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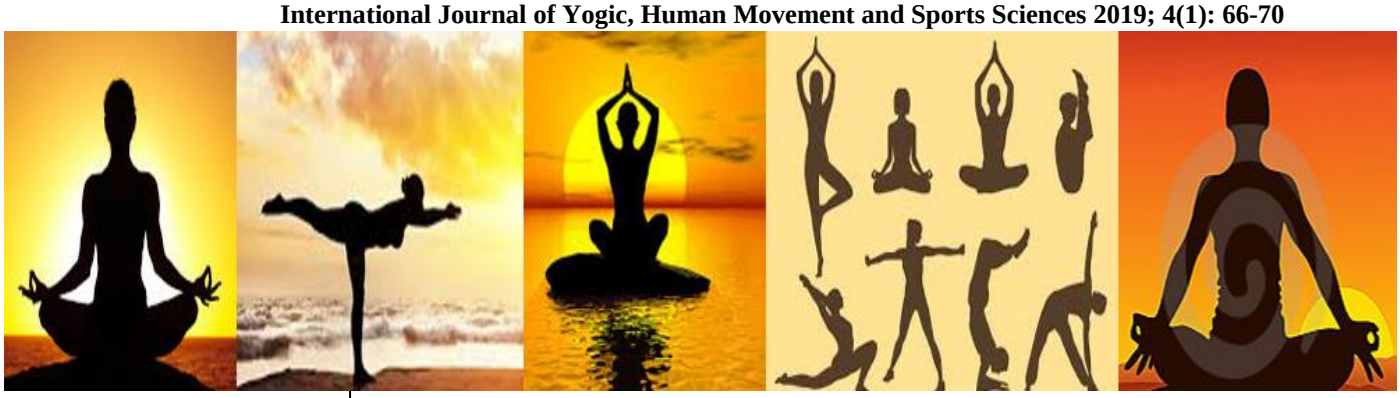

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Zahoor ul Haq Bhat
Research Scholar, Department of Physical Education, Pondicherry University, Pondicherry, India

Dr. DD Sultana
Professor, Department of Physical Education, Pondicherry University, Pondicherry, India

Correspondence
Zahoor ul Haq Bhat
Research Scholar, Department of Physical Education, Pondicherry University, Pondicherry, India

Assessing the offensive and defensive efficiency of English premier league teams by data envelopment analysis

Zahoor ul Haq Bhat and Dr. DD Sultana

Abstract
In this paper we use a linear programming based Data Envelopment Analysis (DEA) methodology to evaluate the offensive and defensive efficiency of football teams in English Premier League (EPL) over a period of five years from 2012 to 2016. There is high level of inefficiency in EPL in the analyzed seasons. Many clubs could be efficient in one season but stop being efficient in other seasons. As a result the teams have many problems maintaining their efficiency during the seasons. It can be concluded from the analysis that offence is more dominating than defense in EPL. Moreover, to avoid being relegated defense should be more a priority for the teams. The study can help coaches, trainers and managers assess their team's performance and plan accordingly in future.

Keywords: Data envelopment analysis, offence, defense, efficiency

Introduction
The English Premier League (EPL) commonly referred as Premier league is the most watched sports league in the world, broadcast in 212 territories to 643 million homes and a potential TV audience of 4.7 billion people. In the 2017-18 season, the average Premier League match attendance exceeded 38,000. There are 20 clubs in the Premier League. During the course of a season each club plays the others twice, once at their home stadium and once at that of their opponents, for 38 games. Teams receive three points for a win, one point for a draw and no points are awarded for a loss. Teams are ranked by total points, then goal difference, and then goals scored. If still equal, teams are deemed to occupy the same position. If there is a tie for the championship, for relegation, or for qualification to other competitions, a play-off match at a neutral venue decides rank.

Each football match is a sports clash between two teams of 11 regular players and three substitutes, directed by a manager and the coach whose purpose is to convert the player's talent into the team's success. One among the 11 regular players is a goalkeeper whose defensive role is to prevent the opposing team from scoring a goal. The other ten players include backers, midfielders and forwards to develop defensive and offensive strategies. The three substitutes can be used either to replace injured players or to modify the match strategy. Therefore, it can be said that football teams produce identical outputs, use the same units of input abilities, compete under identical rules and share the same technology (García-Sánchez, 2007, p. 23) [7].

The objective of this work is to evaluate the attacking and defensive efficiency of Premier league football teams between the years 2012 and 2016 (which have at their disposal a certain level of abilities or skills) using the tool Data Envelopment analysis (DEA). Efficiency can be understood as behavior or performance that generates the maximum output for a given amount of resources. The primary focus of each team is to score goals by offense and to prevent the other team from scoring by defensive action.

Therefore, we can talk about estimating the efficiency of the offense which means the relationship of the player's attack skills and the number of goals scored. The efficiency of the defense means the relationship of the player's abilities to defend and the inverse of the goals received, as a factor to minimize.

