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Application of an artificial neural network optimization model in e-commerce platform based on tourism management

Cao Wei*, Qinan Wang and Chengying Liu

*Correspondence:
lcy@chzu.edu.cn
Chuzhou University,
Chuzhou 239000, China

Abstract

The advantages of e-commerce and information technology play an extremely important role in enhancing the competitiveness of the tourism industry and adapting to the needs of global economic integration. The development of e-commerce has played a huge role in all walks of life. For the tourism industry, the role of e-commerce is even more important. This article analyzes the influence of e-commerce on tourism production factors, such as optimizing tourism production factors, optimizing industrial structure, improving the competitiveness of tourism enterprises and playing the leading role of the government. This article attempts to find out the fundamental reason why e-commerce can enhance the competitiveness of China's tourism industry, so as to find a better way for e-commerce to promote the development of China's tourism industry. In order to accurately predict the scale and quantity of domestic tourism, an optimized neural network model is proposed to analyze and predict tourism data, and then analyze and research the data. Tourism development factors such as tourism development factors, changes in tourism demand and the optimization of industrial structure have effectively promoted the development of China's tourism industry.

Keywords: Tourism market, Competitive factors, Tourism resources, Artificial neural network

1 Introduction

With the acceleration of the globalization of the world economy, the tourism industry is facing more intense competition. How to enhance the competitiveness of the tourism industry is also an important issue in China's economic development [1]. The application of network technology and e-commerce will greatly improve the service level, management level and management level of the tourism industry, improve the operation quality of the tourism industry and thus greatly enhance the international competitiveness of China's tourism industry [2]. With the popularization of Internet technology, e-commerce has developed rapidly and become an important strategic choice for many countries to promote economic growth and cope with global competition [3]. After more than 20 years of rapid development, China's tourism industry has become a new growth point of China's national economy, but compared with the world's tourism powers, there

is still a big gap. How to improve the competitiveness of tourism industry has become a topic of concern to the industry. The nature and characteristics of tourism determine its unique advantages in the development of e-commerce. The combination of tourism and information technology will greatly improve the competitiveness of tourism. By analyzing the role of e-commerce in the competitiveness of tourism industry, this paper tries to find a feasible way to develop tourism e-commerce to enhance the competitiveness of China's tourism industry [4]. The transformation of traditional retail companies to Internet retail companies, the exploration of the O2O model of Internet brands, creating the ultimate user experience under the O2O model, big data boosting the development of e-commerce, and cross-industry integration to create new business models.

The competitiveness of tourism products with tourism resources as the core, in which the tourist area (point) is the carrier, mainly depends on product quality, product brand and product innovation, which is the decisive factor of the final result of competition. The competitiveness of tourism products is the most important foundation of the competitiveness of the tourism industry, and its situation basically determines the competitiveness of the tourism industry [5]. Tourist resources are the most important factor of tourism production and the essential factor of tourism products. The attraction to tourists is the commonness of all tourism resources and the core component [6]. Therefore, the relationship between tourism resources and core competitiveness is unified to a certain extent, especially when the competitiveness is at a lower level of the value chain, these basic elements play a decisive role. The establishment of tourism product brand forms its own unique advantages, which is indispensable to enhancing the competitiveness of the tourism industry [7]. The innovation of tourism products is of great importance to the competitiveness of tourism industry in the era of Internet economy. The innovation of tourism products is mainly manifested in the innovation of tourism resources, tourism projects and tourism modes. All of these three innovations can enhance the core competitiveness [8]. Through these innovations, the functions of the original tourism resources can be effectively enlarged in the operation, thereby enhancing the core competitiveness. Tourist facilities are set up to match the sales of tourism products. The degree of perfection is an important weight to determine the competitiveness of a country or region's tourism industry. It is also an important prerequisite for tourism products to enter the market [9]. Therefore, improving the tourist facilities is a necessary condition to realize the core competitiveness of the tourism industry. Tourism services are all kinds of services provided by the service staff to tourists during the whole process of tourism. Service is not only the lubricant for the smooth development of tourism activities, but also the adhesive for a complete tourism product. Only when all enterprises and departments of tourism activities are linked by service, it is a complete tourism product for sale. Through the effective integration of tourism facilities and tourism services, the competitiveness of tourism products plays a key supporting role [10].

The research contributions of this article include:

1. This article analyzes the influence of e-commerce on tourism production factors, such as optimizing tourism production factors, optimizing industrial structure, improving the competitiveness of tourism enterprises and playing the leading role of the government.

2. This article attempts to find out the fundamental reason that e-commerce can enhance the competitiveness of China's tourism industry, so as to find a better way for e-commerce to promote the development of China's tourism industry.
3. In order to accurately predict the scale and quantity of domestic tourism, an optimized neural network model is proposed to analyze and predict tourism data, and then analyze and research the data.

The rest of this paper is organized as follows. Section 2 discusses the related work, followed by the artificial neural network model and its optimization discussed in Sect. 3. The role of e-commerce in enhancing tourism competitiveness is analyzed in Sect. 4. Section 5 shows the simulation experimental results, and Sect. 6 concludes the paper with summary and future research directions.

2 Related work

2.1 Related theoretical analysis

Industry is composed of many enterprises with the same attributes. Competitiveness is an important symbol reflecting the quality and development potential of an industry. Therefore, the competitiveness of an industry is reflected by the competitiveness of the enterprises in the industry, and the competitiveness of the enterprises is expressed by the competitiveness of the products or services of the enterprises [11]. According to Professor Michael E. Porter of Harvard University in the USA, a country's specific industry can be regarded as a whole and its ability to open up, occupy the international market and obtain profits, that is, competitiveness [12]. The core of industrial competition is competitive advantage, especially the formation and exertion of comparative advantage. This kind of comparative advantage shows some difference in the competition, that is, the resource endowment of the region or the advantageous conditions of industrial development, which is the basic source of forming regional differential products (or characteristic products) [13]. Porter pointed out that from a macroscopic point of view, a country's industrial international competitiveness depends on four basic factors (i.e. factors of production, demand conditions, related and supportive industries, competitive conditions of enterprises) and two auxiliary factors—government and opportunity. These six factors determine the source, strength and durability of industrial competitiveness, among which production factors, demand conditions, related and supportive industries, and competitive conditions of enterprises are decisive factors [14].

