Hindawi
Wireless Communications and Mobile Computing
Volume 2022, Article ID 9351522, 10 pages
https://doi.org/10.1155/2022/9351522

*Research Article*

# Sports Event Model Evaluation and Prediction Method Using Principal Component Analysis

**Weiwei Yu[1,2] and Jinming Xing[3]**

[1]*Suan Sunan Rajabhat University, Bangkok 10300, Thailand*
[2]*Faculty of Infrastructure Engineering, Dalian University of Technology, Dalian 116024, China*
[3]*School of Physical Education, Northeast Normal University, ChangChun 130024, China*

Correspondence should be addressed to Jinming Xing; xingjm100@nenu.edu.cn

Received 30 October 2021; Revised 22 December 2021; Accepted 27 December 2021; Published 19 January 2022

Academic Editor: Mu-Yen Chen



Aiming at the problems of poor average fitness, low-risk prediction accuracy, high mean square error, low-risk evaluation precision, and long average running time of traditional sports event model evaluation and prediction methods, a sports event model evaluation and prediction method using principal component analysis (PCA) is proposed. Sports event risk monitoring microbase is deployed by ZigBee technology, and sports event risk monitoring data is monitored and packaged at each base station. Optical fiber and Ethernet are used to transmit the data to the monitoring and management center to complete the risk data collection of sports events. After data standardization, the risk evaluation index system of sports events is constructed, and the comprehensive score of each risk index of sports events is obtained by using the PCA method. The BP neural network is improved by genetic algorithm (GA), and the comprehensive score of risk index is input into the network to obtain the evaluation and prediction results of sports event risk. The results show that the proposed method has good average fitness, the predicted value of sports event risk is almost equal to the actual value, the prediction mean square error is less than 0.15, the evaluation precision is high, and the average running time is only 8 s. The cost (time complexity) is low. Overall, the method has a good application prospect in the field of sports event evaluation and prediction.

## 1. Introduction

Under the background of rapid economic growth, the proportion of sports events in the sports industry is also rising [1]. The holding of sports events is a review of a city's comprehensive ability, such as the degree of civilization of citizens, the governance of the urban environment, the planning level of urban construction, and will play an inestimable role in promoting the development of the city in all aspects [2]. It can not only improve the quality of the city's population, improve citizens' fitness awareness, enrich urban cultural life, promote urban construction, but also promote the development of related industries. However, sports events not only bring all kinds of opportunities, but also imply huge risks. Some sudden international and domestic political, economic, social and natural events may seriously interfere with or even hinder the normal operation of the event, making all the efforts of the event organizers go east. At present, the development of China's sports industry is slow, the degree of marketization is low, and there are many uncertain factors in the process of holding events [3, 4]. Therefore, it is very necessary to take risk management measures during the operation of sports events, and risk evaluation is a very important part of risk management. The event organizing committee needs to carefully understand the risks of sports events, assess and predict the risk level of sports events, make emergency strategies for the holding of sports events and control the probability of risks in combination with the local actual situation, so that sports events can better promote the development of local social economy [5].

In order to realize the risk evaluation and prediction of sports events, literature [6] determines which artificial intelligence (AI) methods have been used to investigate sports performance and injury risk, and seek which AI technologies are used in each sport, so as to improve the intelligence of sports risk analysis. Literature [7] used the survey method and catastrophe progression method to evaluate the risk of the governance model of large stadiums, identified the risk factors, build the index system, and explored the factors behind the indicators, in order to provide an explanation for decision makers to choose the governance model of large stadiums. Literature [8, 9] took the application of BP network in sports risk early warning design as the starting point, started from the necessity of applying BP network in sports event risk early warning, analyzed the risk early warning model and operation process, and verified the sample data to verify the effectiveness of the model. According to the risk management theory and the organization and operation law of sports events. Literature [10] took the 2014 Nanjing Youth Olympic Games as the research sample, used the list arrangement method to analyze and predict the weight, and proposed the risk response measures of Nanjing Youth Olympic Games. Through the study of risk system of sports events, it provided reference for risk management in China. Literature [11] fully combined the improved risk matrix method with Delphi method and analytic hierarchy process, established a school sports competition risk index system covering 27 indicators around the four main lines of personnel risk, facility risk, organization and management risk and environmental risk, and quantitatively analyzed the occurrence probability, influence, risk grade, weight and acceptability of each risk index to proposed countermeasures. At present, the research on the risk evaluation and prediction of sports events has also achieved good research results. For example. Literature [12] used the methods of the literature, expert investigation, and analytic hierarchy process to analyze the ecological risk types, risk sources and risk receptors caused by urban hosting large-scale sports events, and constructed a system consisting of 4 primary indicators and 14 secondary indicators, the ecological risk evaluation system composed of 40 three-level indicators is used to predict the risk of sports events. Literature [13] introduced the hierarchical holographic modeling HHM risk identification analysis tool to build a holographic model suitable for sports games risk identification, including 24 hierarchical holographic subsystems in five categories: Sports Games ontology, organization and management, personnel quality, venue facilities and environment, and quantified and rated it by using analytic hierarchy process and Pareto analysis, it provided a reference basis for the quantitative risk evaluation of sports games. Literature [14] uses neural network as a predictive network modeling method. With the support of MATLAB neural toolbox, a risk warning model is designed for sports events based on neural network. This paper starts with the gray network in the sports risk early warning design, starting from the necessity of applying grey network in sports event risk early warning, this paper analyzes the risk early warning model and operation process, and verifies the feasibility of the model with sample data. The main contributions of this paper are as follows: (1) through PCA, several relevant factors can be transformed into nonrelevant indicators, which can reduce the dimension of the original indicators in the case of a small amount of missing data, filter duplicate data, and obtain comprehensive indicators related to the risk of sports events. (2) Using ZigBee technology to deploy sports event risk monitoring micro base stations, monitor and package sports event risk monitoring data in each base station, and use optical fiber and Ethernet to transmit the data to the monitoring management center to complete sports event risk data collection, which can improve the accuracy and efficiency of data collection.(3) Using ZigBee technology to collect sports event risk data and analyze the influencing factors of sports event risk assessment, so as to carry out sports event risk assessment, and use the BP neural network improved by GA to predict sports event risk, which can reduce the prediction error and improve the prediction efficiency.

