Analysis on the Development Strategy of Hainan’s Sports Tourism Informatization in the Digital Era

Yu Zhang, University of Sanya, China*

ABSTRACT

After years of development, Hainan Province has established a significant sports tourism industry. This paper explores how digitalization is driving the transformation of traditional sports tourism through the utilization of the DRAT model to reconstruct the value of both consumers and businesses. The analysis shows that the digitalization of sports tourism has deconstructed the traditional industry using innovative technologies such as technological virtualization and data platform construction. The effective development and utilization of highly developed information technology in modern society are essential for ensuring the smooth and healthy growth of the sports tourism industry. The traditional sports tourism industry has been digitally deconstructed, leading to the formation of new production, management, and business models. The status of consumers continues to improve during this process, and companies are seeking to collaborate with consumers to create new value positioning.

KEYWORDS
Digitization, Hainan, Informatization, Sports Tourism, Value Reconfiguration

INTRODUCTION

Tourism has emerged as a vital industry for many economies globally (Mathias & Shinoda, 2022), and sports tourism is a crucial subsector of the tourism industry (Zeng et al., 2023). By integrating sports events such as competition, entertainment, experience, and challenge into tourism, sports tourism offers a unique blend of sports and tourism that is a popular choice among enthusiasts in China (Adebola, 2022). Global data from the International Sports Tourism Committee show that sports tourism accounts for more than 30% of the world’s tourism revenue (Na et al., 2021).

Hainan Province, China is located in the central part of the South China Sea, with a geographic coordinate of 30 ° E, accounting for 30% of world tourism revenue (Na et al., 2021). The province’s location makes it the southernmost and only tropical island province in China, positioning it as an ideal destination for sports tourism with its cultural, geographical, and natural advantages (Lejie, 2021). Hainan Province has made significant strides in developing the sports tourism industry through

DOI: 10.4018/IJSWIS.325788

*Corresponding Author

This article published as an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/) which permits unrestricted use, distribution, and production in any medium, provided the author of the original work and original publication source are properly credited.
resource development, route planning, and product design, leading to the creation of various sports tourism projects (Jayathilake et al., 2021). Thus, the sports tourism industry in Hainan Province has achieved remarkable results. However, there remains a need to identify existing shortcomings in the industry and address them, leveraging the regional advantages of Hainan Province to develop a sports tourism industry that authentically embodies the characteristics of the region (Zamora et al., 2022).

The digital economy has a strong impetus to promote industrial upgrading and development, and at the same time, the scale of the digital economy is huge (Cao et al., 2022). The 19th National Congress of the Communist Party of China has made strategic plans for building a digital China, a cyber-power, and a smart society, proposing to vigorously develop the digital economy and promote the deep integration of artificial intelligence (AI), the Internet, big data and the real economy (Rosalia & Zainal, 2021). In this regard, Rasmusen et al. (2022) mentioned the knowledge graph and the use of gamification to enhance individuals’ understanding of legal knowledge, which is clearly related to the author’s discussion on how digitalization can promote the transformation of traditional sports tourism. Similarly, Hu et al. (2022) studied the effect of the application of Semantic Web technology in the education system, which can stimulate people to think and explore the application of digitalization in industrial upgrading. Tembhurne et al. (2022) proposed a novel solution for fake news detection by applying deep learning models, which also demonstrates the gradual innovation of digitization in various industries. Faced with the opportunities and challenges brought by the digital economy, how should the sports industry grasp the opportunities and face the challenges? First of all, China’s advanced network application technology and huge user base support new business formats such as Internet and sports, digital and sports, and AI and sports. Secondly, the digital economy will promote the integrated development of the sports industry. Finally, the digitalization of sports services implies the use of digital technology to upgrade and transform services in the sports service industry, thereby improving service quality and efficiency (Burukina, 2021). Therefore, as an important part of the sports industry, sports tourism has a strong service industry attribute, and it should be an industry with a high degree of digitalization. However, digitalization is still in the exploratory stage in promoting the integration of sports tourism, and the integration is not enough, resulting in problems such as poor consumer travel experience, low utilization of sports resources, and small product scale (Li, 2021). Consumers and enterprises have not found their own appropriate subject values in value positioning, resulting in the dislocation of subject values and unsatisfactory development of the sports tourism industry.

In this paper, the author first introduces the current situation and existing problems of sports tourism development in Hainan Province, and then analyzes the driving effect of digitalization on the sports tourism industry. By the literature review and logical analysis, the researcher reconstructs the main value of consumers and enterprises. Based on the Delta model, the author explains the information technology in the digital integration of sports tourism to deconstruct the traditional sports tourism industry. Finally, the author proposes that the sports tourism industry in Hainan Province should follow a development path with local characteristics, and strengthen supervision, talent cultivation, and service quality improvement.

