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Assessment of Football Cooperation Performance Based on Evaluation Model: a Case Study of the Everton Team

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ABSTRACT

To comprehensively measure the effect of football team cooperation, this paper established a football team performance evaluation model and takes the performance of Everton F.C. in 2017 to 2018 season as an example. We selected 12 indicators from three aspects and use hierarchical clustering to divide the performance into four levels: very successful, relatively successful, unsuccessful and very failed. Then, we evaluated the performance of the team's changes and focus on the opponent's strategy indicators to analyze its impact. It is found that the reason for most of the failed games is that the team is affected by the away effect, the intra-team cooperation is not dominant and the opponent's ability is strong, resulting in low CPI scores. At the end of the season, the influence of the opponent strategy on team performance becomes stronger and stronger.

Keywords: Football team performance; Everton F.C.; Entropy weight method; Coefficient of variation method

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1. Introduction

Nowadays, the importance of teamwork has been widely accepted [1]. The collaborative research team is an essential part of most scientific work, especially in sports competition, it needs the team's delicate cooperation to score goals. Football is widely regarded as the most popular sport in the world and one of the most challenging sports to analyze quantitatively due to the almost uninterrupted flow of the ball and the complexity of the game [2, 3]. We know that the composition of the team determines their chances of success [4]. However, it is not clear what kind of team process can bring the best performance, or how team value and personal ability are combined to get the best results. Therefore, it is of practical significance to explore the effect of team cooperation and provide feasible cooperation strategies.

At present, many studies have explored the teamwork mechanism of football, such as J. M. Buldú et al [5] using network science, Guardiola's F.C. How is Barcelona different from other teams, including its clustering coefficient, shortest path length, maximum eigenvalue of adjacency matrix, algebraic connectivity and centrality distribution. Cintia P et al [6] used a data-driven method to extract a set of performance indicators based on passing from the observed data of football matches and simulated the four major European championships. Jordi Duch et al [7] developed a network approach that provides a powerful quantification of the contributions of individual players and of overall team performance.

Most studies gave the evaluation criteria for the passing mode of the football team, taking into account the impact of the opponent's strategy and the limited degree of success in quantifying teamwork. Therefore, this study synthesized technical and non-technical indicators to reasonably quantify the successful motivation characteristics of teamwork. A total of 12 performance indicators are selected from three aspects to establish a team performance evaluation model to comprehensively evaluate the success of team cooperation. And take the cooperation of the Everton team as an example to provide some reference for the cooperation of the team.

2. Teamwork Performance Evaluation Model

2.1 Cooperation Performance System

Successful cooperation is often reflected in many aspects, not just in the results of the game. At the same time, many studies [8,9] have not clarified whether the football strategy is affected by the opponent's strategy. Referring to the existing research, we summarize the generally accepted classification results and build the system from three levels.

2.1.1 Indicator description

(1) Environmental factors

Season pressure y_1**.** With the progress of the season, the energy and confidence of the players will have a positive impact, and the pressure of the season will change with the ups and downs of the game.

Forward looking impact y_2**.** Considering that the result of each game and the players' performance will affect the tactics and psychological pressure of the next game, we introduce the result of the last game to reflect the forward-looking influence. Here, we assume that the previous game of the first game was a draw.

Effect of away from home y_3**.** Away effect refers to "when the number of home and away games is the same, compare the schedule of home and away games, and the failure rate of away games is higher than that of home games[10]." This effect exists objectively, especially in football matches according to the team's playing field.

Coaching level y_4**.** To get a higher winning rate and more effective attack, coaches often need to develop appropriate attack strategies and team plans according to the passing habits and players' level. Considering that the team will change coaches in multiple games, we introduce the coaching success rate of each coach in the whole season to measure the coaching level.

(2) Team chemical reaction

Team flexibility y_5**.** Practice has proved that passing is the "link" of offensive tactics. Due to the variety of passes and the high technical requirements, we introduce the number of total

passes in each game to reflect the team's flexibility.