The organization of this paper is as follows. We introduce the introduction and related works in Section 1. Then, we describe the risk evaluation and prediction of sports event model in Section 2. We further present the experimental results and discussions in Section 3. Finally, we conclude the paper in Section 4.

## 2. Methodology

*2.1. Sports Event Risk Data Collection Using ZigBee Technology.* The wireless sensor network suitable for collecting sports event risk data is established by using ZigBee technology, and then the sports event risk monitoring micro base station is deployed based on the sports event risk monitoring network to collect sports event risk data [15]. ZigBee network has complex topology and powerful functions. It improves the information transmission rate through multi hop transmission, and can complete its own organization and repair. It has good robustness and wide application range.

A sports event risk data monitoring network is established through ZigBee mesh network, which mainly includes two parts: initializing network subroutine and node application link [16]. Initialize the ZigBee network, deploy the coordinator at the network node, take the coordinator as the network join point, the node transmits the connection application to the coordinator, and the coordinator judges the node access according to the network connection status and replies to the application. The data sending and receiving are based on the node connection coordinator, and the node requests access to the network mainly including the search coordinator, then passing the application for joining the network, waiting for processing, and application for data transmission. The design core of ZigBee network is the protocol stack, which can obtain, transfer, store, and process data channels and methods and determine the logical structure of communication at the same time. In the process of data sending and receiving, the node sending and receiving data realizes unlimited data sending and receiving by applying the sending and receiving function in the protocol stack [8, 17].

The coordinator program includes networking, status detection, network maintenance and information acquisition command sending, etc. After the coordinator starts running, initialize the internal program through the functions in the protocol stack, then build the ZigBee network and log in to the GPRS network, and send the feedback data to the monitoring center through Ethernet to complete the processing and display the data. The task of the terminal node is to collect the risk data of sports events and transmit the data periodically through the coordinator, as shown in Figure 1.

*2.2. Risk Evaluation of Sports Events.* Preprocess the sports event risk data collected by the ZigBee technology, and after the data is standardized, construct a sports event risk evaluation index system, and use the PCA method to obtain the comprehensive risk score of the sports event.

*2.2.1. Establishment of Risk Evaluation Indexes for Sports Events.* Taking the event risk attribute as the starting point to evaluate the risk of sports events, the risk has the characteristics of possibility, uncontrollability and randomness [18]. Its core index is risk probability, which indicates the possibility of risk, the degree of loss caused by risk is risk loss, and the risk control level is uncontrollable, which is directly proportional to the risk level. Through expert review, it is preliminarily determined that the evaluation indexes are risk probability, risk loss and uncontrollability. The risk evaluation index system of sports events is detailed in Table 1.

According to Table 1, the target layer of sports event risk evaluation index system is sports event risk. The criterion layer includes risk probability, risk loss, and uncontrollability. The primary level indexes are personnel risk, operation risk, facility risk, economic risk, and external environment risk. The secondary level indexes are staff risk, athlete, coach, referee risk, onsite audience risk, event schedule risk, event participants' traffic risk, safety guarantee risk, site quality and safety risk, site lawn and drainage risk, event scale risk, pregame budget risk, sponsor risk, natural environment risk, and food safety risk.

*2.2.2. PCA.* Through PCA, several relevant factors can be transformed into nonrelevant indexes, which can reduce the dimension of the original indexes in the case of a small amount of data loss, filter duplicate data, and obtain comprehensive indexes related to the risk of sports events [19].

The PCA steps are as follows:

(1) Assuming that the study area is $A$, select $B$ indexes in this area, and set the sample matrix of this index as $F$ to obtain:

$$F = \left(F_{ij}\right)A * B, \tag{1}$$

where $i = 1, 2, \cdots, A$, $j = 1, 2, \cdots B$

(2) Assuming that $R_{b*b}$ represents the index correlation coefficient matrix, and its eigenvalue meets the condition range is $\wedge 1 \geq \wedge b \geq 0$ [20], the PCA expression formula is as follows:

$$T_i = F_{ej} \tag{2}$$

where $T_i$ represents the principal component, and the normalized eigenvector of the correlation coefficient matrix is $e_j$

(3) When the variance contribution rate of the $j$-th principal component is higher than 86%, only the first $q$ principal components are selected $T_1, T_2, \cdots, T_q$. [21] At this time, $q$ can reflect the information of $B$ initial indicators, and the contribution rate $a$ is as follows:

$$a = \sum_{i=1}^{q} a_j \tag{3}$$

(4) The comprehensive risk score $W$ of the sports event studied is as follows:

$$W = aX_1 + bX_2 + \cdots + xX_x \tag{4}$$

where $X$ is the eigenvector of the eigenvalue $b$ and $x$ represent the normalized data of the initial index [22].

