Hindawi
Mathematical Problems in Engineering
Volume 2022, Article ID 2317397, 11 pages
https://doi.org/10.1155/2022/2317397

Research Article

Research on Performance Management Evaluation of Public Sports Venues Based on GFAHP

Lei Li, Yixiong Xu, Tengda Li, and Yang Liu

School of Physical Education, Nanchang Normal University, Nanchang, Jiangxi 330032, China

Correspondence should be addressed to Yang Liu; 1711111016@sus.edu.cn

Received 20 April 2022; Revised 26 May 2022; Accepted 30 May 2022; Published 23 June 2022

Academic Editor: Wen-Tsao Pan

The importance of public stadiums has become increasingly prominent, but the efficiency of its performance management operation mechanism is low, which affects the overall operation efficiency of the whole stadium. However, due to the diversity and incompleteness of its data types, the traditional analytic hierarchy process is difficult to construct its index system. This article introduces the grey fuzzy analytic hierarchy process. Based on the analysis of its performance management problems, this article constructs the index system and makes an application case analysis. The results show that the GFAHP method (group fuzzy analytic hierarchy process) can ensure the integrity of information data. In data classification, the highest accuracy of sample classification is 40.13%, and the relative error rate is basically less than 6%. The performance effect is much higher than other classification algorithms. At the same time, the total score of the evaluation index system constructed by GFAHP is more than 3, the overall operation is good, and the risk evaluation effect of each influencing index factor is also good. Using the grey analytic hierarchy process to evaluate the operation and performance management of public stadiums and gymnasiums will help managers do a good job in risk control and quality dynamic adjustment, so as to improve the operation efficiency and benefit of stadiums and gymnasiums.

1. Introduction

As an important material carrier for people to participate in sports activities, public sports venues play an indispensable role in the public service system. However, due to the diverse use types of venues and high operation and maintenance costs, their overall management efficiency is low, which has seriously affected the holding and operation of their normal activities. It is urgent to speed up the performance management of public sports venues [1]. Most scholars often construct the index system with the help of a fuzzy analytic hierarchy process and cluster analysis, but because they ignore the incompleteness of index data, there are many deviations in the selection of indicators, and some scholars discuss the performance management evaluation of public stadiums and gymnasiums in the form of literature summary and balanced scorecard [2, 3]. Based on the grey fuzzy analytic hierarchy process and combined with the balanced scorecard, this article designs a performance management evaluation index system and discusses its application effect under the condition of reducing the subjective interference of data, in order to provide suggestions and improvement countermeasures for improving the management efficiency of public sports venues.

This time, for the performance management evaluation of public stadiums and gymnasiums, the grey fuzzy analytic hierarchy process is used to construct the evaluation model system, that is, based on the traditional analytic hierarchy process, the grey association rule algorithm and fuzzy theory are introduced to improve it, so as to reduce the subjective randomness of data information processing and the uncertainty of index selection. At the same time, the balanced scorecard is added to screen the influencing factors of the index system, and an evaluation index system in line with the actual situation and actual needs of sports venues is constructed on the basis of ensuring the integrity of data information, so as to provide practical guiding value for its performance management evaluation.

The innovation of this study is to improve the traditional analytic hierarchy process with the help of the grey correlation algorithm and fuzzy theory and introduce the balanced scorecard to comprehensively consider and divide the index factors according to the characteristics of public sports venues, so as to further ensure the scientificity and rationality of the constructed performance management evaluation system and realize the possibility of dynamic adjustment for its venue management and later maintenance.

This article mainly studies the performance management evaluation of public sports venues from four aspects. The rest of the study is organized as follows: Section 2 summarizes and discusses the current situation of the application field of the GFAHP method as well as the influencing factors and research status of the current performance management evaluation of sports venues. Section 3 explores the influencing factors and evaluation indicators of performance management of public sports venues with the help of a grey fuzzy analytic hierarchy process and balanced scorecard and constructs the performance management evaluation index system of public sports venues by comprehensively considering the index weight. Section 4 details the performance test of the algorithm and the analysis of practical cases, where the results are sorted and analyzed. Section 5 is a summary of the whole article.

2. Related Works

Huang et al. proposed the combination of the analytic hierarchy process and grey fuzzy evaluation to construct the training index system from the characteristics and coverage of the building scene, determine the weight value of each evaluation index by analytic hierarchy process, and apply the constructed model to the practical application effect. The results show that the constructed model can effectively evaluate the safety evaluation of the training site of building collapse ruins. It has good application practice [4]. Ju et al. proposed an EVCS site selection framework in the image fuzzy environment, determined the weight value of the index criterion with the help of the fuzzy analytic hierarchy process, constructed an improved comprehensive graphic fuzzy decision matrix, correlated the ideal value of the site selection site with the grey correlation projection, and found that the proposed framework model can select the appropriate EVCS site among the potential charging stations [5]. Ramezanianpour and Sivakumar compared the effects of different solar ash water treatment systems according to socioeconomic conditions and standards, aimed at promoting the sustainable development of water treatment systems, and studied the comparison of sustainability indicators under different standards by using multi-standard decision analysis on the basis of optimization analytic hierarchy process [6]. Yang et al. designed the evaluation system of a port emergency logistic distribution system and built the evaluation model of the logistic distribution system with analytic hierarchy process and grey system theory. After determining the index weight, it was applied to the actual system application. It was found that the model has good practicability and effectiveness [7]. In order to meet the market demand and the economic benefits of enterprises, Valmohammadi et al. studied the introduction of the fuzzy analytic hierarchy process to determine the Shima project and ranked the projects in the scheme with the help of the fuzzy grey correlation method. The results show that the DSS system of the project can effectively improve the performance of the production process and organization process [8]. In order to improve the accuracy of decision-making and reduce the subjective error of expert judgment, Uluta introduces fuzzy set theory to build a composite fuzzy multi-criteria decision-making model, ranks and fuzzy expands the weight value of the index, and applies it to a practical case [9]. In order to improve the network error caused by the difficulty of the original handover algorithm to deal with the changes in network conditions and user preferences, Topside et al. designed a system handover algorithm by integrating grey prediction theory and analytic hierarchy process. In the performance test, it is found that the research algorithm has only 5% data loss and more than 95% throughput performance [10]. In order to speed up the informatization combination of college dance teaching and artificial intelligence, Wang and Zheng constructed the performance analysis model of artificial intelligence application in dance teaching based on fuzzy interval number and grey system theory, which provides a new perspective and reference way for the application of new technologies in college education [11]. In order to improve the safety of underground engineering construction and improve the classification and prediction accuracy of rock burst to reduce its destructiveness, Yin et al. studied the determination of the weight value of subjective and objective evaluation indexes by analytic hierarchy process and anti-entropy weight method and built a rock burst combination weight attribute interval identification model. Through the performance test of the model, it is found that the prediction accuracy of the model is more than 90% and has good application efficiency [12]. Tüysüz and Yıldız studied on the basis of fuzzy integration, due to the analytic hierarchy process in the fuzzy language environment, in order to better ensure the control of the uncertainty dimension in the decision-making process, put forward a mixed multi-criteria bank performance evaluation model, conducted an empirical application test with an Agricultural Bank of Turkey, and found that the proposed model has good applicability [13]. Taking the sports risk analysis of a university as the research object, Wu and Li constructed a fuzzy comprehensive evaluation model with the help of a video summary algorithm and analytic hierarchy process to determine the risk weight index in a special environment, so as to provide reference significance for school safety management and have important value for building a healthy campus [14]. Chen combined with the machine learning algorithm to analyze the athlete's field. The analysis system and user preference model are established by using the improved hierarchical k-means algorithm, which has certain practicability [15]. Kaiyan et al. proposed a monitoring algorithm based on big data in order to recognize the stadium image information and used the map function to generate mapping records to realize the monitoring and recognition of the stadium. The results show that the algorithm can effectively improve the efficiency of stadium management [16]. Celik et al. used a multivariable empirical model and EMD with adaptive noise (CEEMDAN) method to reveal the energy change in dynamic system, which can be applied to the analysis of structural response mechanism in the actual site, so as to improve the innovation of management means [17].