Team offensive y_6**.** To score a goal, and the team needs to create an opportunity to attack in the frontcourt. The larger the number of passes in the frontcourt, the more opportunities for attack. Therefore, we consider the number of frontcourts passes in each game of the team to reflect the team's offensive threat ability.

Team competitive y_7**.** Duels often take place on the court to fight for the ball. When a player has control of the ball, he will use his skills, vision, and lies to cross the opponent's defender or use his physical fitness to play 1-1 with the opponent's players. Therefore, Everton players use duels to describe the team's competitiveness in each game.

Team rhythm y_8**.** Considering that players on the field can speed up the movement of dribbling and shaking, which can change the situation and adjust the rhythm of the game, we introduced the number of others on the ball in each game to measure the team rhythm.

Team structure y_9. In section 4.4, we have used the network patterns to identify the passing formation when winning or losing. Therefore, we use the team structure in each game to reflect the winning rate of the team formation.

(3) Opponent strategy

Team flexibility y_{10}**.** The flexibility of passing between the opponent and us reflects the level between the two teams. Therefore, we introduce the number of total passes of the opponent team in each game to reflect the flexibility of the opponent.

Team competitive y_{11}**.** The competition between the opponent and us for the right to the ball, or with the ball, is the competitiveness of both sides. Use the duel times of each match of the opponent team to reflect the competitiveness of the opponent.

Team rhythm y_{12}**.** As the same as the definition of our team rhythm, it introduces the number of others on the ball in each game to measure the team rhythm.

The 12 indicators form a team performance evaluation indicator system from three aspects. The schematic diagram of the CPI is as follows:

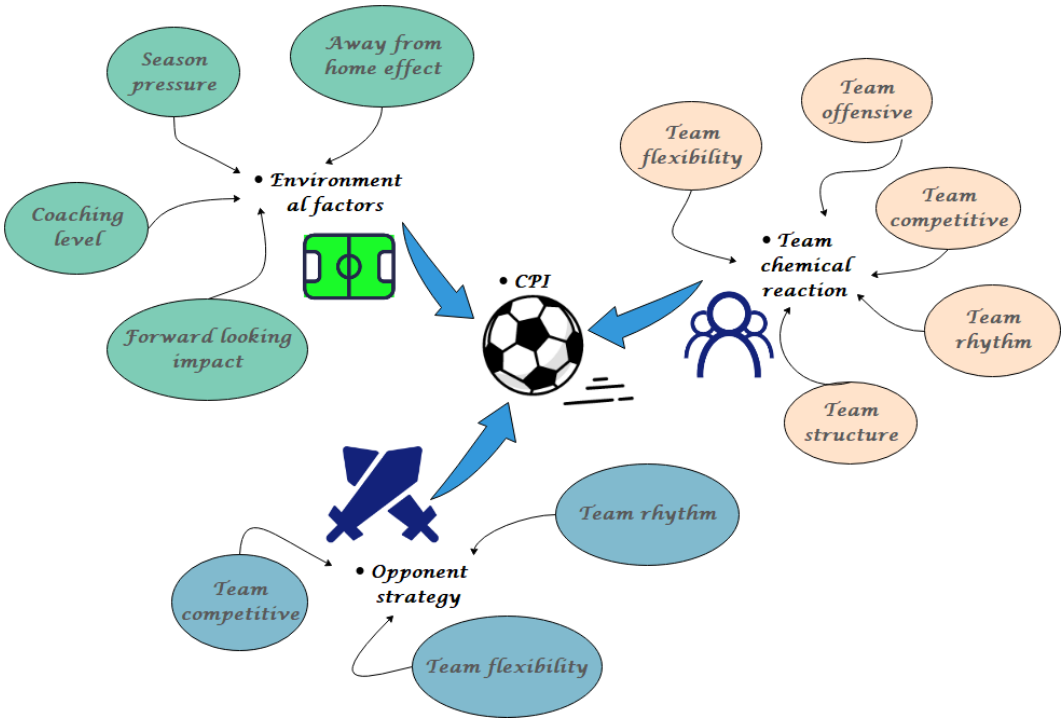


Fig.1 Cooperation Performance Indicators

2.1.2 Weight calculation

（1）Entropy weight method

On the basis of the above evaluation indexes, we further determine the weight of these 12