*2.3. Risk Prediction of Sports Events*

*2.3.1. BP Neural Network.* In order to realize the risk prediction of sports events, the risk characteristics of sports events extracted by PCA are input to the input layer of BP neural network, and the prediction results are obtained by output layer [23]. The neurons in each layer of BP neural network are only sensitive to the input of feedforward neurons. The output of each layer affects the output of the next layer, and its structure is shown in Figure 2.

The number of units of BP neural network is processed according to specific problems, and the following is obtained through linear transformation function:

$$f(x) = x, \tag{5}$$

where the independent variable $x$ represents the number of network inputs of BP neural network.

Let $L$ be the hidden layer nodes, $I$ the input layer nodes, and $J$ the output layer nodes, then:

$$L = (I + J)/2, \tag{6}$$

$$L = (I * J)^{1/2}. \tag{7}$$

In the network output layer, the number of processing units through the nonlinear conversion function, and the hyperbolic function in the nonlinear conversion function is:

$$f(x) = \frac{1}{1 + e^x}, \tag{8}$$

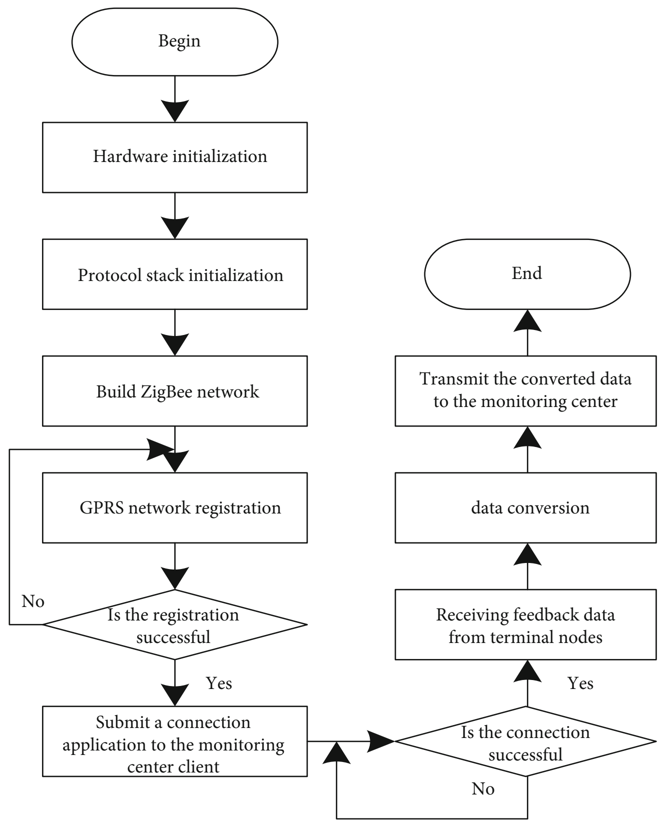


Figure 1: Terminal node program process.

Table 1: Risk evaluation indexes system of sports events.

| Target layer | Criterion layer | Primary index layer | Secondary index layer |
|---|---|---|---|
| Sports event risk | Risk probability $B_1$ | Personnel risk $C_1$ | Staff risk<br>Risks of athletes, coaches, and referees<br>Live audience risk |
| | Risk loss B2 | Operational risk $C_2$ | Event schedule risk<br>Traffic risk of event participants<br>Security risk |
| | | Facility risk $C_3$ | Site quality and safety risk<br>Site lawn and drainage risk |
| | Uncontrollability B3 | Economic risks $C_4$ | Event scale risk<br>Precompetition budget risk<br>Sponsor risk |
| | | External environmental risk $C_5$ | Natural environment risk<br>Food safety risk |

where when x is close to positive or negative infinity, the function value is close to the constant, and its value range is [0,1].

The input data $X = (x_1, x_2, \cdots, x_n)$ of BP neural network is the risk characteristics of sports events extracted by PCA. Starting from the input layer, traverse each hidden layer node to the output layer node, and the output data is as follows:

$$Y = (y_1, y_2, \cdots, y_n). \quad (9)$$

Let $L_{in}$ and $L_{out}$ be the input and output of each node of the hidden layer, respectively, and the mapping from input to output is expressed as follows:

$$L_{in} = \left( \sum_{i=1}^{I} u_{ij} x_i \right) + b, \quad (10)$$

$$L_{out} = net(L_{in}), \quad (11)$$

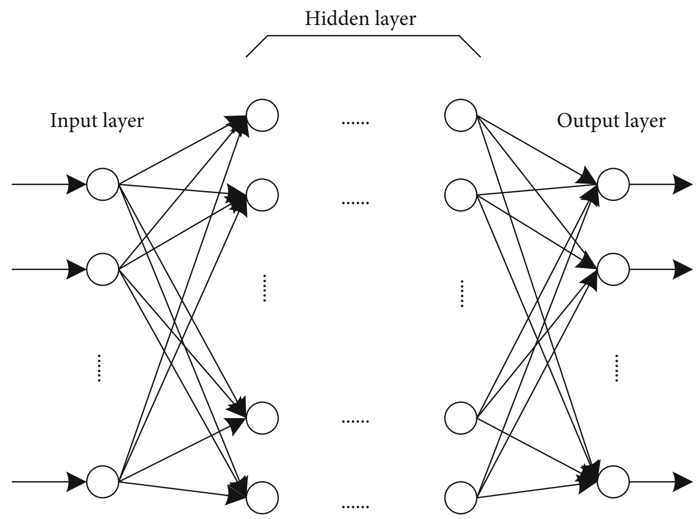


Figure 2: Structure of the BP neural network.