It can be seen from the above literature that the grey fuzzy theory has a wide range of applications, mostly in the fields of construction, electric power, logistics, and so on, and the analytic hierarchy process method is mostly combined with other algorithms for quality evaluation. At the same time, for the management means related to stadiums, most scholars use computer algorithms for technical management innovation, but rarely evaluate according to the characteristics of the index system, and the level of performance management is less involved. Therefore, the study uses the grey fuzzy analytic hierarchy process (GFAHP) to construct and analyze the index system of performance management of public stadiums and gymnasiums.

3. Construction of Public Stadium Performance Management Evaluation Model Based on GFAHP

3.1. GFAHP Based on Fuzzy Theory and Grey Model Algorithm. Combined with the actual situation of large stadiums and gymnasiums in China and integrating the functional characteristics of sports venues different from general public buildings, this article constructs a subjective evaluation index system of the environmental quality of large stadiums and gymnasiums. The combination of expert interview, analytic hierarchy process, and entropy method is usually used to weight each index. Using the established subjective evaluation index system, the multilevel fuzzy evaluation method is used to evaluate and verify the environmental quality of the gymnasium of Civil Aviation University of China.

A scientific and comprehensive evaluation of the performance of stadiums and gymnasiums is an indispensable and important means of effective management. It is important to ensure the overall business direction of stadiums and gymnasiums, strengthen the macro control of recreational venues by the competent department of the Sports Commission, and scientifically assess the work results. And it has important practical and theoretical significance for enriching the content of sports management and promoting the construction of sports economics. As an important part of China's sports development, public sports venues are the basic part to ensure the normal development of sports and the normal operation of social functions. However, with the increase in investment in the construction of public sports venues, the comprehensive benefits reflected are not satisfactory. The performance evaluation of public stadiums and gymnasiums includes the construction of multidimensional content. The quality of its performance will affect the efficiency of venue operation. At the same time, some of its information data are difficult to be analyzed quantitatively, which will affect the scientificity and rationality of the constructed index system. Figure 1 shows the statistics of the use of public stadiums and gymnasiums in a province.

It can be seen from Figure 1 that the current land occupation and use of stadiums and gymnasiums are diverse and unbalanced, which involves a lot of data content, and some of them cannot be analyzed quantitatively, which provides great difficulty for the management of public stadiums. The research constructs the performance management evaluation system model by introducing the grey fuzzy analytic hierarchy process, and the grey fuzzy theory can reduce the interference of uncertainty, fuzziness, and incomplete information of influencing factors and improve the scientificity and rationality of the index system. The evaluation semantics of experts with triangular fuzzy numbers are transformed into quantitative values, so as to obtain more accurate quantitative calculation results. It is defined that the final domain of the triangular fuzzy function is U, and any fuzzy subset on U is x. If there is a number $\mu_{(x)} \in [0,1]$ corresponding to subset x, then $\mu_{(x)}$ is the membership degree of x to U, so the membership function of x is μ. If the triangular fuzzy number is defined as (m,n,r), the membership function $\mu_A(x)$ is shown in the following equation:

$$\mu_A(x) = \begin{cases} \dfrac{x-m}{n-m}, & m < x < n, \\ \dfrac{x-r}{n-r}, & n < x < r, \\ 0, & \text{other}, \end{cases} \tag{1}$$

where $\mu_A(x)$ ranges between $[0,1]$, and, m,n,r are real numbers, m is the upper limit of A, n is the most likely value of A, and r is the lower limit of A. Arbitrary triangular fuzzy numbers $A_1(m_1,n_1,r_1)$ and $A_2(m_2,n_2,r_2)$ need to satisfy the following equation:

$$\begin{cases} A_1 + A_2 = (m_1+m_2, n_1+n_2, r_1+r_2), \\ A_1 - A_2 = (m_1-m_2, n_1-n_2, r_1-r_2), \\ \lambda A_1 = (\lambda m_1, \lambda n_1, \lambda r_1), \\ A_1 \otimes A_2 = (m_1 m_2, n_1 n_2, r_1 r_2), \end{cases} \tag{2}$$

where λ is the limiting value of the fuzzy matrix. In order to reduce the subjective error of experts in evaluation, it is necessary to carry out a triangular fuzzy transformation on the expert evaluation results, obtain the specific value that can be calculated, and explain the fuzzy in detail at the end. The defuzzification method usually includes area average method, maximum average method, and center of gravity method. Among these methods, the center of gravity method is least affected by the preference of decision-makers and is relatively simple to apply. The specific formula is shown as follows:

