



# Influence of the viewers on the performance results of sports teams

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## Abstract

**Objective of the study** was a theoretical substantiation and description of the calculation of the rating using numerical methods in team sports.

**Methods and structure of the study.** The formation of rating classifications in team sports was carried out using mathematical modeling using high-level programming languages and numerical calculation methods. The requirements that must be met by the general targets, guidelines that form the rating of teams are determined: taking into account the results of previous performances, the factor of influence of one's field, the number of spectators at the stadium, the potential of teams. The mathematical model was evaluated by the indicator of the convergence of the current rating of the teams participating in the match with the actual result of the game. The analysis of the results of the performance of teams in the matches of the championships of Russia in 1992-2022 was carried out.

**Results and conclusions.** Three variants of calculation were performed: 1) calculation of a unified system of equations, taking into account the factor of influence of one's own field; 2) calculation with the calculation of the index of the coefficient of influence of spectators on the results of games; 3) calculation of the coefficients of influence of the home field factor and spectators on the results of the games. The system of linear equations has a unique solution if the results of the teams' performance do not have zero uncertainty during the entire period of the competition. The developed rating system is aimed at numerical confirmation of the level of readiness and potential of teams, the accuracy of predicting the performance of teams in the short and long term in all team sports.

**Keywords:** *rating, system, viewers, classification, modeling, numerical method.*

**Introduction.** The relevance of the research topic is that the athletes' performance is never been realized without the attention of the audience, who directly affect the results of the teams' performance by their behavior and reaction. The spectators are the ones who create a positive or negative mood for the athletes, stimulate, activate and motivate their efforts to achieve results in the competition. Consequently, competition conditions, the internal and the external environmental factors have a direct impact on team's success.

A.A. Polozov together with other Russian scientists S.V. Mikhryakov, E.S. Naboychenko, E.M. Bozhko, E.A. Suvorova, A.V. Melnikova and A.V. Korelin have devoted research works to the improvement of the rat-

ing calculation methods in sports [1]. Foreign authors are also engaged in improving the methods of the rating evaluation [7].

The impact of fans' benevolent or negative mood on the success and results of a sports team has not been well studied. The practical examples of the spectators' influence on the results of teams' performances are considered. The introduction of the rating is essential for further development, an analysis and prediction of the performance results in team sports.

**Objective of the study** was a theoretical foundation and description of the rating calculation with the use of numerical methods in team sports. For the first time the notion of mathematical model correspondence to real results, tending to the maximum, is in-



roduced, as well as the calculation of impact factor indices: one's own field and spectators on the result of the game. The following parameter is suggested as an indicator of the degree of compliance for the mathematical model: the percentage of matches with the converged result based on the results of the rating evaluation for two teams with the actually obtained result of match to a total number of matches with the identified winner.

**Methods and structure of the study.** The methodology for determining the teams' rating, based on the factor of own field, which was used in the first variant of calculation, is presented in the works [3, 4].

In the second calculation variant, let us determine the teams' ratings only including the factor of the spectators' impact on the result of the game.

The value of the spectators' factor influence index is calculated by the following formula

$$k_s = 1 + v_s \cdot S, \quad 1$$

where  $S$  – is a number of matches with the home field advantage of one of the teams;  $v_s$  – is a value of one spectator's impact on the result of the game.

In the third variant of calculation, we will determine the teams' ratings, including the impact of the factor: own stadium and spectators on the result of game. The necessity of the calculation for given variant is obvious - the result of match is affected not only by a number of spectators, but also by the psychological factor of being at own stadium during the game.

Considering the spectators factor (1), a total number of goals scored and conceded will be:

$$F_i = \sum_{j=1}^n (G_j^f \cdot \sqrt{R_j} \cdot \sqrt{k_v} \cdot \sqrt{k_s}); \quad A_i = \sum_{j=1}^n ((G_j^a / \sqrt{R_j}) / (\sqrt{k_v} \cdot \sqrt{k_s})). \quad 2$$

where  $i$  – is a number of teams, calculated in the system;  $F_i, A_i$  – is a total given number of goals scored

and conceded by  $i$ -th team, correspondingly;  $G_j^f, G_j^a$  – is a number of goals scored and conceded by  $i$  – th team in  $j$  – th game, correspondingly;  $R_j$  – is the opposing team rating in  $j$ -th game;  $k_v$  – is an index of the impact factor of the game on home field.

**Results of the study and their discussion.** For the analysis, we choose the results of 7492 matches, played by the teams in the championships of Russia 1992-2022, with the period from April 29, 1992 to April 3, 2022.

After calculating a system of the equations for the first variant, we summarize the obtained results in Table 1, using the following notations: PM – is a number of the outcomes, which matched the result of the opponents' rating assessment, RM – is a number of matches with the identified winner.

The sixth line shows the results of calculating for one's own field factor, obtained using the formula described in [5]. All other results were obtained using the assigned own field factor, which were changed in the increments of 0.1.