indexes and form the combination of the first level indexes. Combined with the entropy weight method (EWM), the weight of the first level index is calculated [11,12]. First of all, the data needs to be standardized so that the value range of all data is $[0,1]$.

Different types of indicators have different effects on CPI. Among them, the benefit index is directly proportional to CPI, and the cost index is inversely proportional to CPI. So, we got:

$$\text{Cost value: } x_{ij} = \frac{y_{ij} - \min(y_i)}{\max(y_i) - \min(y_i)} \qquad j = 1, 2, \text{K}\ , n$$

$$\text{Benefit value: } x'_{ij} = \frac{-\min(y_i) - y_{ij}}{\max(y_i) - \min(y_i)} \qquad j = 1, 2, \text{K}\ , n$$

Where x_{ij} is the standard value in the evaluation index.

After the standardization of indicators, we will use EWM to calculate the standardized matrix. x_{ij} and y_{ij} can be used to describe the cooperative performance coefficient of a team. The formula is as follows

$$p_j = x_{ij} \Big/ \sum_{j=1}^{n} x_{ij}$$

Then, describe the information entropy E_i of a team's cooperation performance indicators, and the formula is as follows:

$$E_i = -\ln(n)^{-1} \sum_{j=1}^{n} p_{ij} \ln(p_{ij})$$

On the basis of E_i, calculate the weight of each index defined previously w_i .

$$w_i = \frac{1 - E_i}{k - \sum_i E_i} \qquad i = 1, 2, \text{L}\ , k$$

Then, we get three comprehensive evaluation indexes: environmental impact, team chemical reaction, and opponent strategy. The following will be abbreviated as EFI , TRI , OSI . The weights of these indicators will be calculated according to CVM as follows:

$$\begin{cases} EFI = w_1 x_{1j} + w_2 x_{2j} + w_3 x_{3j} + w_4 x_{4j} \\ TRI = w_5 x_{5j} + w_6 x_{6j} + w_7 x_{7j} + w_8 x_{8j} + w_9 x_{9j} \\ OSI = w_{10} x_{10j} + w_{11} x_{11j} + w_{12} y_{12j} \end{cases}$$

（2）Coefficient of variation method

After 12 indicators are expressed as 3 comprehensive variables, the three coefficients of the first-level indicators need to be weighted by applying the coefficient of variation method, and further aggregated into an indicator that comprehensively measures the performance of successful cooperation. Directly evaluate the effectiveness of team cooperation, and lay the foundation for a reasonable and valid assessment of team cooperation performance and a general performance pattern.

The equation for each indicator can be expressed as:

$$A_i = \frac{\theta_i}{Z_i} \qquad i = 1, 2, 3$$

A_i is the coefficient of variation of an index i ,which we usually call the marked deviation coefficient, θ_i is the standard deviation of index i , Z_i is EFI , TRI and OSI .we can calculate the weight of three comprehensive indicators:

$$W_i = \frac{A_i}{\sum_{i=1}^{n} A_i} \qquad i = 1, 2, 3$$

In conclusion, we can calculate the weight of each index without any subjective factors. Then, on the basis of these calculated weights, we can derive the comprehensive evaluation index CPI based on the successful cooperation performance indicators.

$$CPI = \left(W_1 \times EFI + W_2 \times TRI + W_3 \times OSI\right) \times 100$$

2.2 Cooperative performance evaluation

Although CPI has been defined to indicate the degree of cooperation success, we need to give the specific relationship between the CPI and the performance to analyze the team cooperation reasons that cause the performance gap. Using Euclidean distance to measure similarity[13], the status of cooperation performance is divided into four categories: very successful, relatively successful, unsuccessful and very failed. As shown in Fig. 2, we give different colors to different levels of cooperation performance.