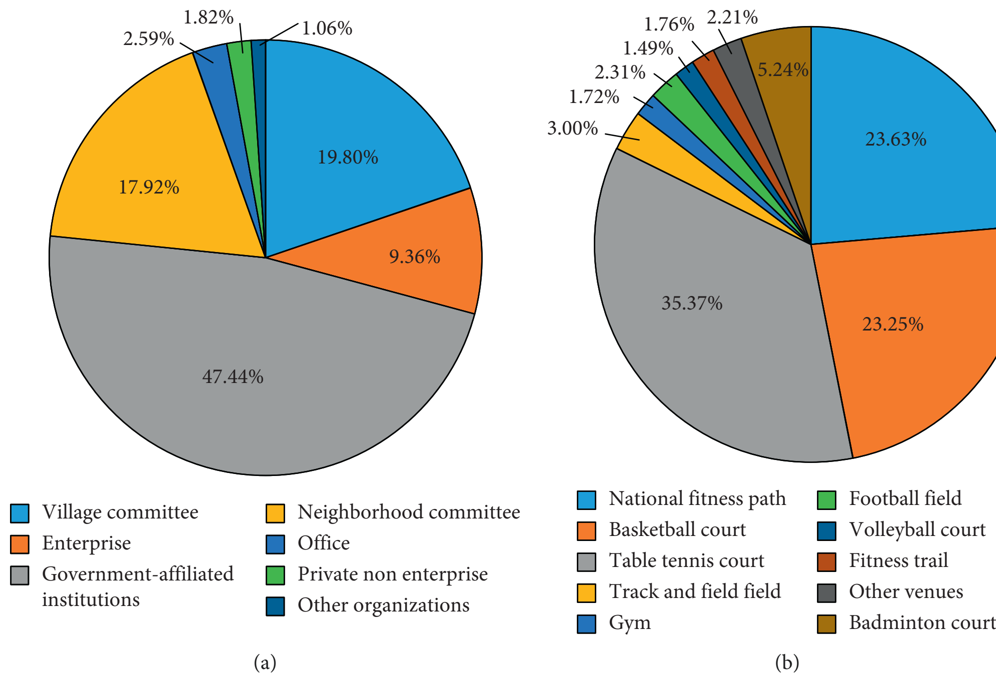

Figure 1: Statistical chart of site area, and type and quantity of public stadiums and gymnasiums. (a) Site area structure type distribution map. (b) Distribution map of site quantity and type.

$$f = \frac{(r-m)+(n-m)}{3} + m. \tag{3}$$

In the above equation, f represents the clear value obtained after the ambiguity is solved by the center of gravity method. The disadvantage of traditional analytic hierarchy process is that the objectivity of fuzzy comprehensive evaluation is improved compared with AHP. When there are many factors (more than 9), the workload of scaling is too large, which should cause disgust and confusion of judgment of scaling experts. Insufficient consideration is given to the possible negative value of the scale. The scale does need to be negative, because the implementation of some measures will endanger some specific targets. As a multi-criteria decision-making method, the traditional analytic hierarchy process is easy to be disturbed by subjective factors and limited to the inherent scheme, so it is unable to divide the weight of some nonquantifiable data. Grey fuzzy theory is the combination of fuzzy theory and grey system theory, which means to reveal the change trend, mutual relationship, and other mechanisms within the fuzzy phenomenon system by mathematical methods and grasp the relationship between various influencing factors by correlation coefficient and correlation degree, so as to provide a quantitative basis for the main factors of development and change of things [18]. According to the different characteristics of related phenomena, the names of their statistical indicators are different. For example, the statistical index reflecting the linear correlation between the two variables is called the correlation coefficient (the square of the correlation coefficient is called the judgment coefficient). The grey fuzzy theory is introduced to improve the analytic hierarchy process to solve the disadvantages of incomplete information and insufficient comprehensive evaluation, and its applicability is further expanded. The mathematical expression is shown as follows:

$$\begin{cases} \underset{*}{\overline{M}} = \{(x, \mu M(x), \nu M(x) | x \in X)\} = \left\{\overline{M}, \underset{*}{M}\right\}, \\ \overline{M} = \{(x, \mu M(x) | x \in X)\}, \\ \underset{*}{M} = \{(x, \nu M(x) | x \in X)\}, \end{cases} \tag{4}$$

where $\underset{*}{\overline{M}}$ is the membership degree of x with respect to fuzzy subset $\overline{M}$, $\overline{M}$ is the fuzzy subset on space $X = \{x\}$, $\mu M(x)$ is the grey number within the interval of 0 and 1, $\nu M(x)$ is the grey level of membership degree, $\underset{*}{M}$ is the grey part of $\underset{*}{\overline{M}}$, and $\overline{M}$ is the fuzzy part of $\underset{*}{\overline{M}}$. At the same time, the grey fuzzy set of data is expressed in two-dimensional space, which is expressed as follows:

$$\underset{*}{\overline{R}} = \{([x, y], \mu R[x, y], \nu R[x, y] | x \in X, y \in Y)\}. \tag{5}$$

In the above equation, $X = \{x\}$, $Y = \{y\}$ is the space set of spaces x and y, respectively, and $\underset{*}{\overline{R}}$ represents the grey fuzzy relationship on direct product space $X \times Y$. Then, the evaluation sample matrix can be constructed, and then the importance of factors in the fuzzy complementary judgment matrix can be quantitatively compared, and the judgment matrix P between $Z-U$ can be constructed to analyze the importance of u_i and u_j. $i, j = 1, 2, \ldots, n$ and v_{ij} are the importance ratio of u_i and u_j to Z. The eigenvalue method is used to calculate the weight, and the maximum eigenvalue $\lambda_{\max}$ of the matrix P and the corresponding eigenvector w are obtained. The function is shown as follows:

$$P_w = \lambda_{\max} \cdot w. \tag{6}$$

The feature vector w is normalized to obtain the importance ranking of indicators at all levels, that is, the division of weight coefficients of indicators. The normalization function is expressed as follows:

$$\overline{w} = \frac{w}{\sum_{i=1}^{n} w_i}. \tag{7}$$

The consistency of the matrix is tested, and the consistency index function is shown in the following equation:

$$\begin{cases} CI = \dfrac{\lambda_{\max} - n}{n-1}, \\ CR = \dfrac{CI}{RI} = \dfrac{\sum_{i=1}^{n} v_i CI_i}{\sum_{i=1}^{n} RI_i}, \end{cases} \tag{8}$$