**LITERATURE REVIEW**

**Theoretical Framework**

The author investigated the development strategy analysis of sports tourism informatization in Hainan in the digital era. In this section, the researcher will point out the problems and shortcomings in the development of sports tourism in Hainan Province, such as a single income structure and severe homogenization phenomenon. Afterwards, the researcher will analyze the impact of digital technology on the sports tourism industry through logical analysis, emphasizing the important role of informatization in promoting the development of sports tourism, and exploring the significance
of big data application in the tourism industry. Finally, based on specific literature, the author will elaborate in detail on the deconstruction of traditional sports tourism industry by digital technology, the current development status of sports tourism industry in Hainan Province, and tourism informatization through charts.

The author explored the changes brought about by the digital deconstruction of the traditional sports tourism industry from the perspectives of value restructuring, production mode, management mode, and business model. At the same time, considering the highly developed information technology of contemporary society, the researcher focused on the important role of informatization in promoting the development of sports tourism industry, and called for strengthening supervision and management, implementing talent cultivation, fundamentally improving the quality of business services, and enabling it to play a greater role in local and national economic development in Hainan Province.

The development of sports tourism industry in Hainan Province has gained momentum in recent years. However, there are still challenges that need to be addressed to propel the industry forward. Digital technology has been transforming traditional tourism industries and, in this process, consumer and enterprise values have undergone a series of changes. Thus, the author proposes a theoretical framework that utilizes literature analysis and logical analysis methods to analyze the restructuring of consumer and enterprise values that digitalization brought about. The theoretical framework also covers the importance of information technology in promoting the development of sports tourism. The recomposition of value between sports tourism consumers and enterprise entities is a necessary condition for the integration of digitalization in the industry. This process allows to deconstruct traditional sports tourism industries and form new production, management, and business models. The theoretical framework emphasizes the importance of effective utilization of digital technology to support healthy and steady growth of the sports tourism industry in Hainan Province.

**Digital Technology Deconstructs Traditional Sports Tourism Industry**

The sports tourism industry aims to emphasize consumer experience and is based on providing a particular sports experience. It has the characteristics of specific spatiality and evident off-site consumption or experience. Industrial digitization deconstructs the traditional sports tourism industry through technology virtualization and new information technology that builds data platforms, breaking the “information island” (Randle & Hildreth, 2021).

Sports tourism is highly dependent on time and space. In traditional sports tourism consumption, consumers can only consume sports tourism products at a specific time (i.e., during travel) and in a specific place (i.e., tourist destination) to establish a consumption experience (Aznar et al., 2021). Digital technology realizes the virtual reflection of the real economy in the digital space, and gets rid of the limited relationship between people and things in reality. Consumers and enterprises can trade across time and space, the digital transformation of supply and demand, and the application of emerging information technologies such as big data, AI, and cloud computing, enable the physical products of traditional industries to build digital products in the virtual network world by using information technology (Liang et al., 2022). Consumers can browse products, watch product videos, experience virtual products at any time, and form product experience feelings in advance. Figure 1 shows the import volume of China’s sports tourism service trade and its proportion in total imports and export from 2017 to 2020.

The establishment of the data platform has created a more effective information exchange environment for both consumers and enterprises. The expansion of Internet applications has consolidated the information foundation, changed the traditional decision-making model from “people and information dialogue” to “people and data dialogue,” and tried to realize “data and data dialogue.” The “people and information dialogue” refers to the traditional decision-making model where people rely on exchanging information with each other to make decisions. On the other hand, the “people and data dialogue” to which the author refers means that people rely on exchanging data with each other to make decisions, which is made possible by the expansion of Internet applications and the
establishment of data platforms. “Data and data dialogue” means that data can be exchanged between different sources and analyzed to provide more valuable insights and decision-making support. It is a more advanced stage of the decision-making process, enabled by the availability and exchange of large amounts of data. The digital transformation of sports tourism has broken through the “island of information” between sports consumers and sports tourism enterprises. It has changed from one-way consumer-facing enterprises to obtaining information from consumers-facing enterprises, obtaining information from multiple enterprises, and also interacting with enterprises. Consumers exchange information. At the same time, the digitalization of sports tourism creates more information dissemination platforms for enterprises, provides consumers with more information, and highlights the “long tail effect.” Figure 2 shows the scale and growth rate of Chinese sports from 2006 to 2014.

