



# The Construction and Research of Football Evaluation Index System

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**Abstract:** In order to establish the evaluation model of football performance indicators, this paper refers to the literature and determines the performance evaluation indicators such as the diversity of matches, players' contribution, flexibility, adaptability, coordination and tempo among players through expert consultation. Next, the paper uses analytic hierarchy process to determine the weight of each indicator. The study is of practical significance for the comprehensive and reasonable evaluation of football performance level.

**Key words:** Football; Analytic hierarchy process; Performance evaluation; Index model

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## 1 Introduction

The interconnection of the society bring about a series of menaces which demand team members with interdisciplinary, multicultural knowledge and close team collaboration. Good team cooperation can bring the advantages, skills and knowledge originally belonging to each member together, and stimulate the potential of team members.

The competitive team sports with strict rules makes themselves one of the most study worthy template. The football team is composed of members with different skills, physical qualities, mental awareness and different roles and positions. In order to win the fierce competition, in addition to the display of individual skills, team members need to cooperate closely, give full play to the overall strength of the

team, focus on the interests of the whole team.

Performance evaluation is a process to promote the overall performance improvement of individuals and organizations, to stimulate and strengthen the skills of relevant responsible persons to continuously improve and become more competent in relevant work, and to promote the optimal allocation of various resources and the sustainable development of potential in campus football work<sup>[1]</sup>. This paper studies the performance indicators that affect team performance in football matches, and then explores the structure, structure and dynamic aspects of team cooperation. It has certain reference significance for formulating football training strategies and optimizing the cultivation of football competitive talents.

## 2 The Construction of Football Evaluation Index System

### 2.1 Overview of Performance Evaluation Index System

The fast pace of the game, the high intensity of confrontation and the fierce competition between the attacking and defending sides in time and space are the characteristics of today's football[2]. By referring to relevant literature and combining with the experience of football coaches, six performance indicators affecting the success of a team were determined: competition diversity, players' contribution, flexibility, adaptability, coordination and rhythm between players. Based on these six factors, a correlation model was established and the weights of these six performance indicators were calculated by analytic hierarchy process.

## 2.2 Performance Evaluation Index

### 2.2.1 The Diversity of the Competition

Football competitions can be splitted into cup competitions and league competitions. Teams face different competitive pressure in cup and league competitions, resulting in different impact on team's performance.

### 2.2.2 Contribution Allocation

We adopt offensive indicators like duel, free kick, shot, and defensive indicators like defending duel to measure a player's contribution to the competition. (Other behaviors are too few to be considered.) Offensive indicators include passing (long pass, hand pass), free kick, dueling (ground attack, grab in the air), shooting. Defensive: pass (header, high pass, simple pass), duel (defensive duel, ground grab). Pass quantified for 1 point, free kick quantified for 3 points, duel quantified for 4 points, shot quantified for 9 points. Players are assigned a contribution based on the final player's combined score.

### 2.2.3 Adaptability

First, we introduce the concept of adjacency matrix.: the logical structure of the network is divided into two parts: V and E set, where V is the vertex and E is the edge. Therefore, a one-dimensional array is used to store all the vertex data in the graph; A two-dimensional array containing data about the relationships between vertices (edges or arcs) is called an adjacency matrix. Therefore, the adjacency matrix of a directed network graph is defined as follows:

$$A[i, j] = \begin{cases} w_{ij}, & \text{if } \langle v_i, v_j \rangle \text{ or } \langle v_j, v_i \rangle \in E(G) \\ 0 \text{ or } \infty, & \text{if } \langle v_i, v_j \rangle \text{ or } \langle v_j, v_i \rangle \notin E(G) \end{cases}$$

According to the correlation between the weights, we can get the adjacency matrix of a team. Next, we can calculate the number of eigenvalues Nch by the adjacency matrix of the team. The higher the Nch, the higher the correlation between the teams, so we can adopt Nch to measure the adaptability of players.

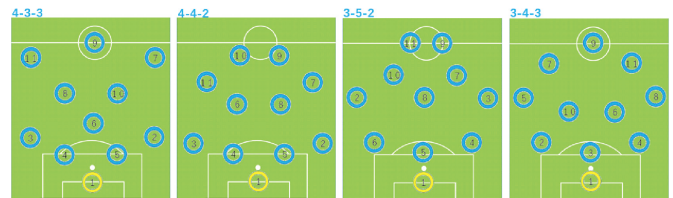
Assume the maximum eigenvalue of the connectivity matrix A (also known as the weighted adjacency matrix) as  $\lambda_{max}$ , its element  $w_{ij}$  containing the maximum eigenvalue of the transmit number between player  $i$  and player  $j$  has been used as a quantitative indicator of the strength of the network, which increases with the number of nodes and links<sup>[3]</sup>.

It is also worth analyzing the behavior of  $\lambda_{min}$ , the second minimum eigenvalue of A, also known as algebraic connectivity. The value of  $\lambda$  is associated with multiple network properties. In synchronization, networks with higher  $\lambda$  require less time to synchronize. In the diffusion process, the time to equilibrium is also proportional to the inverse of  $\lambda$ . In the football passing network,  $\lambda_{min}$  can be used as a metric for quantifying team divisions. The reason is that a low  $\lambda$  value indicates that the network is very close to being divided into two groups, and finally breaks down at  $\lambda = 0$ . Thus, the higher the  $\lambda$  value, the more interconnected the teams are, which is a measure of structural cohesion.