where CI represents the corresponding consistency index, n is the hierarchy of the matrix, when $CI = 0$, P meets the consistency analysis, and the value of CI is negatively correlated with the degree of consistency. CR is to calculate the consistency ratio and RI is the average random consistency index. You can find the value of the corresponding stratum of the matrix. When CR is equal to 0.1, the judgment matrix has complete consistency. When CR is less than 0.1, the consistency of the judgment matrix is good. Otherwise, the index in the judgment matrix should be corrected. Determining the evaluation grey category can delimit the evaluation value with different ranges of grey information, and the grade of the evaluation grey category can be divided into three types, and the corresponding function expression is formulas follows:

$$\left[\begin{array}{l} f_u(b) = \begin{cases} \dfrac{b}{b_u}, & b \in \{0, b_u\}, \\ 1, & b \in \{b_u\}, \\ 0, & b \in \{0, b_u\}, \end{cases} \\ f_m(b) = \begin{cases} \dfrac{b}{b_m}, & b \in \{0, b_m\}, \\ \dfrac{(2b_m - b)}{bm}, & b \in \{b_m, b_{2m}\}, \\ 0, & b \notin \{0, 2b_m\}, \end{cases} \\ f_s(b) = \begin{cases} 1, & b \in \{0, b_s\}, \\ \dfrac{(2b_s - b)}{b_s}, & b \in \{d_s, 2b_s\}, \\ 0, & b \notin \{0, 2b_s\}, \end{cases} \end{array}\right. \tag{9}$$

where b is the number of evaluation indexes and m, s, and u are the number of evaluation indexes in different environments, and the grey fuzzy evaluation matrix of the evaluation index set is calculated as follows:

$$R = \begin{Bmatrix} r_{11} & r_{12} & \cdots & r_{15} \\ r_{21} & r_{22} & \cdots & r_{25} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n2} & \cdots & r_{n5} \end{Bmatrix}, \tag{10}$$

where R is the grey fuzzy evaluation matrix, r is the number of evaluation team members, and $rji = nji/nj$ is the grey weight, that is, the i evaluation level claimed by the j index. Then calculate the grey statistical value, that is, the possibility of an evaluation factor under a certain risk value, and its calculation formula is as follows:

$$\begin{cases} h_i = \sum_{j=1}^{n} \left(r_1 f_j [k_{1i}] + r_2 f_j [k_{2i}] + \cdots + r_n f_j [k_{ni}] \right), \\ c_{ij} = \dfrac{h_{ij}}{h_i}, \end{cases} \tag{11}$$

where hi represents the sum of the grey statistical values of the i evaluation factors, cij is the grey weight value of the i evaluation factors under the risk level of j, $kni\,(n = 1, 2, \ldots, n)$ is the expert evaluation score matrix, of which n is the number of experts. The grey weight matrix is constructed according to the grey weight value, and the weight value is constructed to obtain the final comprehensive evaluation vector, as shown in the following equation:

$$\begin{aligned} Z = W \cdot C = (w1, w2, w3, \ldots, wm) \cdot \begin{bmatrix} c_{11} & c_{12} & \cdots & c_{1n} \\ c_{21} & c_{22} & \cdots & c_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ c_{m1} & c_{m2} & \cdots & c_{mn} \end{bmatrix} \\ = (z1, z2, z3, \ldots, zn), \end{aligned} \tag{12}$$

where the grey weight matrix is constructed by Z, Zj represents the probability that the system is under risk level j, and the level corresponding to the maximum value in Z is the risk level faced by the system.

3.2. Construction of Public Stadium Performance Management Evaluation Model. Performance management is a result-oriented means to achieve the integration of individual goals and organizational goals and pay attention to the development of individual ability and the improvement in the overall service quality level of the enterprise in the working process. Good performance management pays attention to multi-channel and multi-field management and incentive, so as to play a positive incentive role in the development process [19]. The commonly used performance management methods include 360 degree assessment method, key performance index method, and balanced scorecard. The balanced scorecard is introduced into the performance management evaluation of public sports venues, and the performance management evaluation system is determined by considering the selection of indicators and influencing factors. With the help of the balanced scorecard, the factors affecting the performance management of sports venues are screened, and the results are shown in Figure 2.

The balanced scorecard includes the goal balance of learning and growth, internal operation, customers, and finance and is mostly used in the evaluation of performance management system, including internal and external multilevel and multidimensional indicators. According to the characteristics and operation mode of public stadiums and gymnasiums, and according to the aspects involved in their performance management, the research subdivides the contents of the four dimensions into internal management; internal personnel and service audience; promotion and development; and social and economic benefits [20]. When constructing the hierarchical matrix, it is necessary to judge the consistency of the matrix with the help of scale consistency. Figure 3 shows the specific conditions of random consistency index.

There are two cases when the consistency index CI = 0. One is that you keep fewer decimal places. In this article, the consistency of the analytic hierarchy process is Cr = CI/RI, and this ratio is less than 0.1, which proves that the consistency of the matrix passes the test. Suppose $t(k)$ is the corresponding scale of the k level language. If $p(i) \geq p(j)$ and $s(i, j) = t(k)$, the difference between the relative weight values of the two things to be evaluated can be expressed by as follows:

$$\Delta k = \frac{p(i) - p(j)}{(p(i) + p(j))/2} = 2\frac{t(k) - 1}{t(k) - 1}, \tag{13}$$

where $s(i, j)$ represents the weight of two factors, $p(i)$ and $p(j)$ are the comparison evaluation scales, and $s(i, j)$ is the weight comparison detection scale. By improving the 1–9 scale system, set k continuous changes and grade x satisfaction:

$$\begin{cases} \dfrac{d_2\Delta(k)}{ak^2} = \text{Constant value}, \\ \\ \Delta(x) = \dfrac{2}{3}\Delta(4) + \dfrac{1}{3}\Delta(5). \end{cases} \tag{14}$$

The approximate calculation formula of the scale is equation (14).

$$s(k) = \frac{9}{(10 - k)}. \tag{15}$$

With the help of the balanced scorecard, the selection of performance management index factors of public stadiums and gymnasiums will be more targeted and flexible, so as to make the GFAHP method more scientific and reasonable in the construction of evaluation index system. Figure 3 is the flow chart of building the performance management evaluation model of public sports venues based on GFAHP.

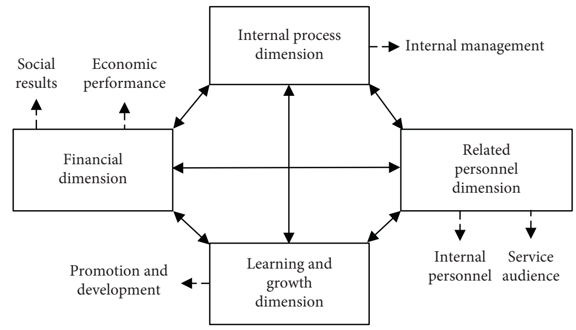

Figure 2: Schematic diagram of influencing factors of performance management under a balanced scorecard model.