For tourism industry, it is a highly related industry, almost involving economic, political, social, scientific and technological, cultural, educational and other aspects, which increases the complexity of tourism industry competitiveness research [15]. From the functional point of view, the tourism system has the so-called five-element theory and four-point method, in which the "five-element theory" is commonly referred to as eating, living, traveling, shopping, entertainment and "four-point method" refers to the tourism system that consists of four subsystems: tourist source system, tourist destination system, travel system and support system. The development of tourism can promote the development of retail, catering, accommodation, entertainment, transportation, communications and other industries [16]. At the same time, the relevant and auxiliary industries with advantages can provide strong

support for the tourism industry and the two-way accommodation of information, technology, capital and manpower, which greatly strengthens the supply capacity of the tourism industry, thus forming a dominant industrial group [17]. It is precisely because of the high relevance of tourism industry that it determines the systematic competitiveness of tourism industry. Based on Porter's theory of industrial competitiveness and the characteristics of tourism industry, this paper constructs a "diamond model" of tourism industry competitiveness based on Porter's industrial competitiveness, as shown in Fig. 1 [18].

2.2 Analysis of the components of tourism industry competitiveness

2.2.1 Elements of competitiveness in tourism industry

By constructing the diamond model of tourism industry competitiveness and combining with Porter's theory of six elements of industrial competitiveness, we can analyze the elements of tourism industry competitiveness concretely [19].

1. The factors of tourism production refer to the various inputs needed for the development of tourism, including natural tourism resources, human tourism resources, human resources represented by tourism practitioners, development funds, etc.
2. Tourism market demand mainly refers to the effective demand in tourism market. Although tourism participates in international competition, its competitiveness comes from the development of domestic tourism and the development and maturity of domestic tourism market.
3. Relevant and supportive industries mainly refer to upstream enterprises that provide raw materials and equipment for tourism enterprises. Supportive industries also include industries or complementary industries that share certain technologies and marketing channels or services with the tourism industry.

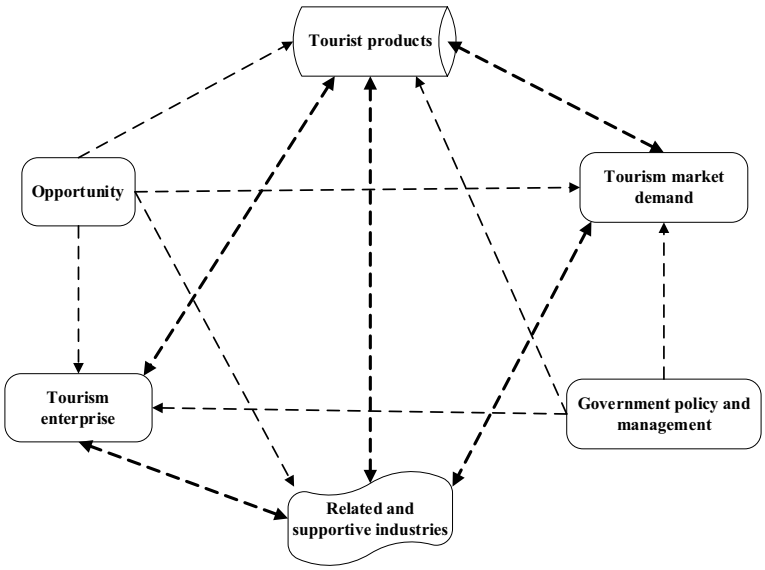

Fig. 1 Tourism industry competitiveness "diamond model"

4. The strategy, structure and competition of tourism enterprises and the final formation of tourism competitive advantage depend on the tourism enterprises of the tourist destination. Tourism enterprises are the main actors to promote the continuous development of tourism. The scale, development strategy, management strategy, self-accumulation and development mechanism of tourism enterprises play an active role in the formation and promotion of tourism competitiveness.
5. Opportunities refer to events conducive to tourism, such as major technological changes and changes in foreign exchange rates.
6. Government policy and management refers to the government's influence on the competitiveness of tourism industry through its planning and promotion functions, management and supervision functions, participation in operational functions, information promotion and tourism image publicity functions.

2.2.2 Embodiment of competitiveness of tourism industry

Through the analysis of the elements of the competitiveness of the tourism industry, we put forward the viewpoint that the tourism products formed with tourism resources as the core are the core of the competitiveness of the tourism industry, and the integration degree of enterprises, relevant departments and society in the competition of the tourism industry plays a decisive role in the effective enlargement of the core competitiveness. Accordingly, the competitiveness of tourism industry can be embodied in the following three levels [20]:

The integration degree of enterprises, relevant departments and society in the competition of tourism industry play a decisive role in the effective enlargement of core competitiveness. The core competitiveness of tourism industry is affected by many factors, such as government policy and management, enterprise strategy, market demand, the degree of support of related industries and departments, and local society and environment. Tourism industry is highly related and has chain effect [21]. The government's industrial objectives, investment policies and open policies are the basic conditions for the development of tourism. Active policies are necessary to improve the competitiveness of the tourism industry [22]. The nature of tourism products determines that market demand is an important factor affecting industrial competitiveness [23]. In addition, if tourism enterprises want to win in the increasingly fierce competition, they must focus on consolidating and developing the core competitiveness to optimize the allocation of resources and achieve cost-effectiveness optimization. By establishing strategic alliances with relevant tourism enterprises, we can make more effective use of complementary resources, accelerate the integration of various competitive elements such as service, technology and tangible resources, optimize resources, enhance the core competitiveness of enterprises and create new profit space [24].

3 Methods

3.1 Introduction of artificial neural network model

In order to improve the accurate prediction of China's tourism-related data, a multi-data fusion artificial neural network model is proposed. The flowchart of the artificial neural network model is shown in Fig. 2.

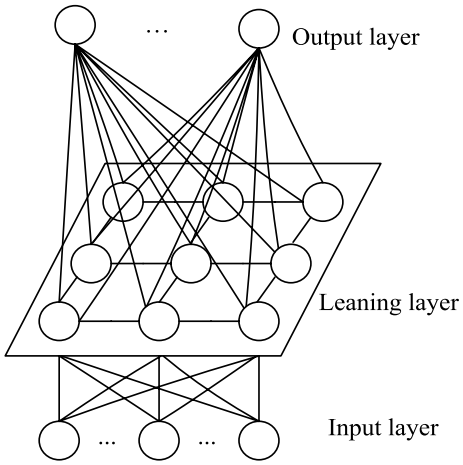

Fig. 2 Three-layer artificial neural network model

Based on the theory of artificial neural network, the evaluation model of multi-data network information platform is established. The steps are expressed as follows:

Step 1. Set $x(t), t = 0, 1, \ldots, n-1$, it is training time for network information platform, and time is set as $t = 0$.

Step 2. Input a new training vector mode to the network information platform $x(t) = (x_0(t), x_1(t), \ldots, x_{k-1}(t))^T$.