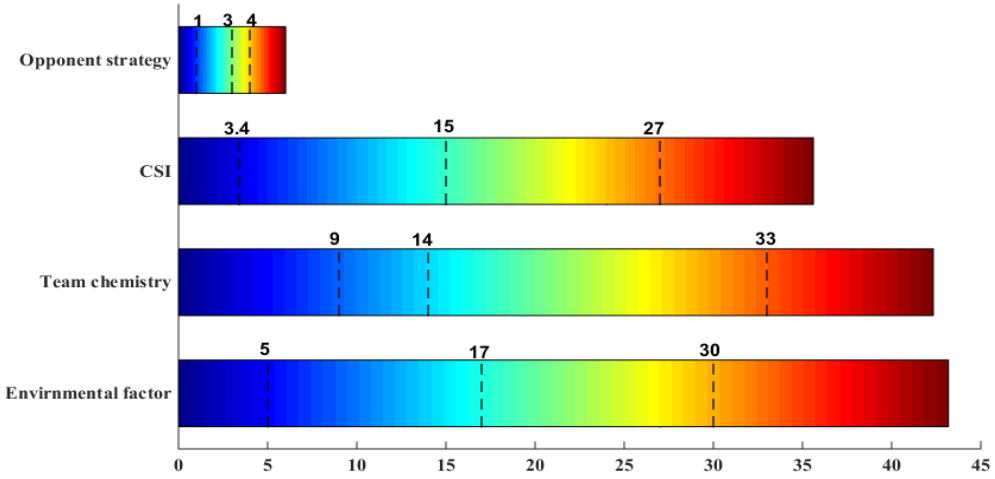


Fig.2 The classification criteria of different cooperation performance indicators are divided into four categories: Very Successful, Successful, Unsuccessful and Failure

The above Figure shows the clustering results of CPI, TRI, OSI, and EFI. When the CPI of a game is higher than 27, it can be judged that the cooperation is very successful. When the CPI of a game is lower than 15, it is basically considered that the cooperation is not very successful. At the same time, by observing the three indicators that affect CPI, we can analyze whether the team cooperation is not successful because of the negative impact of environmental factors or the low flexibility of passing.

3. A case study of the Everton team in 2017-2018

Everton Football Club is a football club located in Liverpool [14], Merseyside, northwest England, which was founded in 1878. The club has won nine top league titles in England, five FA Cups and one European Cup Winners' Cup, and is now playing in the English Premier League. We select the relevant data of the Premiership Everton team in the 2017-2018 season, and use the performance evaluation model of the third section to calculate the weight of each index of the team. Then we analyze the team partnership performance from the performance of the whole season and the representative number of games.

3.1 The solution of the weight of each index

Using the MATLAB software, we calculate the CPI of the selected project. Among three comprehensive indicators, it ranked first in our final standard with a weight of 0.58. And we get the results that the internal cooperation of the team has a significant impact on the performance, which accounts for nearly 58% of the impact. On the other hand, the team structure and away factors have a higher weight, and the remaining indicators have a smaller gap. The proportion of each weight is intuitively reflected in the follow-

ing figure.