In Figure 4, the data evaluation grade is first established, and then the corresponding scoring matrix is constructed with the help of a balanced scorecard and expert scoring. Then, the consistency of the matrix is checked to ensure the weight vector results. In order to reduce the subjectivity and integrity of the scoring index system, grey fuzzy processing is carried out on the matrix vector with the help of the whitening weight function, so as to ensure the formation of grey weight matrix. The comprehensive evaluation vector is obtained by the weight value of evaluation factors, and then the construction of performance management evaluation system of public sports venues is completed.

4. Research on the Application Effect of Performance Management Evaluation of Public Sports Venues Based on GFAHP

4.1. Application Performance Analysis of FAHP Method in Performance Management Evaluation. The GFAHP method is an improved analysis method based on the analytic hierarchy process and grey fuzzy theory. It can effectively reduce the unreasonable phenomenon of the evaluation system caused by the lack of data information or unclear attributes. Public stadiums and gymnasiums will have too much information and data due to the holding of sports events or public welfare activities, and their public welfare far exceeds profitability, resulting in the problem of poor efficiency of the management system. In order to better test the performance of the GFAHP method in the performance management information of public venues, it is applied to the statistics of venue information classification, sorted, and drawn into a graph. The results are shown in Figure 5.

In Figure 5, the distribution of the original sample information is relatively scattered during grade evaluation and division, and some data are missing due to the increase in data volume. However, the GFAHP method supplements the missing data by fuzzy classification and grey evaluation of data information, so as to make the data distribution more uniform and improve the classification effect by 23.14%. At the same time, the management personnel and technical means of public stadiums and gymnasiums are relatively poor, which is prone to data processing errors. The data

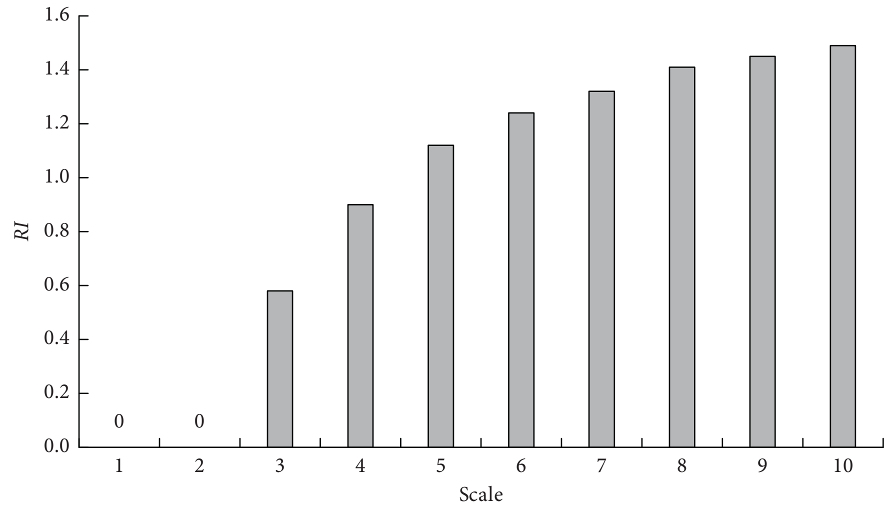

Figure 3: Specific conditions of random consistency index.

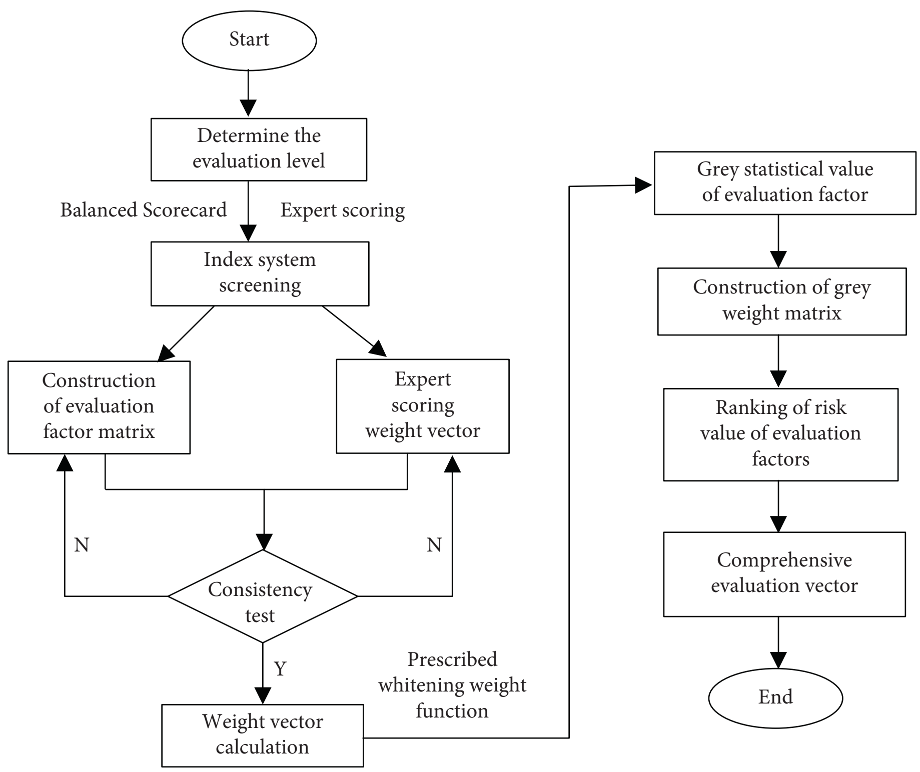

Figure 4: Construction flow chart of performance management evaluation model of public sports venues based on GFAHP.

processing efficiency of different algorithms is counted, and the results are shown in Figure 6.

