Research on Evaluation Model of Football Frontal Line Player Competitive Ability Based on Fuzzy Clustering

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***Abstract**: Sports represented by football are playing a more and more important role in residents' lives. In recent years, the broadcasting of high-level football leagues has also enabled audiences all over the world to enjoy the charm of football at home. On the basis of introducing concepts such as fuzzy clustering, the systematic clustering method, k- means algorithm and FCM algorithm are emphatically analyzed. On this basis, the existing evaluation model of football frontal line player's competitive ability was improved, and a new evaluation model was established. Twenty-seven main indexes affecting the competitive ability of football frontal line player were obtained, and fuzzy mathematical modeling was carried out on this basis. And select a frontal line player as a case, according to the evaluation system, make an objective evaluation of its ability, type and suitability for studying abroad.*

***Keywords**: Fuzzy clustering, Football, Frontal line player, Competitive ability evaluation*

Ⅰ. Introduction

Football is a sport in which feet dominate the ball and two teams attack and defend in the same field. Because football not only breeds rich connotations, but also has the characteristics of integrity, antagonism, variability, hardship and feasibility, it has become the most extensive and influential sport in the world at present, and it is known as “the first sport in the world” [1]. Theoretical research has reached a consensus on the factors affecting the competitive ability of football frontal line player, including skills, physical fitness and mental intelligence. Skills include techniques and tactics, physical fitness includes body shape, function and quality, and mental intelligence includes psychology and intelligence [2]. However, this is only a common factor of competitive ability. For football frontal line player, the factors that affect its competitive ability should be targeted. Therefore, it is of special significance to study the main factors affecting the competitive ability of football frontal line player.

As an excellent frontal line player, its successful scoring depends on many factors: good physical quality, excellent ball control skills, rich competition experience, calm and decisive ability to predict, good shooting awareness and clean footwork under various pressures, and the creation of shooting scoring opportunities that people can hardly imagine in high-intensity and intense competitions and limited space and time. Only with these factors can we make due contributions to the team's victory [3].

The existing evaluation system of football frontal line player's competitive ability generally carries out static evaluation, which is difficult to reflect the dynamic evaluation information, and can only be controlled after the event, which is inconvenient to control before and during the event. Based on the above ideas, starting from the research of fuzzy clustering analysis, this paper puts forward an evaluation model that uses clustering algorithm to improve the fuzzy comprehensive evaluation method, digs out valuable information from these data, and makes continuous summarization to analyze the competitive ability characteristics of football frontal line player.

Ⅱ. Literature Review

Frontal line player is often the leader and backbone of a team. However, in football field, it is a reflection of comprehensive strength. If frontal line player really wants to be the soul of a team and stand alone, it must improve its competitive ability in many ways. Football requires athletes to run in various forms for a long time and complete

all kinds of difficult movements in a fast pace with skillful skills. Besides, it also requires athletes to overcome their opponents' collisions with strong physique and enter the game with high excitement.

Competitive ability refers to the ability of athletes to participate in competitions. It is composed of physical ability, skill, tactical ability, sports intelligence and psychological ability with different forms of expression and different functions, and is comprehensively manifested in the process of special competition [4]. Clustering analysis is an important research field in data mining. Clustering is an unsupervised learning method, which divides a sample set without category markers into several classes according to some criteria, so that the similarity between samples within a class is as large as possible, while the similarity between samples within a class is as small as possible. Literature [5] discusses the special basis and characteristics of the physical training control of football frontal line player. The results show that the physical training control of football frontal line player should follow three basic characteristics: the development of the physical state of football frontal line player has various morphological characteristics instead of a single form; Literature [6] divides the evaluation system of football frontal line player's offensive ability into three-level indicators, and sets up two-level and three-level indicators under four first-level indicators, namely, the ability to use offensive techniques, the ability to cooperate with offensive tactics, the offensive effect and the offensive style. The evaluation system is relatively perfect, which can be used as the basis for the selection of offensive indicators of forwards. Literature [7] adopts the method of expert investigation to construct the complete competitive ability of football frontal line player. The striker players are divided into eight categories, including “tall opportunist”, center, technical type, “lone wolf” and so on. This evaluation scheme scientifically clusters the existing sample forwards. However, because the data is relatively long and the classification system is not formed, it is of little significance to the classification of the current forwards [8].