Step 3. Calculate the distance between input vector $x(t)$ and weight vector $x(t)$ of all output nodes in artificial neural network

$$d_j = \sum_{i=0}^{k-1} (x_i(t) - \omega_{ij}(t))^2, \quad j = 0, 1, \ldots, N-1, \tag{1}$$

in which $\omega_j = (\omega_{0j}, \omega_{1j}, \ldots, \omega_{k-1,j})^T$, the weight calculation method of the artificial neural network is given, and the weight of the artificial neural network is weighted adaptively.

Step 4. Find the minimum distance nodes in the hidden layer of artificial neural network transmission N_{j*}, $d_{j*} = \min_{0 \le j \le N-1}\{d_j\}$.

Step 5. By adjusting the weights connected with output node N_{j*} and the weights connected with the nodes in N_{j*} geometry neighborhood $NE_{j*}(t)$, the self-organizing feature mapping of Kohonen network is realized. The weighted update iterative formula of information security evaluation is obtained as follows:

$$\omega_{ij}(t+1) = \omega_{ij}(t) + \alpha(t)(x_i(t) - \omega_{ij}(t)) \tag{2}$$

in which $N_j \in E_{j*}(t)$, $0 \le i \le k-1 \quad 0 \le \alpha(t) \le 1$. It is the speed of learning and training, which decreases with time just like $NE_{j*}(t)$;

Step 6. According to the adaptive learning and weighted control method, the information security evaluation is carried out and the sample data are input, then $t = t + 1$, and it is applied to the information fusion by using the minimum arti-

ficial neural network pruning algorithm, so that the fuzzy judgment capability is improved.

3.2 Optimization and implementation of neural network model

Based on the theory of artificial neural network, the intelligent computing model of multi-data fusion is constructed, and the c-means clustering method is adopted to classify information. The objective function is as follows. The algorithm improvement and implementation process of the whole neural network model is shown in Fig. 3.

$$L_{SRm} = \lambda_{SRm} T_{SRm} = \sum_{i=1}^{M} \lambda_i p_{im} (T_{wait} + T_{service}). \tag{3}$$

According to the pruning of the kernel minimum artificial neural network, the information vector quantization of the unit m resource fusion center is obtained and the output is:

$$I_{SRm} = \frac{L_{SRm}}{\rho_{SRm}} = \frac{\sum_{i=1}^{M} \lambda_i p_{im} (T_{wait} + T_{service})}{\rho_{SRm}}. \tag{4}$$

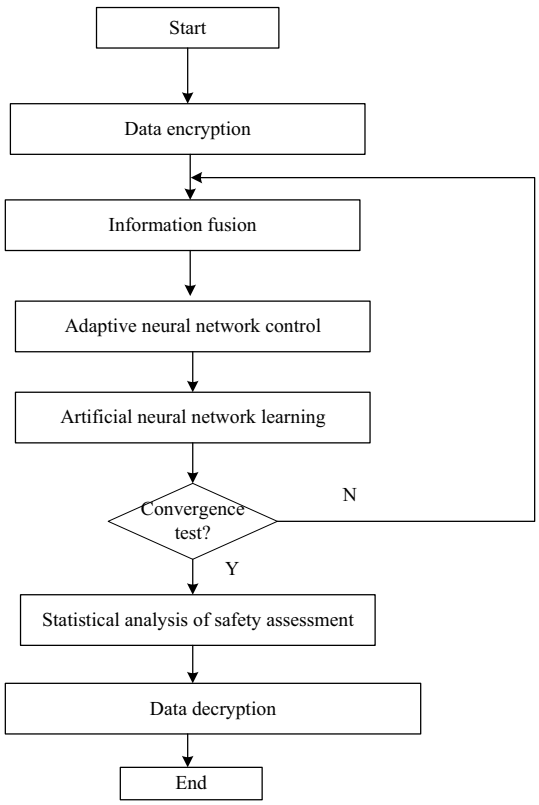

Fig. 3 Implementation flow of the improved algorithm

The strategy of weighted synthesis of various risk calculation methods is used to evaluate information, and the relevance integration of information security assessment is carried out. The optimized objective function can be described as:

$$I_{total} = \frac{L_{total}}{\rho_{SRm}|S_{SR}|} = \frac{\sum_{i=1}^{M}\sum_{m=1}^{|S_{SR}|}\frac{\lambda_i p_{im} T_{SRm}}{\rho_{SRm}}}{|S_{SR}|}. \tag{5}$$

4 Experiment

4.1 The role of e-commerce in tourism production factors

The advantages of China's tourism production factors are reflected in tourism resources, cheap labor and other basic factors of production, but not professional personnel, infrastructure, science and technology applications and tourism information system and other advanced production factors [25]. Therefore, optimizing the factors of tourism production and cultivating advanced factors of production are one of the important measures to enhance the competitiveness of China's tourism industry. The greatest impact of e-commerce environment on tourism production factors lies in the development and utilization of tourism information resources, including the collection, collation, processing, re-creation and utilization of tourism information.

4.1.1 E-commerce and the development and utilization of tourism information resources

There are many kinds of information technology adopted by the tourism industry under the e-commerce environment, such as computer reservation system, Internet protocol, video conference, videotext, electronic brochure, computer management information system, avionics information system, electronic currency trading system, digital electronic network and mobile communication [26]. Tourism e-commerce system not only can carry and transmit a large amount of information, but also has the function of intelligent information processing. It plays an important role in solving the problem of information asymmetry and incompleteness in the tourism economic system, understanding the supply and demand of the market, improving and innovating the product design and operation [27].

The information flow of tourism e-commerce system provides a convenient global network communication mode. Its information capacity is large, information transmission is completed instantaneously, and its cost is low. It can transmit text, pictures, sound, video and other forms of information and can be accessed through computers, mobile information terminals, city multimedia touch screen and other ways, information communication is two ways, and it is very suitable for the characteristics of cross-regional operation of tourism and suitable for the use of mobile tourists. The information flow of tourism e-commerce system includes intelligent extraction, organization and reconstruction of information. The input, storage and performance of information in tourism e-commerce are orderly. It can provide the retrieval and navigation of tourism information and can also automatically record, analyze, collate and feedback information. This makes the mining of tourism information more fully and effectively and gives full play to the value of tourism information resources in business activities. For example, customer relationship database is a typical example of tourism information resources

development. Table 1 reflects a typical tourism e-commerce Web site tourist information records.

