tourism supply chain ; sudden crisis event ; big data marketing ; low-carbon goodwill ; online travel agency ; pre-crisis and post-crisis environment

1. Literature Review

1.1. Low-carbon tourism

Some scholars have conducted extensive research on the construction and evaluation index system of tourist attractions, government incentives, consumer perceptions and choices of low-carbon tourism. Huang [1] draws on the successful construction of low-carbon tourist attractions in Pinglin, Taiwan, and explains the significance of building low-carbon tourist attractions. Wang et al. [2] constructed a low-carbon behavior performance evaluation index system using the Delphi method and used analytic hierarchy process to systematically measure the low-carbon performance of 32 scenic spots in Zhangjiajie (World Heritage Scenic Area). The article extracted the key drivers that can significantly influence the performance of low-carbon behavior in tourist attractions and found that Zhangjiajie scenic spots performed relatively well in implementing low-carbon behavior, but there is still much room for improvement and enhancement. Zhao et al. [3] constructed an evolutionary game model of government and enterprises based on tourism development in a low-carbon context and studied the evolutionary strategies of both from a dynamic perspective, finding that the government and enterprises can only make decisions from a long-term perspective to better promote the low-carbon development of enterprises. He et al. [4] constructed an evolutionary game model between the government, tourism enterprises and tourists based on the context of sustainable development to explore effective green incentives for governments to develop traditional tourism into green tourism. Saarinen [5] found that government regulation is an effective way to encourage private enterprises to transform traditional tourism into sustainable tourism to a large extent. Xu and Fox [6] found that anthropocentric or ecocentric values significantly influenced people’s attitudes towards tourism and sustainable development. Jinsoo et al. [7] investigate how guests visit green hotels and conclude that a range of impressions of green hotels may lead to more beneficial behavioral intentions. Chen et al. [8] found through empirical results of structural equation modeling (SEM) that consumers’ environmental concerns did positively influence their attitudes toward green hotels, their perceived behavioral control and their perceived moral obligations. Therefore, the research on low-carbon tourism is increasingly becoming an important direction for business and academia, but there are fewer studies that introduce the idea of supply chain management into low-carbon tourism and consider the differential game of interests among low-carbon tourism enterprises [9][10].

1.2. Sudden Crisis Events

The occurrence of sudden crisis events often has a great impact on the sustainable development of enterprises [11]. Therefore, many scholars have conducted a lot of research on the impact of such crisis events on enterprises and their

coping strategies [12][13]. Jang et al. [14] examined changes in the competitive response of two companies to a defamatory product injury crisis event and its impact on the relationship between advertising and consumer online search behavior. Wang et al. [15] compared the differences between traditional and emergency decision problems and proposed an emergency response strategy for emergencies with complex system characteristics through the special constraints of emergency decision. Using a state-space model, Liu et al. [16] found that when a product suffers an unexpected crisis event, a company's product recall behavior brings negative product information, which adversely affects brand preference and advertising effectiveness. Based on a third-party recycling model, Wang et al. [17] confirmed that a coordinated strategy of a closed-loop supply chain is an effective way to deal with emergencies. So, if there is a sudden crisis event in a tourist attraction, what kind of impact will it have on tourism enterprises and consumers? In addition, if tourism companies can predict the occurrence of future scenic crisis events, how can they develop their own optimal strategies? Unfortunately, few studies are involved in this topic, and most of the literature selects specific scenic spots or single types of scenic spots to study the impact of emergencies and the coping strategies of scenic spots [18][19][20]. Therefore, the idea of supply chain management is introduced into the sudden crisis events of tourist attractions more in line with the realistic requirements. In addition, the repu tation of tourist attractions is dynamic and subject to the influence of tourism enterprises' decisions; therefore, it is necessary to consider the dynamic nature of the reputation of tourist attractions and the long-term impact of this dynamic on the economic, environmental and social benefits of the supply chain.