Ⅲ. Fuzzy Clustering Analysis Method

A. Summary

Clustering analysis is a kind of multivariate statistical analysis and an important branch of unsupervised pattern recognition. Traditional clustering analysis is a kind of hard partition, which strictly divides each object to be identified into a certain class, and has the property of either or the other. Therefore, the boundary of this class partition is obvious. The fuzzy set theory provides a powerful partition tool for this partition. People begin to use fuzzy methods to deal with clustering problems, and call it fuzzy clustering analysis. Because fuzzy clustering obtains the uncertainty degree of samples belonging to various categories, it expresses the intermediary of sample attributes, that is, it establishes the uncertainty description of samples for categories, which can more objectively reflect the real world, thus becoming the mainstream of cluster analysis research.

Fuzzy clustering analysis methods are mainly divided into two types: systematic clustering method based on fuzzy relation and iterative fuzzy clustering method. Systematic fuzzy clustering method is based on fuzzy relation, while the relationship between football frontier line player and evaluation indexes in the evaluation of football frontier line player's competitive ability is a kind of fuzzy relation, so this paper adopts systematic fuzzy clustering algorithm to carry out fuzzy clustering analysis.

B. Basic Algorithm of Fuzzy Clustering

It should be pointed out that the fuzzy logic based on fuzzy theory is not fuzzy in itself, but is used to deal with “fuzzy” in order to eliminate fuzzy logic. In fact, fuzzy logic is an accurate method to solve inaccurate and incomplete information, and its greatest feature is that it can deal with human knowledge more naturally.

Fuzzy clustering method uses FCM method to determine membership function [9]. The goal of fuzzy C- means algorithm is to find $U=\left[u_{ik}\right]\in M_{jk}$ and $V=\left(V_1,\cdots,V_c\right)\left(V_i\in R^P\right)$, which can be expressed as the following objective function:

$$J_m(U,V)=\sum_{k=1}^{n}\sum_{i=1}^{c}(u_{ik})^2\|X_K-V_i\|^2 \quad (1)$$

Where $m\in(1,\infty)$ is a weight index. Next, the necessary conditions of this minimization problem are established first, and then the FCM algorithm is given.

Let $X=\{X_1,X_2,\cdots,X_n\}, X_i\in R^P$ be a given data set. Set $c\in\{1,2,\cdots,n-1\}$ and $m\in(1,\infty)$, assuming that for all $1\le k\le n$ and $1\le i\le c$, only:

$$u_{ik}=\frac{1}{\sum_{j=1}^{c}\left(\frac{\|X_k-V_i\|}{\|X_k-V_j\|}\right)^{\frac{2}{m-1}}},1\le i\le c,1\le k\le n \quad (2)$$

And

$$V_i=\frac{\sum_{k=1}^{n}(u_{ik})^m X_k}{\sum_{k=1}^{n}(u_{ik})^m},1\le i\le c \quad (3)$$

Then $U=[u_{ik}]$ and $V=(V_1,\cdots,V_c)$ are the local minima of $J_m(U,V)$.

Fuzzy clustering algorithm is a method of automatically forming fuzzy sets (fuzzy relations). Its advantage is that when the number of fuzzy clusters is determined, the fuzzy partition of input space is automatically completed, and no initial knowledge about the structure of data sets is needed.

The membership function of poly type has the following characteristics:

$$\sum_{i}^{c}u_i^k=1,i=1,2,\cdots,n,k=1,2,\cdots,n \quad (4)$$

The closer X_k is to V_i, $d_{ik}<d_{jk}\left(d_{ik}=\|X_k-V_i\|,i=1,2,\cdots,c;i\ne j\right)$, so there are:

$$\sum_{j=1}^{c}\left(\frac{d_{ik}}{d_{jk}}\right)^{\frac{2}{m-1}}<1(i\ne j) \quad (5)$$

The closer u_i^k is to 1.