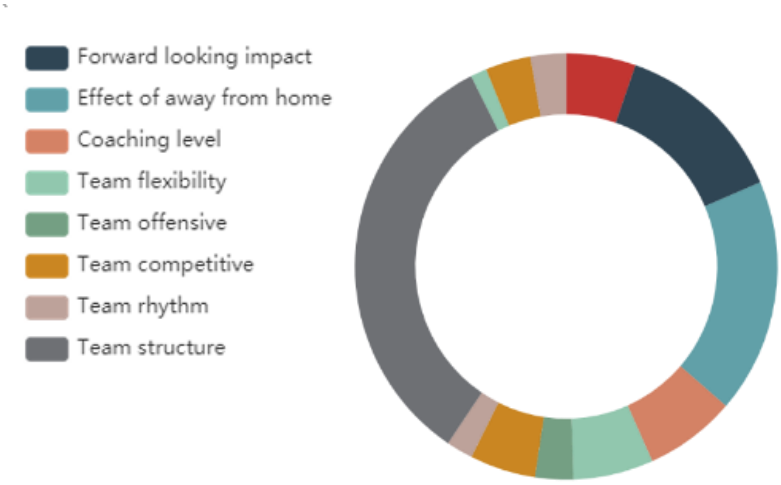


Fig.3 Size of influencing factors

3.2 changes in indicators throughout the season

Based on the cooperative performance model, we visualize the changes in the scores of the Everton team's three major indicators throughout the season, as shown in the figure.

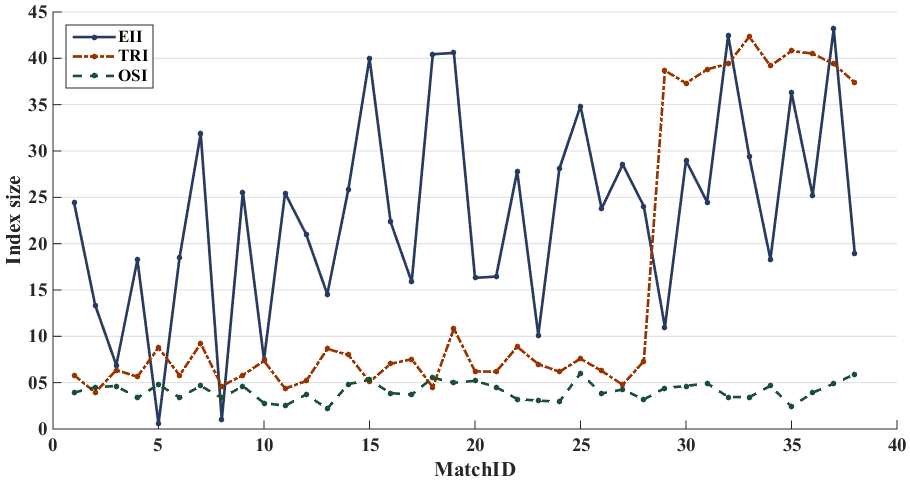


Fig.4 The changing trend of three major factors

Combined with the proportion of evaluation model index and the changing trend of three Indicator II in 40 games of EVERTON team, the analysis shows that:

- EVERTON teams scored "unsuccessful" TRI scores in most games. According to figure 4, the largest proportion is team structure and team flexibility. Based on the results of the evaluation, we speculate that the team's passing skills and other skills in the season are not good enough, and they played better in the second half of the game. This is also consistent with the score and the result of the game.
- There are many ups and downs in EFI scores, so the team is easily affected by the away effect. For example, in-game 25, although they won the game, the performance of teamwork was lower than 15. This shows that the away-field effect will cause non-technical interference to a large extent. It is suggested that aiming at the away competition environment, we should pay attention to the athletes' systematic psychological training

and reduce the negative influence of the away competition environment.

3.3 Evaluation and analysis of representative games

We select the representative evaluation result of the 20th-30th session to analyze the team cooperation performance. The figure below shows the CPI grade of each game.