Figure 6 shows the statistics of classification accuracy and relative error rate of traditional analytic hierarchy process, fuzzy analytic hierarchy process, cluster analysis, and GFAHP under the increase of sample size. In Figure 5, the relative error rate of data classification of the traditional hierarchical method after the data volume is 400 is basically 36.25%, and the accuracy rate shows a downward trend with the increase of the data volume, with the lowest value of 8.97%. The error rate of the fuzzy analytic hierarchy process fluctuates greatly with the increase in the amount of data. The variation ranges of relative error rate and classification accuracy are [32.34%–8.94%] and [8.25%–25.12%], respectively. Cluster analysis is a good and commonly used classification method for data classification. In this experiment, the lowest relative error rate is 19.34%, and the maximum classification accuracy is 23.14%. When the data sample size of the GFAHP method used in the study is more than 400, its error rate always remains at 5.23%, and the change trend is relatively stable, and the highest sample classification accuracy reaches 40.13%. The above results show that the

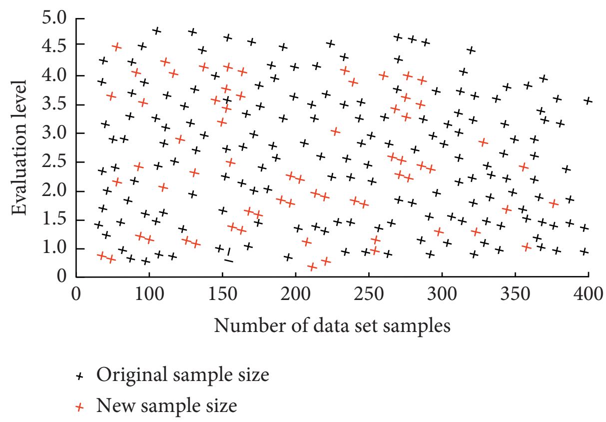

Figure 5: Classification and statistics of information samples under the GFAHP method.

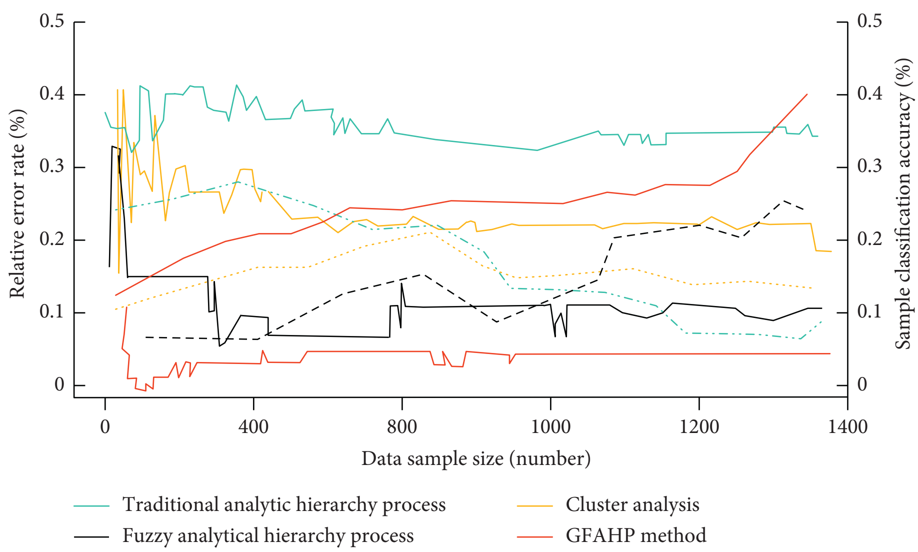

Figure 6: Statistics of sample classification accuracy and relative error rate under different algorithms.

algorithm used in the research has good operation efficiency in data classification and processing and is less affected by the interference of data scale. The processing speed of the algorithm is greatly improved.

4.2. Application Effect Analysis of Performance Management Evaluation Model of Public Sports Venues. Because of the commonweal of its service products and the particularity of operation and construction, the overall operation and management efficiency of public stadiums and gymnasiums has an important relationship with the efficiency of performance management. Scientific and reasonable performance management of public sports venues is a comprehensive-level coordination with a clear structure, reasonable division of each part and overall, and meets the principles of system optimization, feasibility, and goal orientation. In order to better evaluate the applicability of the performance management evaluation system, a provincial public stadium is studied to test the usefulness of the index system, and the assignment and consistency of the criterion level and index level are tested according to the importance of the influencing factors of the stadium's performance management. At the same time, the index factors are screened and determined by the balanced scorecard, so as to reconstruct the index system affecting performance management. The importance evaluation results of the key points of performance management are sorted out and drawn into a diagram, as shown in Figure 7.

In Figure 7, the consistency test of the screened primary indicators B1–B5 and secondary indicators C1–C3, C4–C6, C7–C10, C11–C14, C15–C16, and C17–C19 in the comparative analysis does not exceed 0.1, meeting the requirements of consistency test. Among them, the most influential factors of the relative weight of the index layer in Figure 6(a) are operating income (C15 = 0.119), rationality of management efficiency (C2 = 0.092), and division of rights and responsibilities (C3 = 0.078), followed by professional management (C6 = 0.076), management flexibility (C7 = 0.069), and expense expenditure (C17 = 0.068). The