The information flow of tourism e-commerce is also statistically significant. The traffic analysis system of e-commerce Web site can accurately monitor the arrival and utilization of information, which provides a basis for the tourism industry to formulate network marketing strategy.

Thus, it can be seen that tourism e-commerce makes the information which is difficult to communicate extensively due to geographical separation, limited channels, block division and other factors in tourism industry can be collected, disseminated and shared through the network, greatly increasing the amount of information that can be obtained, and providing better conditions for information development.

4.1.2 E-commerce promotes transformation of tourism production factors

E-commerce provides conditions for the development and utilization of tourism information resources, and the development and sharing of information resources will further promote the transformation of tourism production factors, so as to solve the current situation of information asymmetry and incompleteness in the tourism economic system, and realize the deep development of tourism resources and the optimization of tourism product structure.

1. To solve the problem of information asymmetry and incompleteness in tourism market. Under the environment of e-commerce, tourism information tends to be more accessible and transparent. For tourists, through the Internet, all kinds of tourism-

Table 1 Tourist information record of a typical tourism e-commerce Web site

Information type	Information item	Information extraction purpose
Website registration information	Reminder of user name, password and password used in Web site registration	Visitors can avoid filling in the same information repeatedly during the booking process and improve the booking efficiency by registering their usernames
Customer basic information	Name, ID number, passport/visa information, age, occupation, telephone, e-mail, address, etc.	Description of tourists and basis of market segmentation
Tourism preference	When do tourists want to start traveling most? Which airline do they want to take the most? How often do they fly? What kind of car do they like to rent the most? What kind of hotel do they prefer to stay in?	After the server stores the preference information of tourists, it will automatically track the preference of tourists to find qualified products and services. Tourism agencies can also use the information database to conduct more targeted active marketing
Interested tourist destinations	What information do tourists most want to know about tourist destinations?	Provide local weather, cultural environment, tourist features and currency exchange information according to the destination chosen
Accumulate customers' consumption	The electronic commerce system automatically counts the amount of tourists' booking on the Web site, such as room days and flight distances	Can be used as an integral and promotional reward basis

related information can be queried conveniently, quickly and cheaply, including tourism destination information, tourism enterprise information, tourism product information, tourism price information and so on, providing a basis for tourism decision making. For tourism enterprises, e-commerce makes the market supply and demand information, market price signals and so on be quickly transmitted, which affects the decision making of market participants and forms the feedback and self-regulation mechanism of market economy. Tourism demand is constantly changing. In a specific period, information about where the tourism reception capacity is excessive and where it is inadequate is transmitted, which can guide tourists to adjust their travel plans, guide the organizers of tourism activities to make flexible coordination and arrangements, and optimize the allocation of resources. In the short and long term, tourism enterprises can make rapid response through tourists' information mining, market supply and demand situation and price signal acquisition and adjust the price, type and structure of products, so as to improve the market competitiveness and decision-making level of tourism enterprises.

The deep development of tourism resources and the optimization of tourism product structure. Information can also be used as the knowledge and intellectual resources in the factors of tourism production to guide the improvement and innovation in tourism development, product design and management, so as to realize the deep development of tourism resources and the optimization of tourism product structure.

2. The foundation of deep development of tourism resources and optimization of tourism product structure is to obtain tourism information. The development and application of electronic commerce and information technology have promoted the development and sharing of tourism information resources. It has played a tremendous role in understanding the market supply and demand situation, improving and innovating the product design and management. At present, the tourism industry has developed from simple standardized tourism products to complex combination products, from business tourism to leisure tourism products and from individual tourists to group tourism products. In addition, e-commerce has also brought special opportunities for R&D, enabling tourism to better target the ultra-segmentation market to provide specialized products. E-commerce can provide different products according to the requirements of each tourist. By unpacking the tourism products and allowing the tourists to add all personal factors, the enterprises can subdivide the market into each customer, and the supply structure of the products does not change. This can only be achieved with the support of e-commerce.

4.2 The role of e-commerce in tourism demand elements

4.2.1 The complex and changeable tourism demand under e-commerce environment

The factors that determine the competitiveness of tourism industry include not only the size of domestic tourism demand, but also the complex situation of domestic tourism demand, especially the latter. Under the environment of e-commerce, tourism demand presents a more complex and changeable trend.

The Internet theory "long tail" illustrates the relationship between the Internet and product personalization. In the system of consumer products, there are popular products and small products. If we arrange all commodities according to the sales volume from large to small, we will see a curve similar to logarithm. The demand for many distinctive tourist products is limited, forming the long tail of the curve, as shown in Fig. 4.

4.2.2 The transformation of e-commerce to tourism service

Tourism services include providing information and consultation for tourists at the decision-making stage, facilitating purchasing methods for tourists and consulting and recontacting tourists who have completed their travels. E-commerce provides a series of convenient conditions and technical support for the process of tourism services, making the new era of tourism services to a more value-added direction.

1. Pre-service stage

   Because of the limited means of information transmission, traditional tourism services have restricted the communication between tourism enterprises and tourists in different places. And through e-commerce, tourism enterprises can provide tourists with information services-based consultation and sales. Tourism enterprises put information on Internet Web sites, and tourists get information through active search and reading. Travel service providers query the number of trains, flights, hotel prices through the computer reservation system (CRS), the global distribution system (GDS), the Internet or the Intranet and quickly and accurately provide information and professional advice to tourists. At the same time, information technology enables tourism enterprises to fully communicate with tourists and provides condi-