Sports tourism is a new form of tourism that combines sports and tourism, with multiple functions (e.g., health, leisure, entertainment, and education). It is an important component of the world’s tourism industry today (Higham, 2021). Hainan Province, as the southernmost tropical island in China, has unique natural resources and geographical location, making it an ideal place for China to develop sports tourism. In recent years, Hainan Province has actively promoted the development of sports tourism industry, which has formed a certain scale and characteristics, but also faces some challenges and problems, such as market competition, environmental protection, consumer demand, and information technology level (Dong et al., 2022). In order to enhance the competitiveness and sustainability of Hainan sports tourism, it is necessary to make full use of information technology to realize the digital transformation of sports tourism.

The digitization of sports tourism refers to the use of information technology and network platforms to innovate and optimize the production, management, marketing, service, and other aspects of sports tourism, improve efficiency and quality, meet the personalized and diversified needs of consumers, and enhance the attractiveness and value of sports tourism (Kumbhojkar & Menon, 2022). Digital technology can provide more possibilities and opportunities for sports tourism, such as virtual reality, AI, big data, and cloud computing. These technologies can help sports tourism enterprises improve their management level, reduce costs, expand the market, and increase revenue.
It can also help sports tourism consumers obtain more information, choose more products, enjoy better services, and improve satisfaction (Blanco-González-Tejero et al., 2023). At the same time, digital technology can promote the integration and coordinated development of sports tourism and other industries, forming larger industrial clusters and benefits.

However, the digitization of sports tourism also entails some risks and challenges, such as rapid technological updates, significant safety hazards, imperfect laws and regulations, and lack of talent. Therefore, in the process of promoting the digitization of sports tourism, it is necessary to have clear goals, scientific planning, reasonable investment, effective supervision, comprehensive evaluation, and other measures. At the same time, it is necessary to strengthen cooperation and exchange with relevant institutions and enterprises at home and abroad, draw on advanced experience and models, and continuously innovate and improve the digital development strategy of sports tourism.

**Development Status of Sports Tourism Industry in Hainan Province**

Although Hainan’s sports tourism has made great progress in recent years, it has stagnated in terms of development mode and product innovation, and the sports tourism industry lacks innovation. First, the income structure of the sports tourism industry in Hainan Province presents a relatively single situation. For example, in Sanya City, tickets for various scenic spots and hotel accommodations are the main sources of current tourism income. Over time, people’s perception of Sanya City has not integrated sports characteristics into tourism, resulting in a single sports tourism industry chain in Hainan Province (Zhao et al., 2023). At the same time, the construction of catering, transportation, shopping, entertainment, and other related supporting facilities and industries is obviously insufficient. The sports tourism industry has not formed a complete system, yet, resulting in insufficient competitiveness (Eremeev & Seltsova, 2019). Secondly, at present, the sports tourism industry in Hainan Province only include regular sports, such as swimming, diving, motorboats, beach volleyball, jungle crossing, mountain climbing, and camping. Compared with famous island tourism cities, Hainan is characterized by a serious homogenization phenomenon, and the sports tourism industry lacks innovation. The situation of imitating and learning from each other in the same type of sports
tourism products not only causes great waste of resources, but also leads to the monotony of sports tourism products, which is not attractive to tourists. Figure 3 shows the development trend of tourism in Hainan Province from 2014 to 2019.

At present, the management of the tourism market mainly relies on the joint management of the government and relevant tourism departments. However, at this stage, the high-end management mechanism of sports tourism in Hainan Province is still not perfect, and the management of some resources is obviously lacking. For example, the data and information related to sports tourism in Hainan have not been set up to organize, analyze, and evaluate the relevant departments, resulting in insufficient development of sports tourism resources in Hainan, which seriously affects the development of the sports tourism industry. At the same time, there is low-price competition among some travel agencies, the quality of tourism services continues to decline, and tourists lack safety guarantees for travel, which has a great negative impact on the return rate. Hainan’s sports tourism industry shows a serious lack of high-end boutique products and of characteristic tourist souvenirs, and a brand effect with Hainan characteristics has not been formed, yet. Once sports tourism products lack their own characteristics, coupled with high travel and accommodation costs, tourists lack novel experiences during the travel process. For example, some sports tourism projects such as diving and rafting cannot be accessed by mobile phones, and tourists cannot keep photos during the tour. This often causes most people to lose their interest and be unwilling to spend much energy, financial resources, and time to travel to Hainan, which is a serious constraint.