$$J_{in} = \left(\sum_{j=1}^{L} v_{jk} L_{out}\right) + b, \quad (12)$$

$$J = net(J_{in}), \quad (13)$$

where $J_{in}$ is the input value of each node in the output layer, the weights between the input layer and the hidden layer and between the hidden layer and the output layer are described as $u_{ij}$ and $v_{jk}$, respectively, and $b$ represents the node threshold.

*2.3.2. Improved BP Neural Network Model.* In order to improve the prediction accuracy of BP neural network, GA is used to improve the neural network. The specific operation steps are as follows:

Step 1: Generate code and initial population. Let the number of input layer and hidden layer nodes of GA-BP neural network be $R$ and $S_1$, respectively, then the length of chromosome is:

$$S = R * S_1 + S_1 * S_2 + S_1 + S_2, \quad (14)$$

where $S_2$ is the number of output layer nodes.

The initial population with M individuals and S chromosome length was randomly generated. The large number of individuals $M$ will slow down the convergence speed of the network; too small will reduce the accuracy of network training.

Step 2: Determine the fitness function. Set the fitness function of the individual as follows:

$$F = \frac{1}{\sum_{t=1}^{n} |y_t - \bar{y}_t|}, \quad (15)$$

where $n$ is the number of training samples and $y_t$ and $\bar{y}_t$ are the expected output value and predicted output value of the first training sample, respectively.

Step 3: The fitness values are sorted by mathematical sorting method, and the probability of selecting each individual is allocated according to the sorting results of fitness values:

$$P_x = F / \sum_{k=1}^{x} F. \quad (16)$$

Step 4: Generate new species. Select, cross and mutate the initial population whose individual fitness does not meet the optimization criteria to produce a new population. If the standard is met, proceed to the next step, otherwise return to genetic operation.

Step 5: Generate the initial weight of BP network.

Step 6: Determine the risk level of sports events according to the output results. According to the importance of sports event risk, it is divided into three levels: high, medium, and low risk. The criteria are shown in Table 2.

In summary, the sports event evaluation and prediction model is shown in Figure 3.

According to Figure 3, preprocess the sports event risk data collected by the ZigBee technology, and after standardizing the data, construct a sports event risk evaluation index system, and obtain the comprehensive score of sports event risk by using the PCA method. The GA is used to improve the BP neural network model, and the improved BP neural network model is used to predict the risk of sports events.

## 3. Experimental and Results

*3.1. Data Set.* Experimental environment: on Intel Xeon Gold6254@3.10GHz (X2) CPU, 768GBRAM, 2∗ Tesla v100GPU, the operating system is Windows Server 2019, and the programming language is MATLAB.

Data set: Sgsum (sports game summary) is a large-scale manually cleaned Chinese sports event summary data set. This data set comes from sina sports online. This data set comes from the football game data from 2012 to 2020

Table 2: Risk level classification of sports events.

| Degree of importance ($W$) | Level | Risk factor |
|---|---|---|
| $W \geq 10\%$ | High risk (III) | Event scale, event schedule, natural environment, and preevent budget |
| $5\% < W < 10\%$ | Medium risk (II) | Transportation of participants |
| $W < 5\%$ | Low risk (I) | Site environment, auxiliary personnel, disease video, investment unit, safety measures, event judges, onsite audience, site quality, and safety |

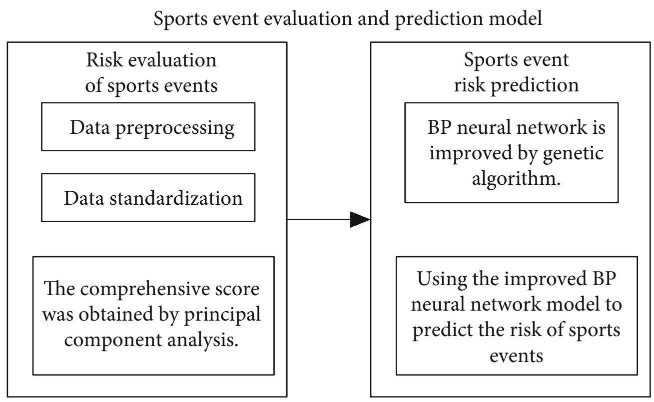


Figure 3: Evaluation and prediction model of sports events.