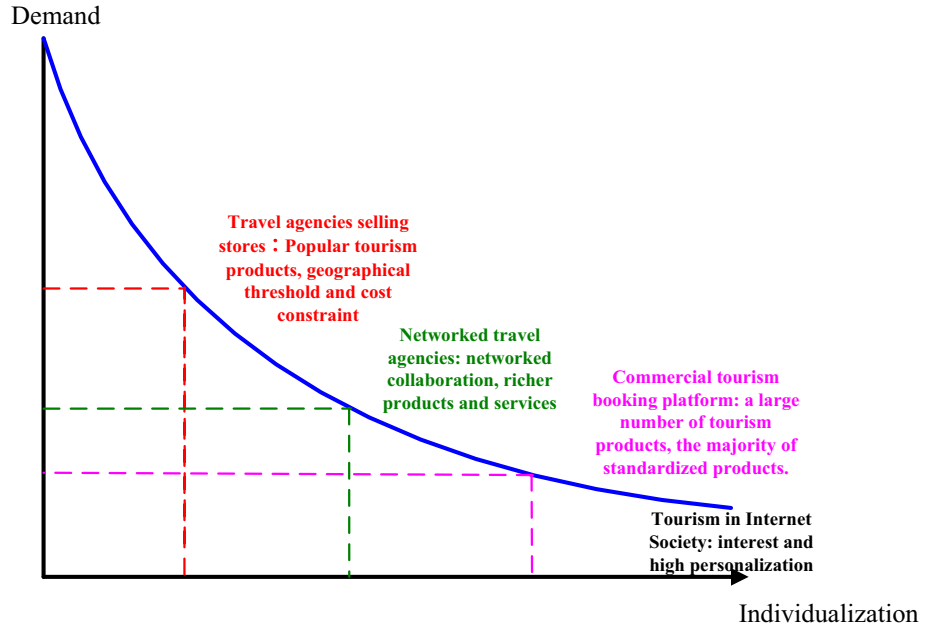

Fig. 4 Internet "long tail" promotes personalized tourism products

tions for tourism enterprises to provide individualized services, one-to-one services, and to carefully understand the needs of tourists and design products. On the other hand, tourism enterprises realize remote services and electronic sales through the Internet, which brings convenience to tourists.

2. Field tourism service stage
   Traditional tourism services provide standardized and procedural services. However, with the development of tourism and the change of tourists' psychological needs, uniform standardized services cannot fully meet the needs of customers. In this case, the application of electronic commerce and information technology provides conditions for the realization of personalized value-added services. Customers' personalized characteristics are a set of information, which tourism enterprises need to record and store for timely invocation when needed. Customer database and customer relationship management software of tourism enterprises can help enterprises to provide tourism services by inquiring tourists' habits, interests and preferences, targeted to provide personalized services to meet the unique needs of customers.
3. After the end of the tourism activities
   E-commerce can strengthen communication and re-marketing with customers. BBS, a Web site of tourism enterprises, provides a garden for enterprises to communicate with customers. It can collect tourists' opinions and suggestions in time and help customers find a reasonable channel to communicate and release their dissatisfaction with the process of tourism service, so as to reach mutual understanding and reduce negative effects. BBS is also a "virtual community" for tourism enterprises and customers to communicate with each other. It can not only enhance the feelings of customers to the Web site of tourism enterprises, but also reduce the service costs and service difficulties related to tourism enterprises through mutual help between customers. Through Web sites, e-mail and so on, tourism enterprises can also keep in touch with customers who have received them at a very low cost, send new products and service information, send questionnaires, etc., to achieve the purpose of customer maintenance and re-marketing. The application of one-to-one travel service system and e-commerce means is shown in Fig. 5.

4.2.3 Customer relationship management to achieve "one-to-one tourism service"

The "one-to-one service" of tourism enterprises emphasizes the full attention to each tourist as an individual with unique needs. From the service process, it can be divided into three stages: "one-to-one" interactive tourism marketing, personalized tourism product design customization and personalized tourism services, as shown in Fig. 3. The development of electronic commerce and information technology provides a possibility for the realization of "one-to-one tourism service."

1. "One-to-one" interactive marketing communication stage.

   Tourism enterprises use database technology, according to the collected detailed information of individual or family tourists targeted to send information, carry out marketing activities, that is, the implementation of database marketing, and also can

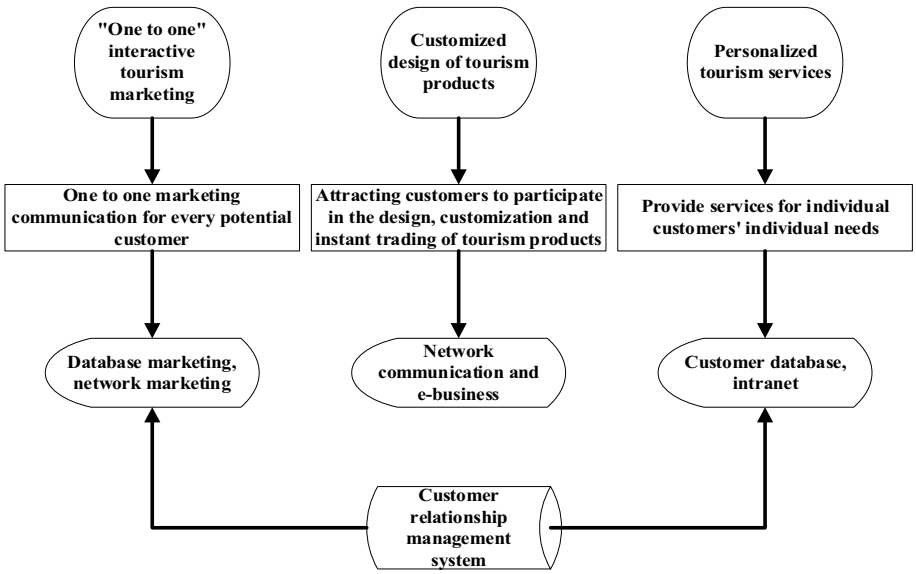

Fig. 5 Application of one-to-one tourism service system and electronic commerce means

use message board, network dialogue and other forms of "one-to-one" exchanges with tourists, that is, the implementation of network marketing.

2. Personalized tourism product design and customization.
   On the basis of communication with potential tourists, tourism enterprises design tourism products according to tourists' requirements and preferences to provide customers with personalized tourism programs. Make tourists fully participate in the design of tourism products, increase tourists' sense of participation and identity, which will make the added value of products to be improved, and make the profit space of enterprises to be expanded.
3. Personalized tourism services.
   In tourist activities, tourism enterprises provide services according to the individual preferences and habits of tourists, so that tourists can get a greater degree of satisfaction and attention to the psychological well-being. Personalized services are provided on the basis of customer information records, customer requests and tourists' preferences observed in actual services. These data are collected and stored in a certain way in the enterprise's customer database, the enterprise intranet can be shared.

5 Results

5.1 The construction of tourism value chain by e-commerce

1. Traditional tourism value chain.

   Tourism industry is characterized by associated collaboration. The traditional tourism value chain begins with the supplier of the destination, goes through the wholesaler and then sells to the tourists of the source, as shown in Fig. 6.