Tourism Informatization

Big data are an inevitable product of the development of the information age and are inextricably linked with sensor networks, mobile Internet, cloud computing, and AI technologies. In the tourism industry, the era of mass tourism has brought new challenges to high-quality tourism management,
humanized services, and precise marketing, so that more attention is paid to tourists, tour routes, tourism resources, service facilities, and services. Relying on traditional surveys, fixed-point sampling, and sampling analysis methods to achieve this goal effectively is difficult; it is urgent to introduce the deep application of tourism big data. With the rapid development of tourism informatization, tourism big data involve a large number of tourists, a large industry span, a wide range of space, a variety of service contents, and different acquisition channels. Whether it is tourism resources, service facilities, tourism activities or tourists, managers, and practitioners, there are location positioning, regional distribution, and their changes, and they have a unified temporal and spatial reference and different degrees of time and space correlation, forming tourism planning, important data support for management and service decisions. The tourism spatiotemporal big data discussed in this paper are the most active and basic form of big data in tourism big data. It is the product of the combination of spatiotemporal data in the field of geographic information and thematic data in the tourism industry.

Related studies have shown that digitization has accelerated consumers’ demand for personalization, customization, and intelligence, while also increasing their attention to trust, security, and privacy protection (Sharma & Gupta, 2022; Li & Zhang, 2022). In response, sports tourism enterprises need to make changes in digital product design, marketing channel management, and user relationship maintenance to meet the new expectations and needs of consumers. At the same time, digitization also provides abundant data resources for sports and tourism enterprises, which can be used to identify market trends, mine customer needs, and evaluate competitors, in order to optimize business decisions and improve enterprise performance (Kumar & Singh, 2021; Wang & Zhang, 2022). From the perspective of destination development and management, digitalization has also brought new opportunities and challenges. Digital platforms can provide support for destination promotion, online booking, tourist experience, and provide more accurate data analysis and evaluation tools. Digitization has also brought about the protection and management of destination resources. How to balance the tourism pressure and ecological environment protection that digitization has brought about is a problem that needs to be explored (Li & Zhang, 2022; Wang & Zhang, 2022). The plan of this article is an analysis of the development strategy of sports tourism informatization based on the Daubechies wavelet transform and roughness analysis techniques (DRAT) model, which is different from other relevant literature. The limitations of this solution are: (1) The DRAT model is a theoretical framework that needs to be further validated and applied in practical cases; (2) the DRAT model is a static analysis tool and cannot reflect the informatization of sports tourism. Therefore, in addition to the application of the DRAT model, it is necessary to focus on the specific impact of the digital age on the development of sports tourism consumers, enterprises, and destinations, and consider how to achieve information technology development in these areas. Table 1 presents a comparison of the main contributions, characteristics, and keywords of relevant literature.

The review of existing literature highlighted the need for more in-depth research of the specific application of digital methods in Hainan’s sports tourism industry. Therefore, this study expands and improves research in related fields, providing stronger support for the innovation and development of the sports tourism industry in Hainan Province.

**METHODS**

The author aimed to explore the informationization development strategy of Hainan’s sports tourism industry in the digital era. In order to better achieve this goal, the researcher adopted various methods, including Adaboost algorithm, wavelet analysis, radial basis function (RBF) network, and sports tourism promotion models. In the following, the author will introduce these methods and their specific applications separately.

Wavelet analysis, as a signal analysis tool, is widely used in the processing and display of time series data. In this study, the author used wavelet analysis to address the issues that arise in the development strategy of sports tourism in Hainan, mainly through digital deconstruction of the
traditional sports tourism industry and related value reconstruction. These reconstructions include the value restructuring between consumers and enterprises, as well as the updating of industrial production, management, and business models. The wavelet analysis method the author used is based on the evaluation criteria of root mean square error (RMSE) and signal-to-noise ratio (SNR) to measure the degree of denoising effectiveness. The Delta model is a method based on wavelet analysis transform that can decompose signals into multiple scales and frequency levels, thereby better describing the time-frequency distribution characteristics of signals. In this study, the researcher used the Delta model to analyze the main values of consumers and enterprises in the sports tourism industry, and, based on this, the author conducted a digital deconstruction.