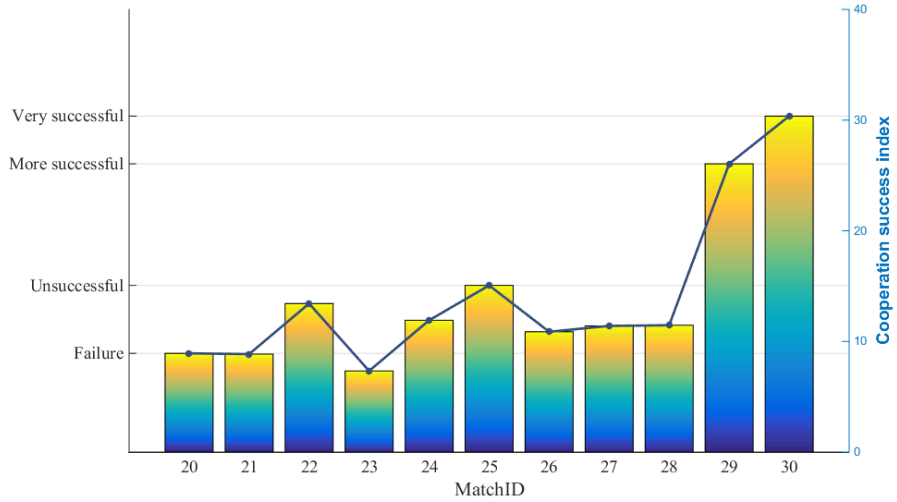


Fig.5 Last season's Everton 20-30 competition cooperation performance evaluation

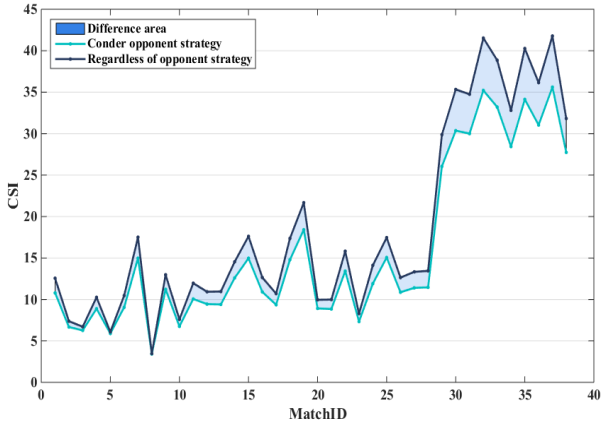
1）It can be seen from the Fig.5 that the CPI of the game 30 is in the "very successful" range, in which the value of tri is 37.31, the EFI is 28.96, and the OSI is 4.64. Each index is in the "very successful" range of the corresponding index.

2）In the game 25, from the result of the game, they won the game with the result of 2:1, but it was not successful to use CPI to evaluate the result. Although it has an EFI of 34.85, it is the highest score in the ten games. However, its tri bottom is 7.59, which is in "failure." Even if there is home advantage, with two goals to win the game, but the team's passing performance is not good, this game team performance is evaluated as unsuccessful.

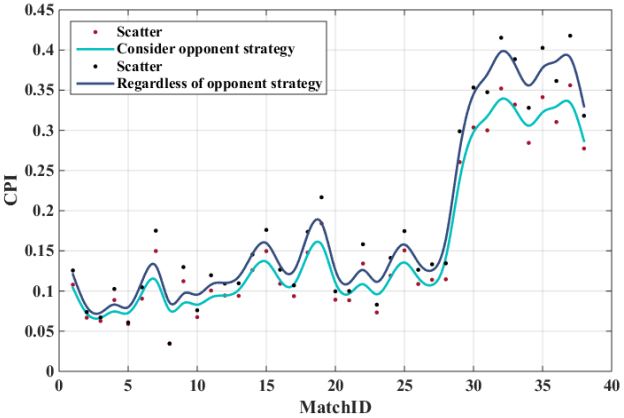
3) The Everton team has an average CPI of 15.9 this season, and the overall score has just passed within the range of success. Analysis of the reasons for most of the failed games is often due to the environmental factors of the team, the lack of advantage in cooperation within the team and the strong ability of the opponent, resulting in low CPI scores. It seems that the football team needs to stand out in all aspects in order to win in the real sense.