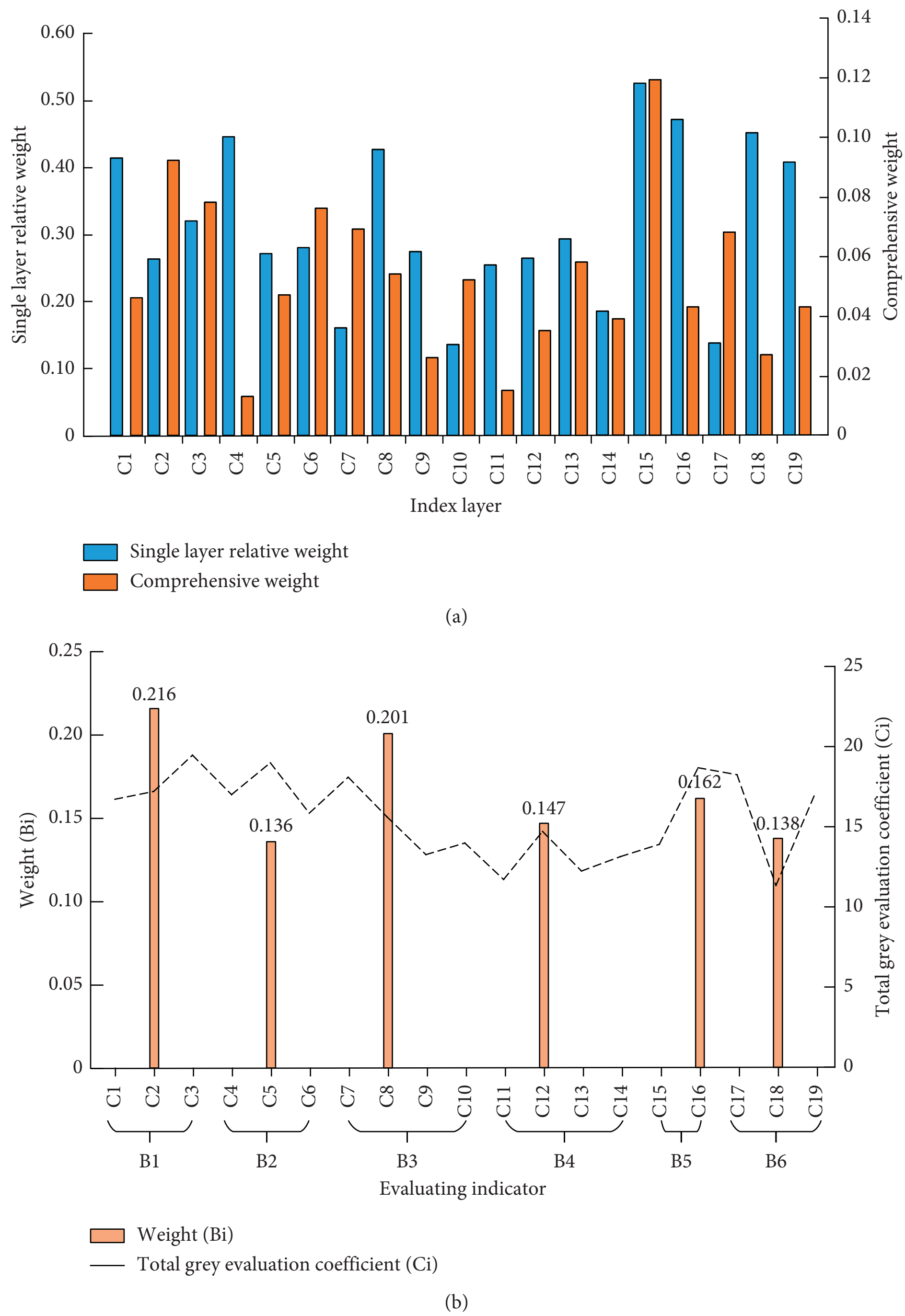

Figure 7: The weight statistics of performance management evaluation indicators of public stadiums and gymnasiums and the statistics of grey evaluation coefficient. (a) Statistical results of single-layer weight and comprehensive weight value of secondary indicators. (b) Statistics of weight value and grey evaluation coefficient of evaluation index.

grey evaluation coefficient indicates the severity of the performance management risk faced by each index. In Figure 6(b), the risk evaluation coefficient values of public stadiums and gymnasiums in management system (B1) and human resource management (B2) are more than 15 points, and the grey evaluation coefficients of performance appraisal system (C5-19.162), management flexibility (C7-18.282), operating income (C16-18.857), and social support conditions (C19-17.242) are in the [17–20] score range, It shows that the risk of its performance management is large, and timely management countermeasures should be taken. The statistical results of the membership degree and final score of the primary evaluation index into a graph are drawn (Figure 8).

In Figure 8, the evaluation membership of evaluation indicators B1–B6 is below 0.1, indicating that they have a good classification effect, and the final score calculation results of indicators are between [3–5], and the overall evaluation grade

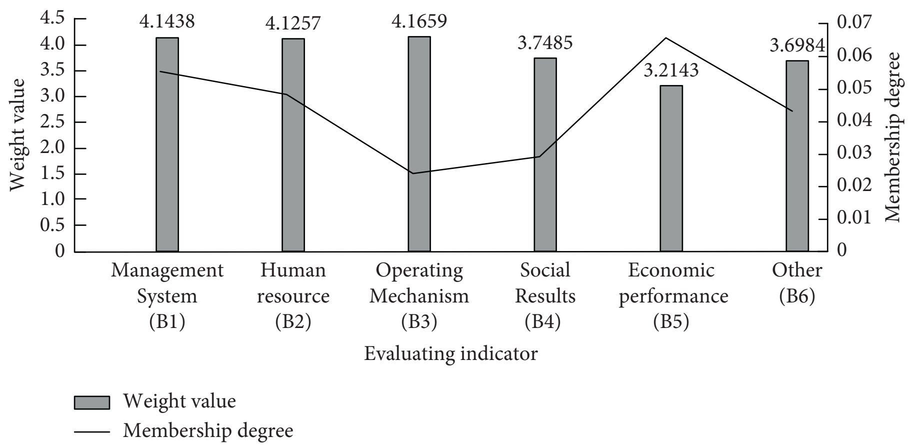

Figure 8: Statistical results of membership degree and final score of primary evaluation indicators.

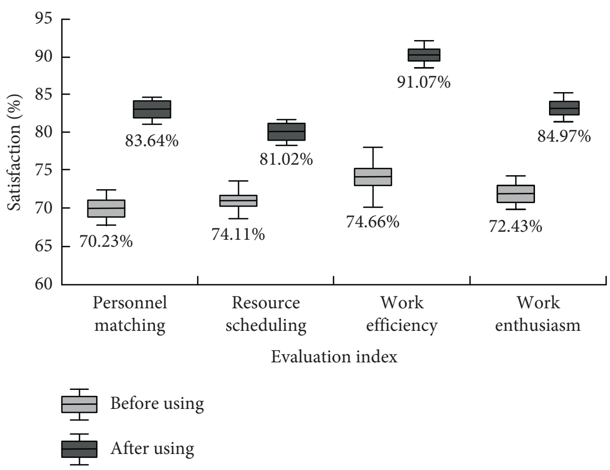

Figure 9: Staff satisfaction statistics before and after the implementation of the performance management evaluation model.

is above good. The above results show that the performance management evaluation based on the GFAHP method has good application efficiency. At the same time, the satisfaction statistics of the staff of public stadiums and gymnasiums are collected before and after the implementation of the performance management evaluation improvement model, data are sorted, and a graph is drawn (Figure 9).

In Figure 9, before the implementation of the evaluation model, the satisfaction of public stadium staff in personnel allocation, resource scheduling, work efficiency, and work enthusiasm is less than 75%, while after the improvement in performance management evaluation means, the satisfaction of staff in the four work dimensions has increased to varying degrees, basically more than 80%. Among them, the satisfaction of staff's work efficiency and work enthusiasm before and after the operation of the evaluation model increased by 10.32% and 13.04%, respectively.