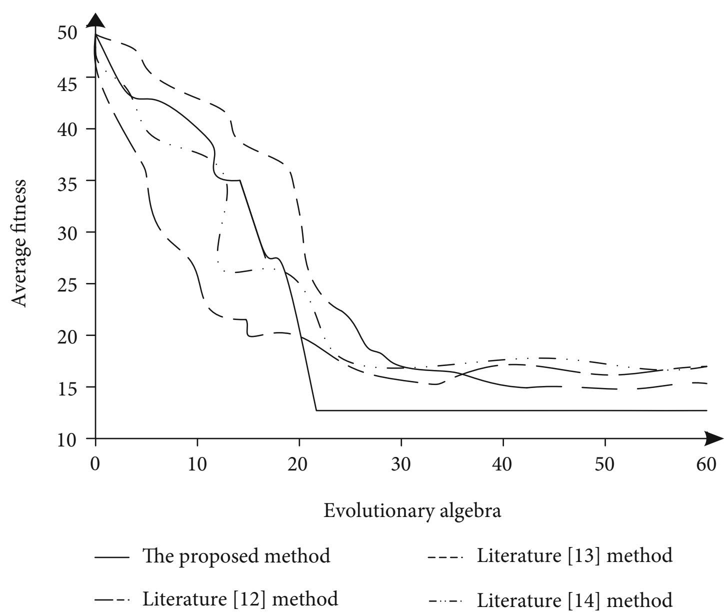


Figure 4: Comparison of average fitness curves of different methods.

in sina sports online, including the online comment text and corresponding news reports of 7854 football games. Sports-1 m: this data set is a sports video data set, including 487 categories and 1.2 million sports event videos. Taking the large-scale sports events held in a region as the research object, this paper studies the risk evaluation and prediction of sports events. The event was held for one week, with three types of competition events A, B, and C.

*3.2. Comparison Methods and Evaluation Indexes.* The methods in this paper: literature [12], literature [13] and literature [14], are used as experimental methods to verify the practical application effects of different methods by comparing different evaluation indexes.

(1) Average fitness: average fitness is an important index to verify the convergence of the algorithm. The earlier the average fitness reaches the stable value, the

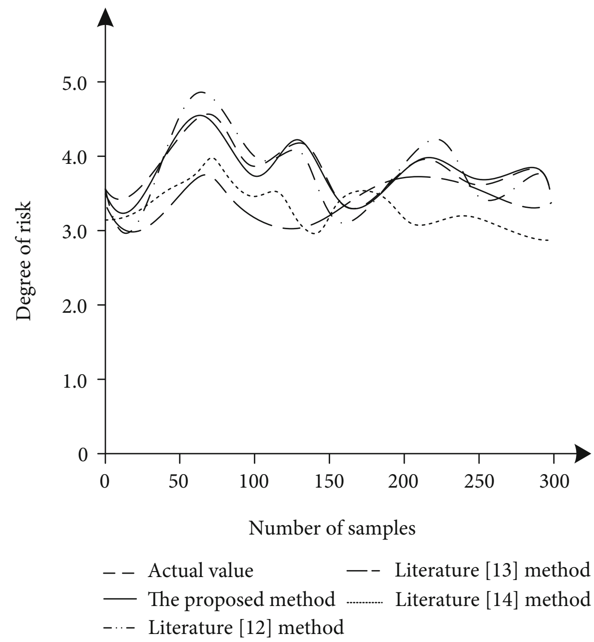


Figure 5: Comparison of prediction accuracy of four methods.

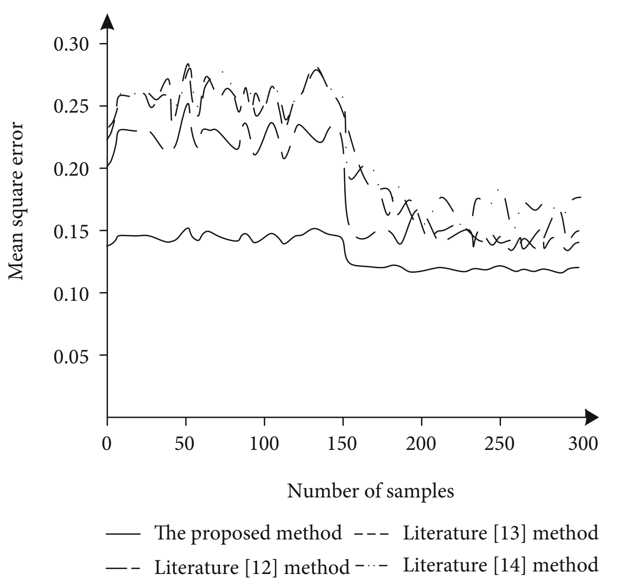


Figure 6: Comparison of mean square error of different methods.

Table 3: Comparison of risk evaluation results of sports events.

| Competition events | Event A | Event B | Event C |
|---|---|---|---|
| The proposed method | III | II | III |
| Literature [12] method | III | I | III |
| Literature [13] method | II | II | III |
| Literature [14] method | II | I | II |
| Actual comprehensive risk level | III | II | III |