The results show that the maximum convergence of the model was 70.414%, when calculating the factor of own field according to the proposed formula.

After calculating a system of the equations for the second variant, using the spectators' impact index on the game results, we obtain the following results (Table 2).

The results show that with the value = 0.370 per 10000 spectators the degree of model consistency was a maximum and it is equal to 70.725. The factor of the spectators impact on the results of matches is  $k_s = 1.37$  per 10,000 spectators. So, if we ignore a fact of the impact of the stadium on the result of the game and we assume that only a number of spectators affects, it turns out that if the team gathers on home field

**Table 1.** The degree of model consistency with different values of the indicators for own field factor

$K_v$	$\sum_{i=1}^n (G_{1i} / \sqrt{R_1/R_2})$	$\sum_{i=1}^n (G_{2i} \cdot \sqrt{R_1/R_2})$	PM	RM	Degree of model consistency, %
1,000			3615	5479	65,979
1,100			3733	5479	68,133
1,200			3809	5479	69,520
1,300			3844	5479	70,159
1,400			3854	5479	70,341
<b>1,430</b>	10533,59	7366,49	3858	5479	<b>70,414</b>
1,500			3860	5479	70,451
1,600			3854	5479	70,341
1,700			3824	5479	69,794
1,800			3794	5479	69,246
1,900			3767	5479	68,753
2,000			3738	5479	68,224



**Table 2.** The degree of model consistency with different indicators of the value for spectators' impact on the result of the game

$V_s$ for 10,000 spectators	PM	RM	Degree of model consistency, %
0,100	3732	5479	68,115
0,200	3803	5479	69,410
0,300	3866	5479	70,560
0,350	3867	5479	70,579
0,365	3872	5479	70,670
<b>0,370</b>	3875	5479	<b>70,725</b>
0,375	3870	5479	70,633
0,385	3868	5479	70,597
0,400	3867	5479	70,579
0,450	3858	5479	70,414
0,500	3850	5479	70,268
0,600	3826	5479	69,830
0,700	3815	5479	69,629
0,800	3804	5479	69,429
0,900	3781	5479	69,009
1,000	3752	5479	68,480
1,500	3684	5479	67,239
2,000	3635	5479	66,344

**Table 3.** The degree of model consistency with the indicators of home field factor and the value of the spectators' impact on the result of the game

$V_s$ for 10,000 spectators	$K_v$	$\sum_{i=1}^n (G_{1i} / \sqrt{R_1/R_2})$	$\sum_{i=1}^n (G_{2i} \cdot \sqrt{R_1/R_2})$	PM	RM	Degree of model consistency, %
0,100	1,290	10002,98	7754,90	3869	5479	70,615
0,200	1,179	9568,27	8116,24	3879	5479	70,798
0,210	1,169	9528,78	8151,13	3882	5479	70,852
<b>0,2125</b>	<b>1,167</b>	9519,01	8159,83	3883	5479	<b>70,871</b>
0,220	1,159	9489,92	8185,82	3879	5479	70,798
0,250	1,131	9376,92	8288,71	3874	5479	70,706
0,300	1,088	9199,51	8456,44	3863	5479	70,506
0,400	1,011	8879,47	8779,36	3867	5479	70,579
0,500	0,946	8597,11	9087,71	3851	5479	70,287
0,600	0,889	8344,84	9383,53	3838	5479	70,049
0,700	0,840	8117,18	9668,39	3838	5479	70,049
0,800	0,795	7910,02	9943,52	3826	5479	69,830
0,900	0,756	7720,23	10209,95	3820	5479	69,721
1,000	0,721	7545,31	10468,52	3825	5479	69,812

of 10000 spectators, the chances of winning increases by 1.37 times.

In the third variant of the calculation, we obtained the results of the application for the factor impact coefficients: own field and spectators (tab. 3).

As we can see from the obtained, results with the value  $v_s = 0,2125$  per 10000 spectators and  $k_v = 1.167$ , as the degree of model consistency was the maximum and it is equal to 70.871. The factor of the spectators

impact on the results of the matches is  $k_s = 1.2125$  per 10000 spectators. It means that together with the factor of the stadium's impact on the result of the game, that increases the chance of winning in 1.167 times, the impact of a number of spectators increases the chance of winning in 1.2125 times, if the team gathers on home field 10000 spectators.

**Conclusion.** The obtained data indicate the compliance of the proposed mathematical model and a



possibility of the rating application for the evaluation of team performance and chances for success in the future tournaments in team sports.

A conclusion can be made that the influence of spectators on the results of teams' performance, as well as the choice of the venue of sports competitions are highly significant. Both factors have a direct impact on the motivation for the athletes, their level of the energy and activity, as well as psychological disposition for winning the competition, success and leadership. We believe that it is required to provide an integrated approach to the problem's solution for the psychological and pedagogical preparation of the athletes, both on the part of specialists-psychologists and on the part of coaches.

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