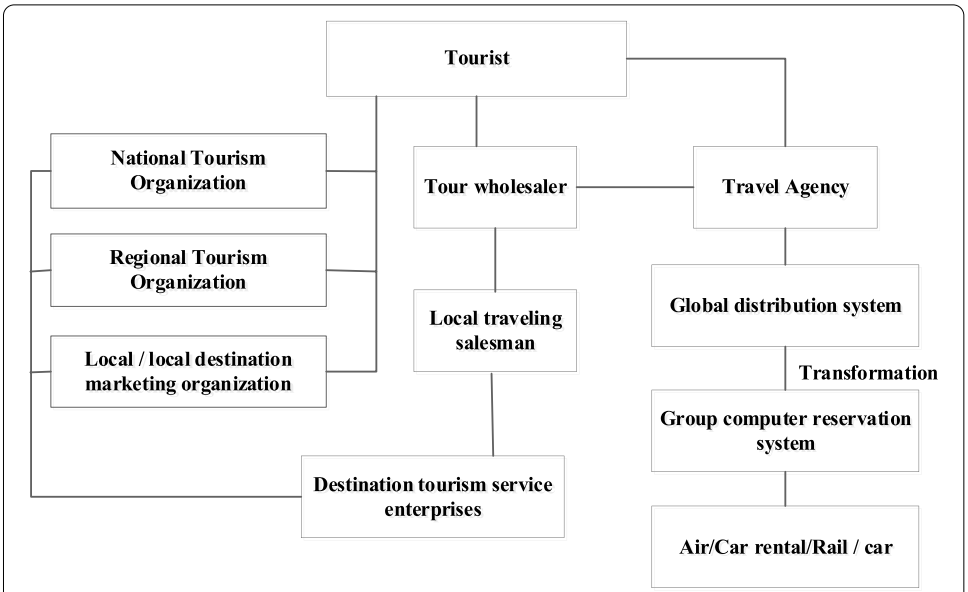

Fig. 6 Traditional tourism value chain

As can be seen from Fig. 4, the value chain of tourism industry can be divided into three parts, the whole value chain presents blocks, and each piece is in a distinct linear form. The independent commercial tourism organization is the main body of the value chain. All tourism activities are coordinated by tourists, travel agencies, local travelers, travel intermediaries and destination travel service enterprises, and the whole process has a fixed order, which is irreversible or jumping. This leads to the slow flow of traditional tourism value chain information and poor flexibility of procedures. This is a fixed chain connected sequentially, the same as the biological chain, and the interruption of one link in the middle will lead to the disintegration of the whole chain. The tourism industry value chain under the e-commerce environment is shown in Fig. 7.

The branch on the right of the traditional tourism value chain, the main part of the value chain composed of commercial tourism institutions, focuses on the arrival of trade in tourism products rather than on the provision of destination tourism information. The left branch, which consists of destination agencies, is in contrast responsible for the provision of destination tourism information without regard to travel transactions. Obviously, the two parts are separated, and there is little cooperation or interaction. Tourism is an industry with a long distance between production, supply and consumption. On the one hand, tourism consumers do not understand the tourism products and services provided by tourism enterprises; on the other hand, tourism enterprises do not understand the needs of tourism consumers, which causes information asymmetry and information delays.

2. The construction of tourism value chain under e-commerce environment.
   The development of network economy redefines the connotation and form of competition and cooperation in each link of tourism value chain. Jefferey F. Rayport and John J. Sviokla proposed the idea of developing virtual value chains in 1995. They

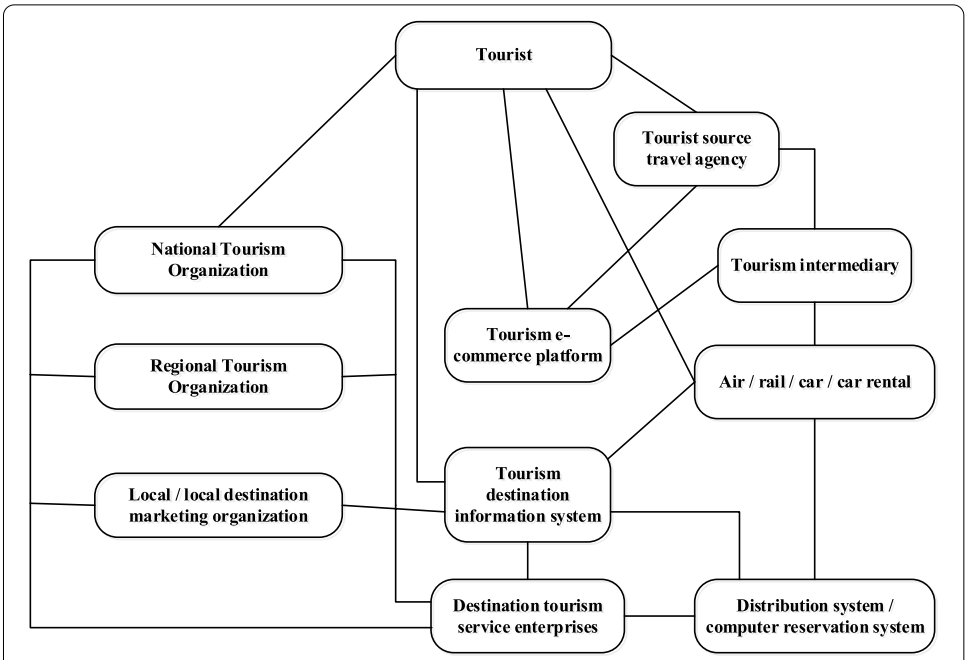

Fig. 7 Value chain of tourism industry under e-commerce environment

argue that every enterprise today competes in two worlds: the managers' perceptible physical world and the virtual world composed of information, which refers to e-commerce as a new value growth point. The increment process of the two value chains is basically different. The physical value chain is composed of a series of linear and continuous activities. The virtual value chain is nonlinear and has potential input and output points. It can obtain and distribute matrices through various channels. E-commercialization of tourism industry has a great impact on the traditional value chain between enterprises. While a large number of direct selling Web sites of tourism destinations have been established, a number of emerging e-tourism middlemen–professional tourism e-commerce platform Web sites have emerged. The new tourism value chain takes the computer network technology as the platform and the Internet as the medium to overcome the disadvantages of the traditional value chain, as shown in Fig. 5.

E-commerce environment promotes the networking of tourism value chain, which takes tourism e-commerce platform and tourism destination information system as the center and distributes in a network, without obvious sequence. Each part of the chain can be linked across links, and the information transmission speed is fast and the loss is small. Among them, tourists, tourism e-commerce platform, tourism destination information system and other five nodes have direct links, so that the past linear information changes into the star-like structure centered on the above three parts, as shown in Fig. 8.