3.4 Impact of opponent strategy

In order to explore the influence of the opponent's strategy on the team's cooperation performance, we removed the opponent's strategy indicators in Section 3.1. Finally, the paper compares the CPI with and without considering the opponent strategy index.



（a）CPI variation of difference



（b）CPI trend change

Fig.6 Analyzing the influence of an opponent's strategy

(1) In the early stage of the game, the opponent's strategy has little influence on our play. But in the later stage, the influence may be intensified because the opponent's understanding of our tactical arrangement is gradually deepened. The shadow area in Fig.6(a) shows the degree of influence. In 1-10 games, the shadow area is small, while in 11-27 games, the shadow area is gradually getting larger, which shows that with the deepening of the season, adjusting strategies for opponents' strategies will increase the cooperation success index of the Huskies team.

(2) The CPI among the players showed an overall rising state in the fluctuation, and gradually increased with the fluctuation of the season. The reason may be that in the whole process of the season, the players have improved their personal status and cooperation with other members, abstracting the game status with their opponents into a form of obstruction, which in a sense improves the competitive status of the players on both sides.

4. Sensitivity analysis

In real life, the statistics are often inaccurate or missing some players' data. There may be some deviations in the input of our patterns. These deviations may affect the results of our patterns. In order to test the robustness of the patterns, in this part, we use the method of reducing some evaluation indexes to evaluate its stability and calculate the change degree of CPI trend.

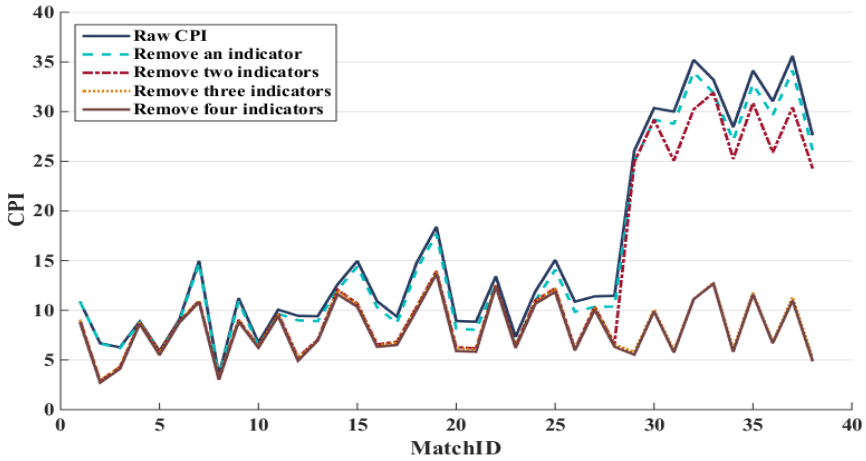


Fig.7 Sensitivity analysis

When some indicators are reduced, we find that there is a small difference in the impact on the patterns results, which indicates that the patterns have strong stability. However, when further reducing more indicator characteristics, such changes to the results will show a clear distinction. This phenomenon shows that we have some essential index characteristics in the patterns, which is attributed to the reality level. For the team, when some key behaviors or theoretical guidance are lacking, the quality of the game will be seriously reduced.

5. Conclusion

To sum up, we have established a football team performance evaluation model, and take Everton team as an example to apply the model. CPI scores are used to evaluate the team's cooperative performance. In addition, the influence of opponent strategy on the model is analyzed, and it is found that the influence of opponent strategy becomes stronger at the end of the season. Using the model to evaluate the 2017-2018 season competition of Everton team, and analyzing the cooperation results of the team, it is found that most of the failed games are due to the away effect of the team, the non-dominance of intra-team cooperation and the strong ability of opponents, which leads to low CPI scores. The far-field effect will cause non-technical interference to a great extent. This football team

performance model can be extended to the performance evaluation of other football teams in order to improve teamwork.

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