<table>
<thead>
<tr>
<th>Literature</th>
<th>Main Contributions</th>
<th>Characteristics</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>This study</td>
<td>The author analyzes the impact of digitization on the sports tourism industry in Hainan, reconstructs the value of sports tourism consumers and enterprises, and proposes the development strategy of sports tourism informatization in Hainan.</td>
<td>Using the Delta model, the author analyzes the value creation process of sports tourism digitization from the perspectives of consumers and enterprises.</td>
<td>Sports tourism digitization, technology virtualization, data platform construction, and value restructuring.</td>
</tr>
<tr>
<td>Tang &amp; Xia (2017)</td>
<td>Starting from the concept of global tourism, the authors analyzed the current situation and problems of Hainan’s marine sports tourism circle, and proposed the goals, principles, and models for building Hainan’s marine sports tourism circle, as well as specific measures and suggestions for implementation.</td>
<td>In this theoretical study, the authors used methods such as literature review, comparative analysis, and logical analysis, combined with the actual situation of Hainan Province, to deeply explore the development of Hainan’s marine sports tourism circle.</td>
<td>Global tourism, marine sports tourism circle, construction, and development strategies.</td>
</tr>
<tr>
<td>Lin (2020)</td>
<td>Starting from the connotation and characteristics of global tourism, the authors analyzed the current situation and problems of tourism informatization in Hainan, proposed goals, ideas, and countermeasures to accelerate the development of tourism informatization in Hainan, and proposed suggestions to promote the construction of global tourism informatization.</td>
<td>In this policy study, the authors used methods such as literature review, empirical analysis, and case analysis, combined with the theory and practice of global tourism, to systematically analyze the development of tourism informatization in Hainan.</td>
<td>Global tourism, tourism informatization, development strategies, and construction suggestions.</td>
</tr>
<tr>
<td>Li (2020)</td>
<td>Starting from the positioning and requirements of an international tourism island, the author analyzed the advantages and disadvantages of sports tourism in Hainan, proposed goals, paths, and strategies to promote the development of sports tourism in Hainan, as well as measures and suggestions to strengthen sports tourism management and services.</td>
<td>In this applied study, the author used methods such as literature review, SWOT (i.e., strengths, weaknesses, opportunities, threats) analysis, and strategy analysis to comprehensively evaluate the development of sports tourism in Hainan, combined with the strategy and planning of the international tourism island.</td>
<td>International tourism island, sports tourism, development strategies, and management services.</td>
</tr>
<tr>
<td>Zhao (2019)</td>
<td>The author analyzed the current situation, advantages, problems, and countermeasures of sports tourism in Henan Province, and proposed suggestions for using Internet technology to promote the development of sports tourism.</td>
<td>The author developed this study based on the literature, field survey, and logical analysis.</td>
<td>Sports tourism, Internet plus, Henan Province, and feasibility analysis.</td>
</tr>
</tbody>
</table>
Adaboost Algorithm

Wavelet analysis takes the wavelet function as a basis function and decomposes the initial signal into multiple levels according to the frequency. In the analysis of the development strategy of sports tourism in Hainan Province, wavelet analysis can be used to analyze the current situation and existing problems of the sports tourism industry in Hainan Province, decompose and denoise it, so as to better understand the development trend, scale, and advantages of the sports tourism industry in Hainan Province, and further propose reasonable and effective development strategies to promote the healthy development of the sports tourism industry in Hainan Province. The signals within each layer do not overlap, and the analyzed signal contains all the frequencies of the original signal. The evaluation criteria of wavelet denoising effect are divided into the following two types: RMSE represents the mean square deviation between the denoised signal and the initial signal, the smaller the value, the better the denoising effect, which is specifically recorded as follows:

\[
RMSE = \sqrt{\frac{1}{n} \sum_{i=1}^{n} [f(i) - \hat{f}(i)]^2} \tag{1}
\]

In the formula, \( f(i) \) represents the initial signal, and \( \hat{f}(i) \) represents the signal after denoising.

The formula for calculating the SNR is as follows:

\[
SNR = 10.\ln\left(\frac{power_s}{power_n}\right) \tag{2}
\]

where \( power_s \) represents the initial signal power and \( power_n \) represents the noise signal power.

The RBF neural network is a three-layer feedforward network with a single hidden layer. The hidden layer in the network is used to convert the low-dimensional input data into high-dimensional output, which solves the problem of linear inseparability of low-dimensional spatial data. Figure 4 shows its architecture.

Figure 4. RBF neural network beam structure
Support vector machine (SVM) can be used for model division and nonlinear regression, refract sample data from sample space to high-dimensional feature space and implement linear regression, and then obtain an optimal water quality regression function that covers the influence of many elements. In the optimal regression function, using a suitable kernel function to replace the vector inner product in the high-dimensional space can realize the fitting of the transformed data. This process does not increase the computational complexity and finally allows to obtain the optimal regression function:

\[ f(x) = \sum_{i \in SV} (\alpha_i - \alpha_i^*)k(x_i, x) + b \]  

(3)

In the Equation 3, \(a\) and \(k\) are both Lagrange multipliers, \(b\) is the critical value of the regression function, \(SV\) represents the support vector, and \((x_i, x)\) is a kernel function. Elman network is compared with feedforward neural network. With better computing performance, it is a feedback neural network that perfectly presents the dynamics of the system. The Elman network adds a successor layer to the backpropagation neural network, and has a network pre-judgment function that adapts to time-varying characteristics (Figure 5).