5.2 The function mechanism of e-commerce on tourism industry competitiveness

Compared with other industries, the tourism industry needs e-commerce more, and it is easier to promote e-commerce. Tourism products have the characteristics of invisibility

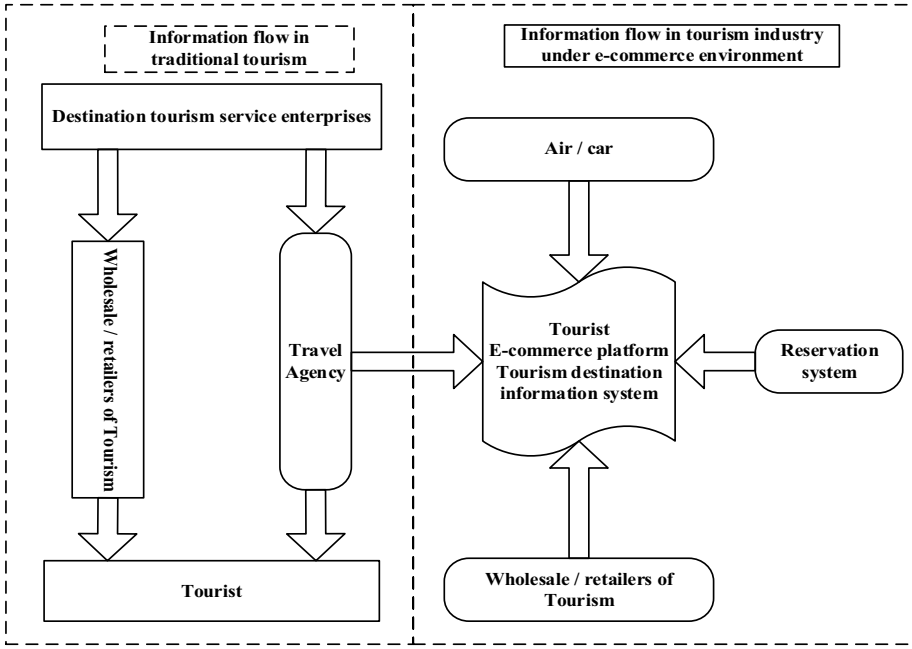

Fig. 8 Information flow in tourism industry

and non-storage, and their production and sales process is completed in the process of service. There is no need to distribute in the realization of e-commerce. The process of selling tourism products is to combine all kinds of product information and convey it to the people who need it. So the conditions of developing tourism e-commerce are unique. At the same time, the role of tourism e-commerce in enhancing the competitiveness of the tourism industry is also very obvious, mainly in the following aspects:

1. Tourism industry is highly related, and it is a seemingly loose comprehensive industry which is composed of a number of distinct industries. The development of tourism involves a wide range of social and economic structure. Tourism e-commerce can quickly integrate various resources, promote cross-linking and complementary advantages among various industries, concentrate the original scattered profit points and move toward a new level of the system economy, forming a win–win situation for tourism intermediaries, producers of tourism products and tourists.
2. Tourism e-commerce helps to solve the problem of asymmetric information in tourism consumption. The consumption form of tourism products is different from other commodities. Tourists cannot see the products before they consume them. Consumption, production and sales are carried out synchronously. Because of the serious information asymmetry between travel agents and tourists, the interests of tourists cannot be guaranteed at all, which not only affects the sales of tourism products, but also restricts the further development of the tourism industry to a certain extent. E-commerce can compensate for the adverse effects of this asymmetric relationship by providing companies with a completely new communication tool that can deliver a large number of valuable information to potential tourists. For example, the transmission of pictures through the Internet about scenic spots, services and transporta-

Table 2 Expenditure of tourism in China from 2007 to 2016 (100 million)

Years	2007	2008	2009	2010	2011	2012	2014	2015	2016
Spending	9000	12,000	14,562	18,625	21,562	26,565	31,236	34,956	38,562

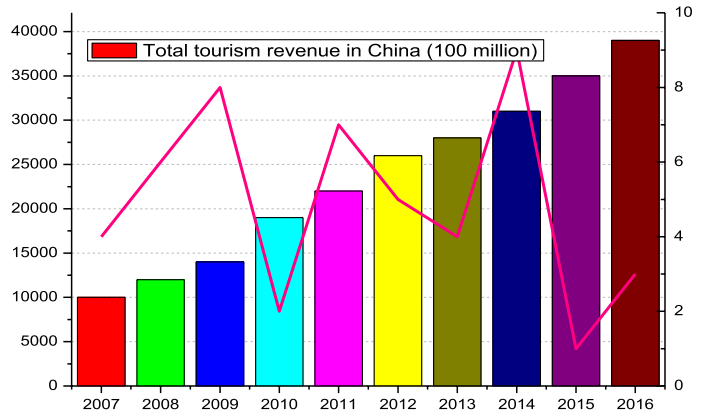

Fig. 9 Domestic tourism spending

tion facilities and through a variety of languages around the world to attract potential customers to click on relevant content to attract them stimulates the needs of tourists.

3. Tourism e-commerce is very suitable for the development of individual and small group tourism market, providing personalized services for tourists. Nowadays, tourists are impacted by various new ideas, and their consumption ideas have changed greatly. They have become more rational and individualized and tend to choose individual tourists and small group self-service tours. Through the Internet, travel agencies can quickly receive various kinds of feedback from potential tourists, especially when potential tourists determine the travel plan and the results of advertising feedback, and can provide different services for different customers. The development of tourism e-commerce will make personalized and customized tourism products gradually become mainstream.
4. The products provided by tourism e-commerce technology have price competitive advantages. The application of tourism e-commerce technology in internal management, network booking, information consultation and other aspects will greatly reduce the internal costs of tourism enterprises and contribute to the rapid growth and development of China's tourism agents. More importantly, the use of e-commerce technology has greatly expanded the business scale of tourism enterprises and large-scale purchase is bound to further reduce the cost of tourism products, more conducive to the survival and development of tourism enterprises in the market.

With the growth of national economy, domestic tourism expenditure increases gradually. According to the data of the national tourism administration, the expenditure data of China's tourism from 2007 to 2016 are shown in Table 2.

The change of domestic tourism consumption and its growth rate is shown in Fig. 9.