The farther X_k is from V_i, $d_{ik}>d_{jk}\left(i=1,2,\cdots,c;i\ne j\right)$, so there is:

$$\sum_{j=1}^{c}\left(\frac{d_{ik}}{d_{jk}}\right)^{\frac{2}{m-1}}>1\left(i\neq j\right)(6)$$

The closer u_i^k is to 0. The larger the weight m is, the greater the degree of overlap among the membership functions is.

m has a great influence on the membership function. If m is too small, the membership degree of input variables is near 1, which will affect the accuracy of modeling. If m is too large, there will be too many intersections among the membership functions, which will also affect the modeling accuracy. In practical application, the size of m should be determined by specific analysis according to specific conditions.

4THE EVALUATION MODEL OF FOOTBALL FRONTAL LINE PLAYER'S COMPETITIVE ABILITY

C. Construction of Competitive Ability Index System of Football Frontal Line Player

In this paper, based on the characteristics of football frontier line player's competitive ability as the principle of index selection, 34 evaluation indexes of football frontier line player's competitive ability were preliminarily selected. Through the investigation and interview of 30 experts who have been teaching and training football for many years, 30 questionnaires were distributed and 28 were recovered, with a recovery rate of 93%. Twenty-seven evaluation factor indexes of football front-line players with high characteristic values are obtained (see Figure 1), and the index weights of expert questionnaires are counted by statistical decision-making method, based on which a fuzzy evaluation set is established (see Table 1 for statistical results).

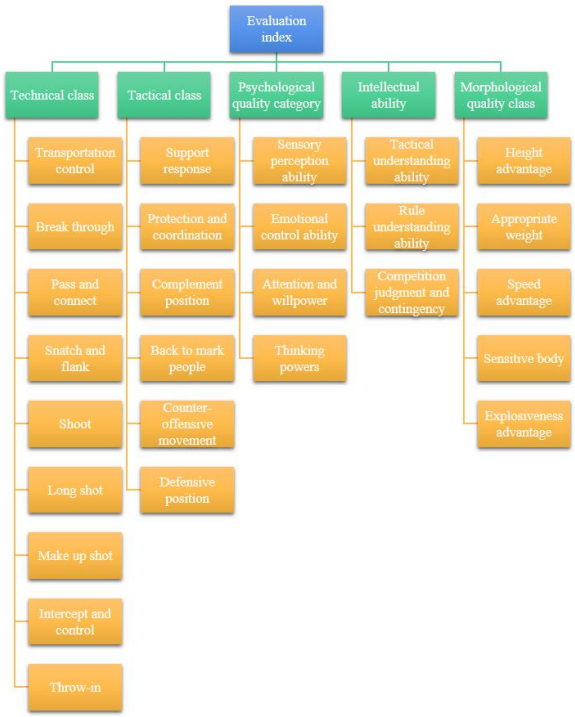

Fig.1 Evaluation Index of Competitive Ability of Football Frontal Line Player

Table 1 Index Weight Allocation

Level I index	Weight	Secondary index	Weight
Technical class	0.31	Transportation control	0.79
		Break through	0.11
		Pass and connect	0.13
		Snatch and flank	0. 22
		Shoot	0. 11
		Long shot	0. 14
		Make up shot	0. 06
		Intercept and control	0. 04
		Throw-in	0. 21
Tactical class	0.22	Tactical class	0. 13
		Protection and coordination	0. 16
		Complement position	0. 11
		Back to mark people	0. 24
		Counter-offensive movement	0. 23

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		Defensive position	0. 31
Psychological quality category	0.14	Sensory perception ability	0. 3
		Emotional control ability	0. 25
		Attention and willpower	0. 22
		Thinking powers	0. 41
Intellectual ability	0.14	Tactical understanding ability	0. 2
		Rule understanding ability	0. 42
		Competition judgment and contingency	0. 26
Morphological quality class	0.21	Height advantage	0. 12
		Appropriate weight	0. 22
		Speed advantage	0. 21
		Sensitive body	0.26
		Explosiveness advantage	0. 2

D. Fuzzy Clustering Evaluation Model

It is not difficult to find that the evaluation of football frontal line player's competitive ability is a fuzzy problem, and a mature algorithm must be selected in the algorithm selection, so FCM algorithm is chosen as the core algorithm of the current model. For example, some algorithms based on cohesion in the hierarchical method also have a good effect on the evaluation of the competitive ability of football frontal line player. If the valve is selected properly, the obtained clustering has certain reference value.