1.3. Cost-Sharing Contracts

Numerous scholars have found that one of the most effective means of improving the performance of supply chain members is cooperation among members and that cooperation among members manifests itself in different contract designs: Quantity flexibility, two-part tariff and cost-sharing contracts, etc. [21][22][23][24]. However, this paper considers cost-sharing contracts among supply chain members. Bai et al. [25] proposed a revenue and promotion cost-sharing contract and a two-part tariff contract to perfectly coordinate a sustainable supply chain system consisting of a manufacturer and a retailer. In the presence of consumers' environmental awareness or carbon taxes, Yang and Chen [26] investigated the effects of revenue sharing and cost-sharing contracts offered by retailers on a manufacturers' carbon emission reduction efforts and the profitability of both members. They found that both contracts stimulated the manufacturers' incentives to reduce emissions, increased manufacturers' emission reduction levels and promoted the profitability of both members. Li et al. [27] studied the impact of revenue sharing and cost-sharing contracts offered by retailers on the low carbon strategies of members with and without bargaining channels in low carbon supply chains and found that both contracts coordinate the entire supply chain, but neither contract coordinates the supply chain if the supply chain members bargain over the sharing rate, regardless of the symmetry of bargaining power. Xiao et al. [28] constructed a sustainable supply chain consisting of a manufacturer and a supplier and investigated the effect of cost-sharing contracts on the sustainable investment level of the supplier and the profit of the supply chain members. They found that cost-sharing facilitated the improvement of the investment level of the supplier and achieved the Pareto improvement of the profit of the supply chain members. All of the above studies have investigated the impact of cost-sharing contracts on supply chain members' decision making and performance. However, since most studies consider member decision making and cost-sharing contracts from a static perspective, it is necessary to consider the long-term effects of the dynamics of supply chain member decision making on the economic, environmental and social benefits of the supply chain.

In summary, most of the existing studies on low-carbon tourism mainly focus on the sustainability issues of individual tourism enterprises and the development of corporate strategies for supply chains composed of multiple tourism enterprises. They neglected the issue of corporate cooperation among tourism enterprises when they form a supply chain. In addition, tourists may also encounter sudden crisis events that occur in the tourist attraction during their visit, and whether crisis events will affect interfirm cooperation is a question that is bound to arise and that is worth exploring. Therefore, our study extends this part of the literature. In addition, research on sudden crisis events has mostly focused on the issue of corporate response strategies after the crisis, neglecting the issue of strategy formulation before the crisis. Finally, studies on the effects of cost-sharing contracts on interfirm cooperation in supply chains have mostly studied the impact of cost-sharing contracts on supply chain performance from a static perspective. They ignore the dynamic change characteristics of the environment in which firms are located and the impact of firms' current decisions on future supply chain sustainability.

Therefore, this paper draws on the theoretical basis of differential game and the characteristics of supply chain dynamics in the context of low-carbon tourism enterprises anticipating the occurrence of crisis events, aiming to explore the problem of how enterprises formulate their strategies before the crisis and how crisis events affect the cost-sharing cooperation among enterprises. This paper provides relevant management insights and supply chain sustainability recommendations for tourism enterprises by the above analysis.

2.Model Analysis

Based on the problem description and various assumptions in the previous section, this section analyzes the member decision, low-carbon goodwill under the three models of the Nash non-cooperative decision (N), the cost-sharing decision (D) and the centralized decision (C) in the pre- and post-crisis reigmes and analyzes the members' and system's profits after the crisis and throughout the planning period. Furthermore, the key parameters under the different decision-making models are compared and statically analyzed to give different decision management insights of the models in order to provide a basis for decision making for the relevant companies in the low-carbon tourism supply chain. For the model to be easily distinguished, this paper will use the superscripts N, D and C to represent the three different decision-making modes and the subscripts A and O to represent the supply chain decision subjects, LTA and OTA, respectively.

2.1. Nash Non-Cooperative Decision-Making Model (Model-N)

When the Nash non-cooperative decision-making model (Model-*N*) is taken between the LTA and the OTA in the low-carbon tourism supply chain, both supply chain members, as autonomous business decision makers, behave as fully rational decision makers, and each decision maker makes decisions separately to pursue the maximization of their own profits. The LTA first determines its own low-carbon service level, and the OTA determines its optimal big data marketing level on this basis. Furthermore, the study finds that the optimal strategies under Nash's non-cooperative decision and Stackelberg's non-cooperative decision are consistent [29].

2.2. Cost-Sharing Decision-Making Model (Model-D)

Under the cost-sharing decision-making model (Model-*D*), the part of the cost of the OTA's big data marketing investment will be borne by the LTA to incentivize the OTA to actively promote tourist attraction and develop potential tourism markets [9]. Therefore, to build a low-carbon tourism supply chain differentital game model led by the LTA, the LTA firstly decides its own low-carbon service and the sharing coefficient of the big data marketing of the OTA, and then the OTA decides its own big data marketing level on this basis.

2.3. Centralized Decision-Making Model (Model-C)

The centralized decision-making model (Model-C) of LTA and OTA is the most ideal state in the low-carbon tourism supply chain, where both members constitute a unified decision maker and jointly determine the service inputs and big data marketing inputs in the supply chain to enhance the low-carbon goodwill, which in turn stimulates the consumers' choice of low-carbon tourist attractions and improves the overall profit of the supply chain system. In this model, the LTA and the OTA seek to maximize system profits and jointly determine the service and marketing strategies, with the letter SC denoting the supply chain as a whole.

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