5. Conclusion

With China's attention to public sports and health and the increase in people's spiritual needs, the importance of public stadiums and gymnasiums has become increasingly prominent, but the efficiency of its performance management operation mechanism is low, which affects the overall operation efficiency of the whole stadiums and gymnasiums. By introducing the grey fuzzy analytic hierarchy process, this article constructs the index system based on the analysis of its performance management problems and makes an application case analysis. The results show that when comparing the performance of the GFAHP method with the traditional analytic hierarchy process, fuzzy analytic hierarchy process, and cluster analysis method, when the data sample size of the GFAHP method is more than 400, its error rate always remains at 5.23%, the change trend is relatively stable, and the accuracy of sample classification shows an upward trend. In the index system constructed by this method, the operating income ($C15 = 0.119$), the rationality of management efficiency ($C2 = 0.092$), and the division of rights and responsibilities ($C3 = 0.078$) with the largest relative weight are consistent with the actual situation. At the same time, the staff efficiency and enthusiasm of public stadiums and gymnasiums have increased by 10.32% and 13.04% after the operation of the evaluation model. The performance of human resource management and comprehensive management will be directly reflected in the income of its operation and construction. The flexibility and scientificity of public sports venue management should be strengthened and attention should be paid more to the prevention and control of risk influencing factors. However, the research still has some limitations. The consistency and coordination between proficiency testing and curriculum standards were not discussed. This needs further analysis in future research and analysis.

Data Availability

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

Conflicts of Interest

The authors declare that they have no conflicts of interest or personal relationships that could have appeared to influence the work reported in this article.

Acknowledgments

This work was supported by the Research Project of Humanities and Social Sciences of Colleges and Universities in Jiangxi Province in 2019: Research on the Development Mode and Path of Rural Sports in Jiangxi Province under the Background of Rural Revitalization Strategy (No. TY19218).

References

[1] F. Qian, "State Council: strengthen the construction of public fitness venues and facilities to develop mass sports," *China City Planning Review*, vol. 29, no. 4, p. 6, 2020.

[2] Y. Chen, "Research on planning and management of large-scale sports venues in Chinese cities," *Open House International*, vol. 44, no. 3, pp. 76–79, 2019.

[3] H. Yan and Z. Huang, "Innovative planning and design of sports teaching venues under audience's emotional experience," *Open House International*, vol. 44, no. 3, pp. 100–103, 2019.

[4] Z. Huang, W. Zhao, Y. Zhang, and X. Yao, "Comprehensive safety evaluation of emergency training for building ruins scenario based on analytic hierarchy process-grey fuzzy evaluation," *IEEE Access*, vol. 13, no. 99, p. 1, 2020.

[5] Y. Ju, D. Ju, E. D. Santibanez Gonzalez, M. Giannakis, and A. Wang, "Study of site selection of electric vehicle charging station based on extended GRP method under picture fuzzy environment," *Computers & Industrial Engineering*, vol. 135, pp. 1271–1285, 2019.

[6] M. Ramezanianpour and M. Sivakumar, "Multi-objective analysis for the selection of a sustainable greywater treatment system," *Environmental engineering and management journal*, vol. 18, no. 1, pp. 159–170, 2019.

[7] L. G. Yang, C. Li, L. Lu, and T. Guo, "Evaluation of port emergency logistics systems based on grey analytic hierarchy process," *Journal of Intelligent and Fuzzy Systems*, vol. 39, no. 3, pp. 4749–4761, 2020.

[8] C. Valmohammadi, F. F. Razi, and F. Einy, "Six sigma project selection using the hybrid approach FAHP-FTOPSIS and grey relational analysis model," *IEEE Engineering Management Review*, vol. 49, no. 99, p. 1, 2021.

[9] A. Uluta, "Supplier selection by using a fuzzy integrated model for a textile company," *Engineering Economics*, vol. 30, no. 5, pp. 579–590, 2019.

[10] E. M. Topside, O. P. Kogeda, and T. Olwal, "Enhanced intersystem handover algorithm for heterogeneous wireless networks," *Journal of Advanced Computational Intelligence and Intelligent Informatics*, vol. 23, no. 6, pp. 1063–1072, 2019.

[11] Y. Wang and G. Zheng, "Application of artificial intelligence in college dance teaching and its performance analysis," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 15, no. 16, p. 178, 2020.

[12] X. Yin, Q. Liu, X. Wang, and X. Huang, "Prediction model of rockburst intensity classification based on combined weighting and attribute interval recognition theory," *Meitan Xuebao/Journal of the China Coal Society*, vol. 45, no. 11, pp. 3772–3780, 2020.

[13] F. Tüysüz and N. Yıldız, "A novel multi-criteria analysis model for the performance evaluation of bank regions: an application to Turkish agricultural banking," *Soft Computing*, vol. 24, no. 7, pp. 5289–5311, 2020.

[14] L. Wu and H. Li, "Retracted article: risk assessment of extreme rainfall climate change and sports stadium sports based on video summarization algorithm," *Arabian Journal of Geosciences*, vol. 14, no. 16, p. 1661, 2021.

[15] G. Chen, "Analysis of athletes' stadium stress source based on improved layered K-means algorithm," *Journal of Intelligent and Fuzzy Systems*, vol. 39, no. 4, pp. 5905–5914, 2020.

[16] H. Kaiyan, G. Xiao, and X. Yang, "An effective stadium monitoring control algorithm based on big data in emerging mobile networks," *Multimedia Tools and Applications*, vol. 78, no. 21, pp. 29971–29987, 2019.

[17] O. Celik, C. Z. Dong, and F. N. Catbas, "Investigation of structural response under human-induced excitations using noise-assisted and adaptively transformed multivariate empirical mode decomposition," *Journal of Structural Engineering*, vol. 146, no. 4, Article ID 04020019, 2020.

[18] H. Wang, Y. M. Zhang, and Z. Yang, "A risk evaluation method to prioritize failure modes based on failure data and a combination of fuzzy sets theory and grey theory," *Engineering Applications of Artificial Intelligence*, vol. 82, pp. 216–225, 2019.

[19] A. Rababah and A. Bataineh, "Factors influencing balanced scorecard implementation," *Research Journal of Finance and Accounting*, vol. 7, no. 2, pp. 204–212, 2018.

[20] M. Alnoukari, "A framework for big data integration within the strategic management process based on a balanced scorecard methodol," *ogy. Journal of Intelligence Studies in Business*, vol. 11, no. 1, pp. 33–47, 2021.