Table 3 Forecast of total domestic tourism expenditure from 2017 to 2022

Years	2017	2018	2019	2020	2021	2022
Spending	42,562	48,653	56,236	59,654	63,236	71,023

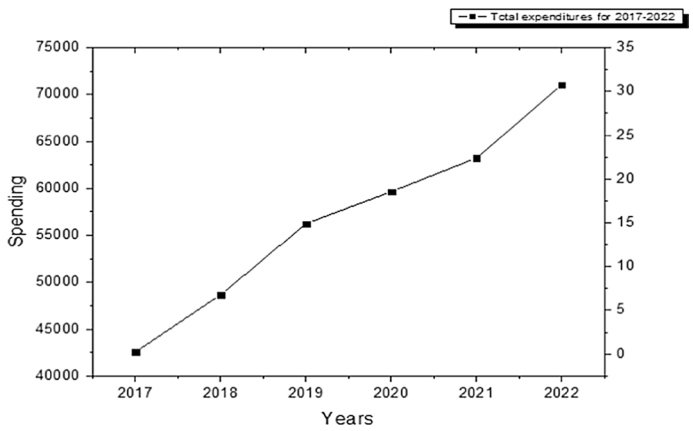

Fig. 10. 2017–2022 total domestic tourism expenditure forecast

It is clearly evident from Fig. 9 that our proposed with the growth of national economy, the expenditure of China's tourism industry is increasing, and the development momentum is very strong, which reflects the good development model of China's tourism industry.

Through the prediction and analysis of tourism expenditure data from 2007 to 2016 through the neural network model, the expenditure data from 2017 to 2022 are obtained as shown in Table 3.

The simulation of the total predicted domestic tourism expenditure from 2017 to 2022 is shown in Fig. 10.

It is clearly evident from Fig. 10 that our proposed the tourism expenditure in China has maintained an overall growth trend from 2017 to 2022, and the growth rate is getting faster and faster, which indicates that the domestic economic situation is getting better and better, and the living standards of the Chinese people have been improving.

(5) Through tourism e-commerce, tourism enterprises can be more closely linked. With the development of tourism industry as the world's largest industry, its economic activities have broken the geographical boundaries, the trend of global integration is becoming stronger and stronger, and the operation of tourism industry is facing an expanding market, but also facing an increasingly severe international competition environment. But at the same time, the rapid development of network technology and e-commerce, but also to the operation of the tourism industry, has brought many changes and new opportunities. In order to adapt to this change, tourism enterprises combine with each other through the Internet, develop strategic alliances among enterprises by using tourism e-commerce technology, integrate the resource advantages of each enterprise by means of strategic alliances, realize

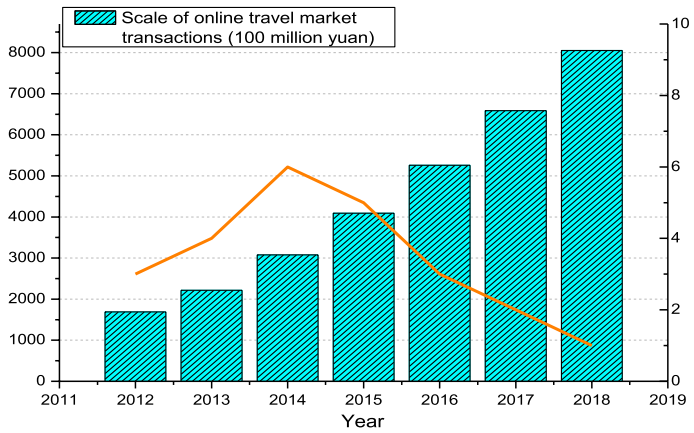

Fig. 11 The scale of online travel market in China in 2012–2018 years

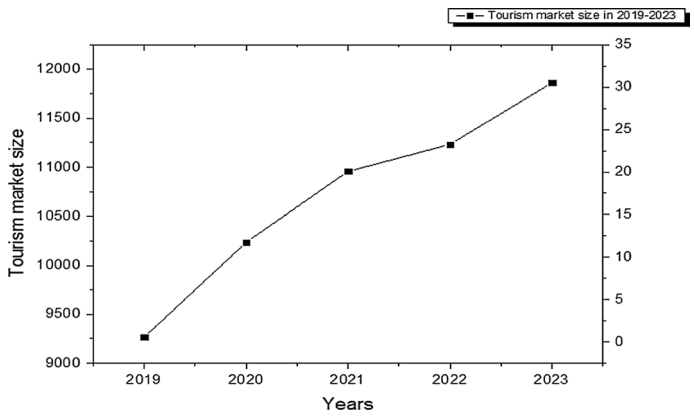

Fig. 12 Tourism market size in 2019–2023

economies of scale and achieve win–win situation among enterprises. The scale of China's online travel market from 2012 to 2018 is shown in Fig. 11.

The 2012–2018 year China online travel market and its scale of penetration are shown in Fig. 9. From 2012 to 2018, the total revenue of China's tourism industry increased from 129 billion yuan to 2850 billion yuan, with an annual compound growth rate of 21.92%, according to the National Bureau of Statistics. At the same time, the profitability of listed companies in traditional industries such as consumer goods, clothing and retail is declining. The overall upward trend of the tourism industry over the past decade, and the strong rebound after the economic crisis, is quite different from the downturn in the consumption sector. With the increase in income levels, it is reasonable to predict that the size of China's tourism market will continue to expand, especially in the e-commerce environment. The scale of the tourism market in 2019–2023 is shown in Fig. 12.

Artificial neural network model is adopted to conduct prediction analysis on the data from 2019 to 2023, and the results are shown in Fig. 10.

It is clearly evident from Fig. 12 that our proposed the scale of domestic tourism continues to expand, the number of residents' tourism continues to increase, and the national living standard continues to improve.

6 Discussion

In order to achieve a successful leap from a big tourist country to a powerful tourist country, China must enhance the comprehensive competitiveness of tourism industry with advanced marketing technology, scientific management means and innovative concept of development. E-commerce, as a new business activity, not only has an important impact on the competitiveness of tourism industry, but also relies on the combination of its information advantages, cost advantages and efficiency advantages in the tourism industry. It has changed the way and connotation of tourism services, promoted the level and quality of tourism services and promoted the development of tourism toward a more reasonable structure and a higher level of operation, thus comprehensively enhancing the comprehensive competitiveness of tourism and promoting the healthy and rapid development of tourism. Nowadays, the tourism industry has been developing rapidly. In the process of development, people should attach importance to the effective role of e-commerce, and the relevant tourism departments should fully combine e-commerce with tourism commerce, so that China's tourism industry has a good development.

Abbreviations
CRS: Computer reservation system; GDS: Global distribution system.

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Authors' contributions
Cao Wei is responsible for the collection of experimental data, Qinan Wang is responsible for the process design of the experiment, and Chengying Liu is responsible for the writing of the paper. All authors read and approved the final manuscript.

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Availability of data and materials
Data sharing is not applicable to this article as no datasets are generated or analyzed during the current study.

Declarations

Ethics approval and consent to participate
This article does not contain any studies with human participants or animals performed by any of the authors.

Consent for publication
All authors agree to submit this version and claim that no part of this manuscript has been published or submitted elsewhere.

Competing interests
All authors declare that they have no conflict of interest.

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