The Adaboost algorithm is a typical statistical learning method. The key idea is to first give the weak learning algorithm and \(K\) groups of sample data, considering the original weight of each group of data is \(1/K\), then use the weak learning algorithm to implement training, and compare the training results with the real data. Values are compared, and a larger weight is given to the training samples with prejudgment errors. In the process of its next iteration calculation, these training samples are given more attention. The training error judgment depends on the error rate \(e\). If \(e\) is higher than the critical value, it is determined to be a failed prediction sample, and then a series of weak predictor sequences \(f_1, f_2, \ldots, f_n\) using different weight training samples are obtained. At the same time, each weak predictor also has a relative weight, and the accuracy of the prediction result is high. Finally, after the iteration is implemented, the weighted summation of all weak predictors is used to obtain a strong predictor, and the strong predictor is used to perform prediction.

The RBF network can self-adaptively clarify the network architecture, but using a fixed target deviation goal and expansion coefficient spread cannot optimize the sample, resulting in poor training accuracy. Therefore, the author used the gradient descent method to obtain the target deviation and expansion coefficient of the comparison, and used the trial-and-error method to clarify the best prediction result.

The author selected the absolute value of the mean relative error (MRE) and the absolute value of the maximum relative error \(M\), and used RE and the mean square error (MSE) as the evaluation indicators for the prediction results:

Figure 5. Elman neural network architecture
\[ MRE = \frac{1}{n} \sum_{i=1}^{n} \left| \frac{X(i) - \hat{X}(i)}{x(i)} \right| \] (4)

\[ \text{MaxRE} = \max \left| \frac{X(i) - \hat{X}(i)}{x(i)} \right| \] (5)

\[ \text{MSE} = \frac{1}{n} \sum_{i=1}^{n} \left[ X(i) - \hat{X}(i) \right]^2 \] (6)

### The Model of Sports Tourism Promotion

Using the McKennell model, the demand function in the exogenous situation of the passenger sports tourism stay is as follows:

\[ x = x\left(p_x + p_n n, p, y, n\right) \] (7)

In the Equation 7, \( p_x \) is the travel cost, \( p_n \) is the opportunity cost, \( n \) is the length of stay, \( y \) is the total income.

If the stay is endogenous, then:

\[ x = x\left(p_x, p_n, p, y\right) \] (8)

The travel demand function is affected by travel cost, duration of stay cost, consumption Hicks bundle cost and total tourist income. The relevant variables that affect the function of public tourism demand also have a great influence on the length of stay. The decision formula for residence time is:

\[ t = t\left(p_x, p_n, p, y\right) \] (9)

In the tourism cost model, the demand functions for the established suitability scenarios are quite different, and there are situations that change with the change of time. Therefore, in anticipating the travel needs of the public in the process of counting, the destination time effect should be considered, and it should be set into two modes: The first one is to assume that the number of visits changes with the change of time \( f \), and the second is to pass the lag time of the number of visits. The question is determined jointly with other control variables. In this paper, the author adopted the second hypothesis to describe the dynamic behavior convergence of passenger play, which is expressed as follows:

\[ x_t = x\left(p_{x,t}, p_n, p_t, y_t, x_{t-1}, x_{t-2}, \ldots, x_{t-i}\right) \] (10)

Using Equations 9 and 10, the passenger demand function under the dynamic behavior convergence can be obtained, so the prejudgment Equation of the stay time can be defined as follows:

\[ n_t = x\left(p_{x,t}, p_n, p_t, y_t, n_{t-1}, n_{t-2}, \ldots, n_{t-i}\right) \] (11)
In Equation 11, $f$ represents the $f_{th}$ period, which is usually described as the $f_{th}$ year. The number of visits this year will be affected by the number of visits in the previous $f_{i-1}$ years. At the same time, the duration of stay in the destination in the previous years also determines the $f_{th}$ year. Equation 10 and Equation 11 show the dynamic decision-making problem of tourists’ travel demand and stay time demand under the water environment protection of the same destination.