According to formula (5), calculate the scores of a football frontier line player on each factor, and arrange them in sequence to obtain a 10-dimensional row vector (number of factors in the factor set). Then, take the scores of each football frontier line player on each factor as a row vector to form a score matrix with N (number of football frontier line players) rows and 10 columns, which is denoted as X. As the original data of cluster analysis.

$$e_{ij} = R_{ij} \circ D^T \quad (7)$$

The steps of the system clustering algorithm are as follows:

(1)Regard each football front line player as a point in the 10-dimensional space, and preset each football front line player as a class.

(2)The distances between points (classes) and points (classes) in 10-dimensional space (corresponding to 10 judging factors) are calculated respectively. For convenience of calculation, Euclidean distance is used in calculation [10].

(3)The two points with the smallest spatial distance are classified into one class, and the coordinate values of the new class are set as the arithmetic mean of the two points. This calculation method is called the class average method in cluster analysis.

(4)Repeat steps (2) and (3) until all points are classified as one class.

The FCM algorithm is more complicated than the system clustering algorithm. To simplify the calculation, we fix the value of m to be equal to 2, and c is a parameter that can be set. The realization steps are as follows:

(1)Parameter $c(1 < c < N)$ is obtained, and c data objects are randomly selected from N football frontal line player as the centroids of c original divisions, and the iteration times are $t = 0$.

(2)For all $i\left(1 \le i \le c\right), k\left(1 \le k \le n\right)$ and $m = 2$, update $U^{(t)}$ to $U^{(t+1)}$ according to formula (3), and the distance shall be Euclidean distance.

(3) According to $U^{(t+1)}$, update the centroid $V^{(t+1)}$ of the $\left(t+1\right)$-th iteration according to formula (4).

(4)Compare $v^{(t)}$ with $v^{(t+1)}$, if $\left\| v^{(t)} - v^{(t+1)} \right\|$, the algorithm is terminated; Otherwise, $t = t + 1$, go to step (2).

With the deepening of the research, people gradually realize that the evaluation of the competitive ability of football frontal line player is a typical fuzzy problem, and it is necessary to introduce the fuzzy set theory to make a qualitative improvement. The fuzzy comprehensive evaluation method came into being just under this thought. Later, after practice, people put forward a more practical two-level fuzzy comprehensive evaluation method. Compared with the traditional simple average method and weighted average method, the two-level fuzzy comprehensive evaluation method has a substantial improvement, which has been specially demonstrated in many documents. However, the problem of information loss and distortion in the process of fuzzy comprehensive evaluation has been

puzzling people, and many objective problems have forced people to seek a more reasonable and effective evaluation model.

Compared with the previous model, the model using cluster analysis has an ideological improvement, that is, from prior division to pattern recognition, more and more effective information is mined from the data, thus making up for the deficiency of fuzzy comprehensive evaluation method. The specific improvement process is shown in Figure 2.

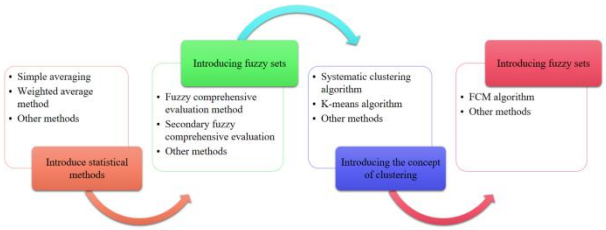

Fig.2 Schematic Diagram of Evaluation Model Improvement Process

E. Construction of Evaluation Set and Evaluation Matrix of Players' Competitive Ability Index

(1)Determine evaluation set

Determine the evaluation set of players' competitive ability, that is, determine the grade or standard of evaluation. This paper uses a 5-point system to determine the evaluation set $V=(v_1,\cdots,v_5)=Excellent, good, moderate, relatively\ poor, poor$ of competitive ability. In the specific evaluation, the players are graded according to an index according to the evaluation grade.