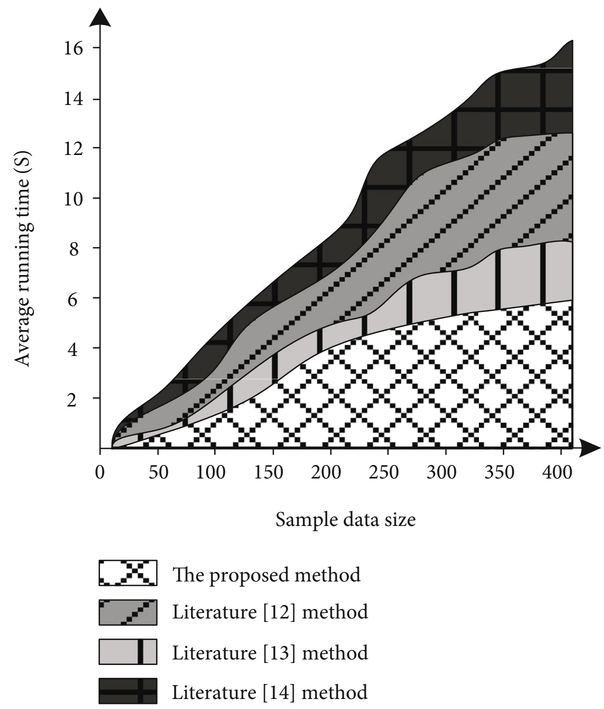


Figure 7: Average running time test results of different methods.

better the convergence performance of this method. The average fitness is calculated as follows:

$$z = \frac{\sum_{i=1}^{n} F_i}{n} \tag{17}$$

(2) Prediction accuracy: in order to verify the accuracy of sports event risk evaluation and prediction of this method, select different numbers of sample data in the test area, and compare the predicted value of sports event risk with the actual value of sports event risk. The smaller the gap between the two, the higher the prediction accuracy:

$$A = |a_1 - a_2|, \tag{18}$$

where $a_1$ is the risk prediction value of sports events, $a_2$ is the risk prediction value of sports events, and the smaller the value of $A$, the higher the prediction accuracy

(3) Prediction mean square error: mean square error is an important index to verify the prediction result error of sports events. Therefore, the prediction mean square error of different methods is compared. The smaller the value, the lower the prediction result error:

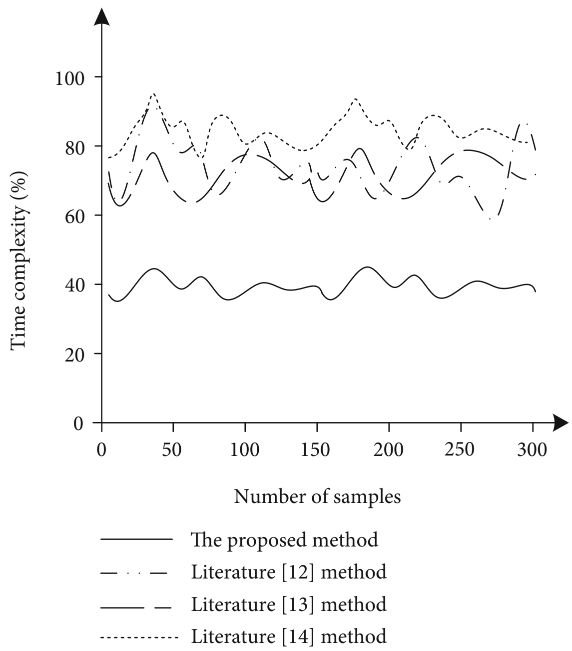


Figure 8: Comparison of time complexity.

$$M = E(a_1 - a_2)^2, \quad (19)$$

where $E$ is the average of expected values

(4) Evaluation precision: The output results of different methods are used to evaluate the sports event risk of five competition items of the experimental object, and the sports event risk level predicted by the four methods is compared with the actual comprehensive risk level of the experimental event. The closer it is to the actual comprehensive risk level, the higher the evaluation accuracy:

$$B = |b_1 - b_2|, \quad (20)$$

where $b_1$ is the predicted risk level of sports events, $b_2$ is the actual comprehensive risk level, and $B$ represents that the evaluation results are completely consistent with the actual results

(5) Average running time: the average running time is the average of the time spent on the risk evaluation result and the prediction result of a sports event. The lower the value, the higher the execution efficiency of the method:

$$T = \frac{t_1 + t_2}{2}, \quad (21)$$

where $t_1$ is the time-consuming for sports event risk assessment and $t_2$ is the time-consuming for sports event risk prediction

(6) Cost of prediction method (time complexity): time complexity is an important index to verify whether the research method can be implemented smoothly. The lower the index, the better the execution performance of the method:

$$Time(n) = \mathrm{O}(f(n)), \quad (22)$$

where $\mathrm{O}(\cdot)$ is complexity and $f(n)$ is the code execution time growth change value of the prediction method.

*3.3. Results and Discussion.* The methods of this paper: literature [12], literature [13], and literature [14], are compared with the average fitness value in sports event evaluation and prediction. The results are shown in Figure 4.

According to Figure 4, with the increase of iteration times, the average fitness value of the proposed method tends to be stable after the iteration times meet the requirements of 20 training times, while the average fitness values of literature [12], literature [13], and literature [14] do not tend to be stable when the iteration times are 60, indicating that the average fitness of sports event evaluation and prediction of this method is good. Therefore, this method has good performance in sports event risk prediction.

Four methods are used to predict the risk of sports events. The predicted value of sports event risk is compared with the actual value of sports event risk. The comparison results of prediction accuracy are shown in Figure 5.

As shown in Figure 5, with the increase of sample data, the error between the predicted value and the actual value of the four methods decreases gradually. The predicted value of sports event risk in this method is almost equal to the actual value, while the predicted value and the actual value of literature [12], literature [13], and literature [14] methods differ greatly, and the maximum error values are 0.6 and 0.9, respectively, All occurred when the number of samples was 70. The results show that the predicted value of the method in this paper is almost the same as the actual value, and it has high prediction accuracy.