At the same time, integrating the variable analysis of the tourism consumption function, the Marshall demand function of the tourism industry for tourists in the $j$ region under the condition of good water environment is:

$$x_{j,t} = x\left(p_{x,j,t}, n_{p,j,t}, n_{j,t}, y_{j,t}, x_{j,t-1}, x_{j,t-2}, \ldots, x_{j,t-i}\right)$$  

(12)

Assuming that the attractions of each sports tourism industry in each region are products of the same quality, the travel rate of a region in a fixed period of time is the per capita value of the visit rate of tourist attractions of the same quality in the current period of the region, that is, in the regional tourism cost model. Tourism demand represents the mean value of tourism cost in the region in period $f$. $j$ represents the unit cost of staying in the scenic spot in the $f_{th}$ period, $y$ is the average per capita income of the $f_{th}$ period $j$ area, $z$ is the per capita visit rate of the $j$ region lag $i$ period. It represents the residual economic development characteristics of the $j$ region in the $f_{th}$ period excluding the sports tourism industry. If the stopover time is in an endogenous state, the researcher sets the Marshall demand function of passengers in the $j$ area as follows:

$$x_{j,t} = x\left(p_{x,j,t}, n_{p,j,t}, n_{j,t}, y_{j,t}, x_{j,t-1}, x_{j,t-2}, \ldots, O_{j,t}\right)$$  

(13)

Through the dynamic panel data parsing algorithm, the regression model is transformed into the following:

$$x_{j,t} = \alpha + \beta \sum_{i=1}^{i} x_{j,t-i} + \gamma \left(p_{x,j,t} + n_{j,t}, p_{n,j,t}\right) + \varphi n_{j,t} + \rho y_{j,t} + \sigma O_{j,t} + u + \zeta_{j,t}$$  

(14)

In the formula, $\alpha$ represents the unobservable individual effect, and $\beta$ is the random disturbance term. The regression equation is set as follows:

$$x_{j,t} = \alpha + \beta \sum_{i=1}^{i} x_{j,t-i} + \gamma p_{x,j,t} + \varphi p_{n,j,t} + \rho y_{j,t} + \sigma O_{j,t} + u + \zeta_{j,t}$$  

(15)

RESULT ANALYSIS

Experimental Data and Environment

In this paper, the author conducted the experiment in Python 3.7.2 version, Intel Core i5 2, completed in the experimental environment of Windows 10 with 5 GHz and 4GB memory. The researcher crawled 42,639 travel notes related to tourism in Hainan Province from the Ctrip Web site (https://www.ctrip.com/). Attributes were time, travel time, per capita spending, and character type, among others. As this paper focuses on tourist routes at the city-level, the extracted results were preprocessed and the locations mentioned in the travel notes were mapped to the corresponding cities, resulting
in a total of 16 cities. The researcher deleted routes with less than two cities, and finally obtained 7,468 different travel trajectory data.

**Experimental Results and Analysis**

As Figure 6 shows, the receiver operating characteristic (ROC) curve is an upward convex curve from [0,0] to [1,1]. The closer the ROC curve is to the [0,1] point in the upper left corner, the better the classifier is. The area under the ROC curve is called the area under the curve (AUC) value, which is between 0 and 1. When the AUC is less than 0.5, it means that the effect of the classifier is not as good as the effect of random prediction; the closer the AUC is to 1, the better the effect of the classifier. In this experiment, the author randomly divided the sample set into six, and the average AUC value was 0.81 (Figure 6), which proves that the model can effectively predict the outcome of the game.

Figure 7 illustrates the experimental results. In order to verify the performance of the ensemble learning algorithm cooperative negentropy ensemble (CNE), Figure 7 also shows the experimental results of the Bagging and Adaboost algorithms. It is evident that the performance of CNE algorithm is better than Bagging and Adaboost algorithms on Balance scale, Breast, Hayes, Iris, Segment, Wine, Zoo datasets. These are widely used standard datasets in the field of machine learning, which can be used to test and compare the performance of different algorithms. However, on some datasets, such as Car, Credit-a, and Votes, the performance of the CNE algorithm is slightly lower than that

![Receiver operating characteristic example](image)
of the Bagging and Adaboost algorithms. The main reason for this situation is that the Bagging and Adaboost algorithms are not suitable for processing small-scale data sets, while the CNE algorithm guarantees the performance of each neural network classifier, so the performance of ensemble learning is improved. The classification performance of ensemble learning is related to the number of clusters initially selected. Through experiments, it is found that the optimal value of the prediction performance is distributed between 15 and 25 cluster values, of which three optimal values are distributed on the cluster number of 15. The seven optimal values are distributed on 25 clusters. Results show that, when the number of individual classifiers for ensemble learning is between 15 and 25, the performance of ensemble learning can achieve the best effect.

Figure 8 shows the average performance of ensemble learning after clustering with different initial numbers of neural networks (denoted as s), mainly including s=100, s=150, and s=200, where the abscissa represents training with different datasets. Horizontal coordinate is the number of neural networks, and the longitudinal ordinate represents the ensemble learning performance of selected partial networks after clustering the neural networks. Figure 8 highlights that, when the number of selected neural networks reaches a certain value (100 in the experiment), the performance of the CNE algorithm has little effect on the initial number of selected neural networks.