(2)Construct a single index evaluation matrix

Ask a number of professionals to evaluate the competitive ability index of a player according to the evaluation grade determined by the evaluation set. As for the evaluation of man-marking ability, 45% think that it is excellent, 33% good, 21% medium, 14% poor and 1% poor, then it is recorded as $x_1=[0.45,0.33,0.21,0.14,0.1]$. And so on.

According to the statistical results of evaluation, a single index evaluation matrix is formed:

$$R=\begin{bmatrix} 0.3 & 0.4 & 0.2 & 0.2 & 0 \\ 0.4 & 0.1 & 0.2 & 0.3 & 0.2 \\ 0 & 0.2 & 0.3 & 0.4 & 0 \end{bmatrix} \quad (8)$$

F. Implementation of K-Means Clustering

After many iterations, the final clustering is obtained. There are 35 strikers in the first category, 20 strikers in the second category, 25 strikers in the third category, 28 strikers in the fourth category, 21 strikers in the fifth category and 6 strikers in the sixth category.

According to the final cluster center table, the first type of striker has the strongest offensive ability and superior ability, while the physical quality is relatively weak. The second type of striker is superior in offensive, defensive ability and physical quality, but the weakest in passing ability, and often does not choose superior in the field, but ends the opponent and launches forced defense near the forbidden area, thus being the representative of “sudden forward”. The third type of forwards are weak in all abilities, but the ability to play without the ball is the strongest

among all forwards. The fourth type of forwards are average in offensive, defensive and ball-free, while their explosive and extraordinary abilities are superior, and their physical quality is the biggest bright spot. The fifth type of forwards are the most outstanding in defensive ability and strong in explosive ability, but their offensive ability is the weakest. The sixth type of forwards hardly have much outstanding ability, so it is difficult to survive in the high-intensity Premier League.

Ⅳ. Applied Analysis

In this paper, a football front line player is selected as a case. firstly, the original data of the football front line player is searched and standardized in the Football Manager database, and the factor score formula is substituted, so that the score of each factor of the football front line player is shown in table 2.

Table 2 the Football Frontal Line Player Scores Each Factor

Factor	Score
Offensive ability	0.5637
Defensive ability	-0.5879
Physical quality	-1.6037
Outbreak ability	-0.8962
Extraordinary ability	-0.7418
Ball-free ability	0.0651

According to the comprehensive score formula, the comprehensive score of the football frontal line player is -0.1639.

According to the size of the group, the prior probabilities of players in the first class to the sixth class are 0.251, 0.163, 0.194, 0.237, 0.131 and 0.041, respectively. According to the classification function, the scores of the observed variables are calculated, and the observed variables are classified into the category with the highest scores. In this case, the football frontal line player belongs to the first class.

From the comprehensive score, it can be preliminarily inferred that the football frontal line player belongs to the first type of striker in the Premier League system, that is, “the tipping point striker”, that is, it exists as a striker with relatively poor physical quality and defensive ability but strong offensive attributes.

Ⅴ. Conclusion

In this paper, the main index system and the weight coefficient of each index are obtained by studying the quantitative evaluation of the competitive ability of football frontal line player. This paper focuses on how to use cluster analysis to improve the evaluation model, puts forward a new evaluation model based on cluster, and summarizes the improvement process of the evaluation model. In order to better reflect the applicability of the evaluation system, this paper makes a discriminant analysis on a Chinese football frontal line player, and concludes that a football frontal line player belongs to the first type of striker in the Premier League system, with a comprehensive factor score of -0.1639. According to this, the football frontal line player may face fierce competition, and it is more likely to be a substitute. It is suggested that the football frontal line player can improve the offensive ability and narrow the gap with the top strikers through training.

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