By analyzing the data in the above experimental process, the prediction mean square error of the four methods is shown in Figure 6.

Comparing the prediction performance of the four methods, it is found that the mean square error of the method in this paper is less than 0.15, while the methods in literature [12], literature [13], and literature [14] are higher than the method in this paper. It shows that the prediction mean square error of the methods in literature [12], literature [13], and literature [14] is large, and the error of sports event risk prediction is high, Therefore, it shows that the prediction performance of this method is better and the result is more accurate.

Taking the large-scale sports events held in a region as the research object, this paper studies the risk evaluation and prediction of sports events. The event was held for one week, with three types of competition events A, B, and C. The risk level of sports events predicted by the four methods

Table 4: Statistical test of prediction results of different methods.

| Methods | Original hypothesis | Test | *P* |
|---|---|---|---|
| The proposed | There is no difference between the predicted results and the real results | Wilcoxon signed rank test | 0.921 |
| Literature [12] | | | 0.903 |
| Literature [13] | | | 0.830 |
| Literature [14] | | | 0.865 |

is compared with the actual comprehensive risk level of the experimental event. The results are shown in Table 3.

It can be seen from Table 3 that the risk prediction level of the five events in this paper is consistent with the actual comprehensive risk level, the event B risk level predicted by the method in literature [12] is inconsistent with the actual comprehensive risk level, and the method predicted by literature [13] The risk level of event A is inconsistent with the actual comprehensive risk level, and the risk levels of event A, event B, and event C predicted by the literature [14] method are inconsistent with the actual comprehensive risk level. The results show that the method in this paper is compared with the methods in literature [12], literature [13], and literature [14]. The risk prediction results of sports events in this paper are more accurate and have higher application value.

The methods in this paper are tested from time. The average running time of the four methods is shown in Figure 7.

According to Figure 7, the average running time of the four methods increases with the increase of sample data. Among them, the average running time curves of literature [12], literature [13], and literature [14] show a rapid upward trend with the increase of sample data, and the average running time is longer. The average running time curve of this paper method shows a small increasing trend before the sample data size is 200, and the increasing range is relatively large when the sample data size exceeds 200. When the sample data size is 400, the average running time of this method is longer than that of literature [12], literature [13], and literature [14], in which the average running time of this method is only 8 s. The above results show that the average running time of this method is shorter.

The time complexity of the four methods is shown in Figure 8.

It can be seen from the analysis of Figure 8 that the time complexity of the four methods does not change greatly with the increase of the number of samples, but it can be seen intuitively from Figure 8 that the overall overhead (time complexity) of the method in literature [14] is large. When the number of samples is about 40 and 170, the overhead (time complexity) of the method is almost 95%, and the complexity is high. The overhead (time complexity) of literature [13] is less than 80%. In contrast, the average overhead (time complexity) of this method is about 40%, which is much lower than that of the other three methods.

In order to ensure the preciseness of the comparison results of the four methods, the statistical test of hypothesis is used to test the four methods, so as to ensure the reliability of the above comparison results. Wilcoxon signed rank test is selected, and the results are shown in Table 4.

According to Table 4, the Wilcoxon signed rank test results show that the *P* values of this method, literature [12], literature [13], and literature [14] are greater than 0.05, indicating that the original hypothesis is tenable, and there is no difference between the predicted results and the real results.

## 4. Conclusions and Future Work

The holding of sports events is very important for the development of a city or even a country. Although the holding of sports events does bring many rare opportunities for the overall development of social economy and society in daily social and economic life, it also implies huge risks due to its wide range and the large number of people involved. Some sudden international and domestic politics and economy, uncertain factors such as social and natural events may seriously affect or even hinder the normal progress of sports events, so as to avoid the impact of uncertain factors on sports events. A sports event model evaluation and prediction method using PCA is proposed. This study collects the risk data of sports events through the establishment of ZigBee technology, and realizes the risk evaluation and prediction of sports events through PCA combined with improved BP neural network. The results show that this method has better average adaptability. The risk assessment accuracy of sports events is higher, the average running time is shorter, overhead (time complexity) is lower and the overall performance is better. However, further work can be carried out from the following perspectives in the future. For data acquisition, the method in this paper collects more samples only within a certain area and does not expand the acquisition area. Therefore, it has a certain one sidedness. In the future, it can also expand the acquisition area that does not build a human-computer interface.

## Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## Conflicts of Interest

The authors declare that there is no conflict of interest with any financial organizations regarding the material reported in this manuscript.

## Acknowledgments

This work was supported by National Social Science Fund (20FTYB002), Key Projects of Jilin Social Science Fund (2020A10), and Social Science Research Project of Jilin Provincial Department of Education (JJKH20211320SK).

## References

[1] J. Sasadai, N. Maeda, R. Shimizu et al., "Analysis of team-sport wheelchair falls during the Rio 2016 summer Paralympic games: a video-based cross-sectional observational study," *BMJ Open*, vol. 10, no. 3, pp. e033088–e033099, 2020.

[2] J. Pino-Ortega, D. Rojas-Valverde, C. D. Gómez-Carmona, and M. Rico-González, "Training design, performance analysis, and talent identification—a systematic review about the Most relevant variables through the principal component analysis in soccer, basketball, and Rugby," *International Journal of Environmental Research and Public Health.*, vol. 18, no. 5, p. 2642, 2021.