DISCUSSION

In this study, the author mainly analyzed the digital development strategy of the sports tourism industry in Hainan Province, exploring the role of informatization in promoting the development of sports tourism and the impact of traditional sports tourism industry being deconstructed by digitization. In the experimental section, the researcher used the ensemble learning algorithm CNE for validation. The results showed that the algorithm outperformed Bagging and Adaboost algorithms on most datasets, but was slightly lower than the latter on some datasets. In order to further validate
the effectiveness and innovation of the CNE algorithm proposed in this paper, the author compared it with some recent related studies. Table 2 lists the AUC values of this study and other studies on different datasets. Table 2 shows that the CNE algorithm in this study outperforms or approaches the results of other studies on all datasets except Car and Credit-a, especially on Scales, Hayes, Iris, Segmentation, Wine, and Zoo datasets. The AUC value of the CNE algorithm exceeds 0.9, indicating that the CNE algorithm has high predictive accuracy. These results indicate that the CNE algorithm proposed in this paper can effectively utilize the features of neural network classifiers to construct a high-performance ensemble learning model through clustering and selection techniques.

<table>
<thead>
<tr>
<th>Dataset</th>
<th>This Study</th>
<th>Biau et al. (2016)</th>
<th>Kong and Yu (2018)</th>
<th>Couvy-Duchesne et al. (2020)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale</td>
<td>0.92</td>
<td>0.88</td>
<td>0.89</td>
<td>0.91</td>
</tr>
<tr>
<td>Breast</td>
<td>0.94</td>
<td>0.92</td>
<td>0.93</td>
<td>0.93</td>
</tr>
<tr>
<td>Hayes</td>
<td>0.96</td>
<td>0.91</td>
<td>0.92</td>
<td>0.94</td>
</tr>
<tr>
<td>Iris</td>
<td>0.97</td>
<td>0.95</td>
<td>0.96</td>
<td>0.96</td>
</tr>
<tr>
<td>Split</td>
<td>0.98</td>
<td>0.96</td>
<td>0.97</td>
<td>0.97</td>
</tr>
<tr>
<td>Wine</td>
<td>0.99</td>
<td>0.97</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>Zoo</td>
<td>1.00</td>
<td>0.99</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Automobile</td>
<td>0.86</td>
<td>0.88</td>
<td>0.89</td>
<td>0.88</td>
</tr>
<tr>
<td>Credit card-a</td>
<td>0.83</td>
<td>0.85</td>
<td>0.86</td>
<td>0.85</td>
</tr>
<tr>
<td>Voting</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
</tr>
</tbody>
</table>
In response to the development of sports tourism industry in Hainan Province, the author proposed multiple measures, such as clarifying its own positioning and integrating it with local traditional culture, to promote cooperation between enterprises and consumers and maximize value. In addition, the researcher found that the selection of the number of clusters has a certain impact on the classification performance of ensemble learning, while the performance of the CNE algorithm has little impact on the initial selection of neural networks. This provides a useful reference for the digital integration of sports tourism and provides guidance for enterprises to improve profitability and production efficiency. Digitalization has become an important trend in the development of sports tourism industry, not only changing people’s consumption habits and needs, but also promoting the transformation and upgrading of traditional sports tourism formats. Digitalization has improved the quality and convenience of sports tourism products, enhanced product experience and satisfaction, and also provided better market information for enterprises for refined management and marketing. To achieve the development opportunities that digital integration has produced, it is necessary to restructure the traditional sports tourism industry and form new production, management, and business models. The theory of innovation and change believes that only through continuous innovation can one gain an advantageous position in the fierce market competition. In the process of digital integration, the sports tourism industry needs to keep up with the times, actively innovate, and comply with market demand, in order to win market share and improve the comprehensive competitiveness of enterprises.

CONCLUSION

This study demonstrates the potential of innovative technologies in enhancing the effectiveness and efficiency of sports tourism marketing strategies. Informatization plays a very important role in promoting the development of sports tourism. The value reorganization between sports tourism consumers and corporate entities is necessary for the digital integration of sports tourism. The sports tourism industry in Hainan Province needs to clarify its own development orientation, reasonably integrate with the local traditional culture, and improve the quality of business services. Ensemble learning algorithm CNE shows promising performance in predicting sports event outcomes, but further exploration is needed to select appropriate clustering and neural network numbers. Future research can explore the application of ensemble learning algorithms in the field of sports tourism and make reasonable optimizations based on actual situations.

ACKNOWLEDGMENT

The author would like to show sincere thanks to those techniques who have contributed to this research.
REFERENCES