### 2.2.4 Flexibility

Players' flexibility on the field is reflected in the speed of network transformation and the number of network subgraphs. Then we need to define the transformation of network model clearly.

Firstly, we are required to determine the network mode of football. We have established the network model of location information in 3.1.1. According to relevant literature, we get the frequently-used football formations: 4-3-3, 3-5-2, 3-4-3, 4-4-2. (full back - centre halfbackforward). A simulation diagram of four formations is shown below.



We discretize and break down total into 54 time periods, each time period is 100 seconds, and we take the end of 100s time period as the pattern recognition. It is assumed that the formation at the end of the period represents the pattern of playing football in the period. Denote 4-3-3, 4-4-2, 3-5-2, 3-4-3 patterns as 1, 2, 3, 4. The conversion frequency is calculated by the following algorithm.

#### Algorithm: Simple AL Based On Sequential Detection

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Input: Discretize Ttotal, 4-3-3 Model-1, 4-4-2 Model-2, 3-5-2 Model-3, 3-4-3 Model-4  
Initial Value  $a_0$ , Time Quantum.  
Output: Formation Change Rate F.  
Initialization: F, i,  $a_0$   
Process: For i = 0 to Time Quantum  
    Time Quantum =  $a_{i+1}$   
    If  $a_i \neq a_{i+1}$   
        F = F + 1  
    End If  
End For  
Get: Player Flexibility

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On the basis of the above algorithm, we can work out the formation change rate F. To sum up, we obtain the expression of players' flexibility through the established network model.

### 2.2.5 Coordination Among Players

Football is a competition of teamwork. Teamwork, compared with individual ability, lay emphasis on the internal cooperation and capability matching among players. Therefore, it is essential to explore the individual ability of different players and combine the advantages and disadvantages of each player to maximize the team's capability.

We evaluate the ability of each player separately based on six angles. Define:

- Attack Ability: measured by a player's average goals per game.
- Passing Ability: measured by the average of pass failures a player makes.
- Physical Ability: measured by the average of duels a player participates in per game.
- Defensive Ability: measured by the average times a player engages in defensive behaviors per game.
- Free-kick Ability: measured by the average free-kicks a player scores per game.
- 1v1 Ability: measured by the average times a player performs 1v1 per game.

We utilize TOPSIS distance method to grade each player based on statistics, and then adopt the interval conversion formula

$$N_{x,y} = \frac{N_{\max} - N_{\min}}{O_{\max} - O_{\min}} \times (o_{x,y} - o_{\min}) + N_{\min}$$

We convert the players' scores to a 70-100 range, define as the players' ability. In addition, the ability values of all attributes are converted to the range of 1~5. Players at different positions have different total ability values and attribution abilities. Maximizing the team capability is regarded as one of the successes of team cooperation.

### 2.2.6 Tempo

Tempo, in a word, is speed. Define the advance ratio  $\frac{|\Delta y|}{|\Delta x|}$ , where  $\Delta y$  is the total length of the y-axis of all passes,  $\Delta x$  is the total length of the x-axis, (the units of the distances are field). Direction x is toward the goal, whereas direction y is parallel to the opponent's goal.

## 3 Determining the Weight by AHP

The decision problem is broken down into two levels, denoting the target level as H and the lower level as G. The lower layer is the scheme layer, with a total of 6 indicators: competition diversity, contribution distribution, coordination among players, adaptability, flexibility and tempo, which are recorded as  $G_1, G_2, G_3, G_4, G_5, G_6$ .

We fill in the matrix following the principle that the interests of the team are greater than the individual ability, and construct the judgment matrix to form the following comparison matrix of  $G_1, G_2, G_3, G_4, G_5, G_6$  at the base level.

H	$G_1$	$G_2$	$G_3$	$G_4$	$G_5$	$G_6$
$G_1$	1	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{7}$	$\frac{1}{9}$
$G_2$	3	1	$\frac{1}{2}$	$\frac{1}{5}$	$\frac{1}{6}$	$\frac{1}{9}$
$G_3$	5	2	1	1	$\frac{1}{3}$	$\frac{1}{5}$
$G_4$	7	5	4	1	$\frac{1}{3}$	$\frac{1}{3}$
$G_5$	7	6	3	3	1	$\frac{1}{3}$
$G_6$	9	7	5	5	3	1

The solution of the eigenvalue  $\lambda_{\max}$  is 6.574. The weight vector  $\omega = (0.0249, 0.0494, 0.0777, 0.1617, 0.2400, 0.4462)$ . Based on the formula, we calculate  $CR=0.0911 < 0.1$ , the consistency of the matrix is acceptable. Therefore, the comprehensive ranking scheme of training is obtained, which in turn includes the tempo, players' flexibility, players' adaptability, coordination among players, contribution distribution and diversity of competition.

## 4 Conclusion

In this study, a football performance evaluation index system is constructed, and a comprehensive ranking of performance indicators is obtained through analytic hierarchy process, so as to achieve a comprehensive and reasonable evaluation of football performance level. This study can extend the model based on the adjacency matrix, and provide some reference value for other teams to solve the optimization scheduling problem.

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