[3] S. de Groot, I. Kouwijzer, L. Valent et al., "Sport participation after the HandbikeBattle: benefits, barriers, facilitators from the event–a follow-up survey," *Spinal Cord Series And Cases*, vol. 6, no. 1, pp. 54–65, 2020.

[4] H. Wang, C. Dong, and Y. Fu, "Optimization analysis of sport pattern driven by machine learning and multi-agent," *Neural Computing and Applications*, vol. 33, no. 4, pp. 1067–1077, 2021.

[5] M. Ghobaei-Arani and A. Shahidinejad, "An efficient resource provisioning approach for analyzing cloud workloads: a metaheuristic-based clustering approach," *The Journal of Supercomputing*, vol. 77, no. 1, pp. 711–750, 2021.

[6] J. G. Claudino, D. Capanema, T. V. de Souza, J. C. Serrão, A. C. Machado Pereira, and G. P. Nassis, "Current approaches to the use of artificial intelligence for injury risk assessment and performance prediction in team sports: a systematic review," *Sports Medicine, - Open*, vol. 5, no. 1, pp. 12–28, 2019.

[7] H. G. Dong and J. H. Sun, "Risk assessment of governance model of large stadiums," *Sports and Science*, vol. 41, no. 5, pp. 106–113, 2020.

[8] I. Fister, D. Fister, S. Deb, U. Mlakar, J. Brest, and I. Fister Jr., "Post hoc analysis of sport performance with differential evolution," *Neural Computing and Applications*, vol. 32, no. 15, pp. 10799–10808, 2020.

[9] T. Zhang and F. Y. Zhang, "Application of BP neural network in the design of event risk early warning system," *Automation Technology And Application*, vol. 25, no. 8, pp. 184–186, 2019.

[10] H. G. Zhu and C. Wu, "Research on risk assessment of large-scale sports events – Taking Nanjing Youth Olympic Games as an example," *Sports And Science*, vol. 13, no. 5, pp. 22–26, 2021.

[11] W. Chen, Y. Y. Li, M. M. Huang, and M. Li, "Research on risk assessment of school sports competition based on improved risk matrix method," *Journal of Wuhan Institute of physical education*, vol. 15, no. 10, pp. 72–79, 2021.

[12] B. Liang, W. Li, and J. F. Li, "Study on the construction of ecological risk assessment system for urban hosting large-scale sports events," *Journal of Chengdu Institute of physical education*, vol. 46, no. 2, pp. 34–41, 2020.

[13] W. Chen, Y. Y. Li, and M. M. Huang, "Research on risk assessment of primary and secondary school sports games based on hierarchical holographic model," *Journal Of Wuhan Institute Of Physical Education*, vol. 53, no. 11, pp. 64–71, 2019.

[14] Z. Wang, "Risk Prediction of Sports Events Based on Gray Neural Network Model," *Complexity*, vol. 2021, Article ID 6214036, 10 pages, 2021.

[15] M. Li, F. R. Yu, P. Si, and Y. Zhang, "Green machine-to-machine communications with Mobile edge computing and wireless network virtualization," *IEEE Communications Magazine*, vol. 56, no. 5, pp. 148–154, 2018.

[16] H. Jiang, T. Qiu, and K. Deepa Thilak, "Application of deep learning method in automatic collection and processing of video surveillance data for basketball sports prediction," *Arabian Journal for Science and Engineering*, 2021.

[17] G. Quer, T. Aktas, F. Librino, T. Javidi, and R. R. Rao, "A wireless vehicle-based mobile network infrastructure designed for smarter cities," *Ad Hoc Networks*, vol. 85, no. 3, pp. 160–169, 2019.

[18] Q. Zhang, X. Zhang, H. Hu, C. Li, Y. Lin, and R. Ma, "Sports match prediction model for training and exercise using attention-based LSTM network," in *Digital Communications and Networks*, Elsevier, 2021.

[19] D. Rojas-Valverde, J. Pino-Ortega, C. D. Gómez-Carmona, and M. Rico-González, "A systematic review of methods and criteria standard proposal for the use of principal component analysis in Team's sports science," *International Journal of Environmental Research and Public Health.*, vol. 17, no. 23, p. 8712, 2020.

[20] D. Rajani and P. R. Kumar, "An optimized blind watermarking scheme based on principal component analysis in redundant discrete wavelet domain," *Signal Processing*, vol. 172, no. 7, article 107556, 2020.

[21] C. Chen, N. Gao, X. Wang, and Z. Zhang, "Exponential fringe projection for alleviating phase error caused by gamma distortion based on principal component analysis," *Optical Engineering*, vol. 57, no. 6, 2018.

[22] K. Krithivasan, S. Pravinraj, and V. S. Shankar Sriram, "Detection of cyberattacks in industrial control systems using enhanced principal component analysis and hypergraph-based convolution neural network (EPCA-HG-CNN)," *IEEE Transactions on Industry Applications*, vol. 56, no. 4, pp. 4394–4404, 2020.

[23] X. Ma and X. Li, "Dynamic Gesture Contour Feature Extraction Method Using Residual Network Transfer Learning," *Wireless Communications and Mobile Computing*, vol. 2021, Article ID 1503325, 11 pages, 2021.