Review of related literature

The efficiency of football clubs and players has been much scrutinized by a number of authors employing both parametric and nonparametric techniques. Among the papers which used the nonparametric approach, which are of special interest for the present paper, we mention Villa and Lozano (2016) [9], who applied DEA tool to measure the scoring efficiency of football teams in Spanish First Division teams. Bosca *et al*. (2009) [3] analyzed the offensive and defensive efficiency of Italian and Spanish football leagues by using DEA optimization method. Espitia and Garcia (2010) calculated the efficiency of football teams in Champions League adopting traditional DEA method as well as super efficiency model. Extending the analysis of efficiency in football Ramon *et al*. (2009) evaluated attacking and defensive efficiency in Spanish football league using DEA model. Barros and Santos (2004) [2] analyzed the Portuguese football first division clubs with a DEA-CCR and BCC model. Haas (2003) [6] used the Data Envelopment Analysis for assessing technical efficiency in the twelve US Major League Soccer.

Data

The data used in this article has been taken from the official website of English Premier League (https://www.premierleague.com/stats). We have chosen four offensive and defensive inputs and one offensive and defensive output.

Offensive inputs

- **Shot on target (ST):** is any shot attempt that would or does enter the goal if left unblocked.
- **Headed goals (HG):** the shot that occurs when a player touches and guides the ball with his head in the opponents goal post.
- **Penalties scored (PS):** a free kick at the goal from a point (penalty spot) within the penalty area and 12 yards from the goal, with only the goalkeeper allowed to defend it.
- **Crosses (CR):** a cross is a medium- to-long-range pass from a wide area of the field towards the centre of the field near the opponent's goal.

Offensive output

- **Goals for (GF):** it is the number of goals scored by a team.

Defensive inputs

- **Blocks (BL):** what the defensive team does to prevent an offensive player from getting the ball.
- **Interceptions (IN):** a pass that is caught by a football player on the defense instead of the intended receiver.
- **Tackle (TA):** a play where a player attempts to take control over the ball from an opponent.
- **Clearances (CL):** when a player kicks or hits the ball away from the goal of his or her own team.

Defensive output

- **Clean sheets (CS):** When a team does not allow their opponent team to score in the match then the team has kept a clean sheet e.g. if Chelsea beat Arsenal 1-0, Chelsea kept a clean sheet or if Chelsea drew with Arsenal 0-0, both teams kept a clean sheet.

With respect to the attacking inputs, the four chosen measures approach the effort and the abilities a team has employed in offensive tasks. Hence, possibly these four variables capture reasonably well the amount of offensive inputs employed by each team. With respect to the offensive and defending inputs/output, the idea is similar. Table 1 and 2 show simple statistics for offensive and defensive inputs and outputs for the English Premier League in the five considered seasons.

Table 1: Descriptive statistics of the offensive variables used

Season	DS	Inputs				Output
		ST	HG	PS	CR	GF
2012-13	Max	241	16	9	1014	86
	Min	114	2	0	676	30
	Average	175.45	9.25	3.4	860.85	53.15
	SD	37.73	3.58	2.18	100.45	14.75
2013-14	Max	258	14	10	1000	102
	Min	122	2	1	643	28
	Average	170.25	8	3.65	812.55	52.6
	SD	40.23	2.7	2.18	88.22	20.61
2014i-15	Max	229	16	7	968	83
	Min	125	3	1	634	28
	Average	159.55	9	3.15	794	48.75
	SD	32.88	3.43	1.75	102.37	14.76
2015-16	Max	252	15	10	969	71
	Min	107	2	1	589	27
	Average	161.75	9	3.7	780.8	51.3
	SD	36.98	3.9	2.07	86.35	13.16
2016-17	Max	257	17	7	947	86
	Min	100	1	1	616	27
	Average	164.4	9.4	4.05	753.25	53.25
	SD	44.13	4.39	1.84	85.55	18.53

Table 2: Descriptive statistics of the defensive variables used

Season	DS	Inputs				Output
		BL	IN	TA	CL	CS
2012-13	Max	178	779	819	1595	18
	Min	177	377	602	873	5
	Average	138.55	591.1	727	1227.65	10
	SD	29.33	115.04	51.79	222.85	3.74
2013-14	Max	199	695	848	1409	18
	Min	61	380	619	903	7
	Average	126.65	522.5	729.6	1163.15	11.6
	SD	37.02	83.73	60.02	153.77	3.6
2014-15	Max	180	762	824	1474	17
	Min	94	376	615	872	6
	Average	135	581.7	736.2	1156.5	11.2
	SD	29.6	102.76	67.85	177.03	3.01
2015-16	Max	176	819	871	1277	18
	Min	66	473	608	755	5
	Average	133.2	645.65	736.45	975.55	10.75
	SD	28.82	93.98	71.62	129.27	3.72
2016-17	Max	221	614	727	1233	17
	Min	65	314	574	838	5
	Average	130.85	510.35	656.45	1023.7	10.7
	SD	39.74	66.44	41.09	106.91	3.61

Data Envelopment Analysis

DEA is a nonparametric linear programming technique that computes a comparative ration of outputs to inputs for each unit (known as decision making unit), which is reported as the relative efficiency score. The efficiency score is usually expressed as either a number between 0 and 1. A unit with a score less than one is deemed inefficient compared to other units. The analysis of efficiency uses the following DEA models:

CCR model

The mathematical formulation of DEA with the assumption of CRS was given by Charnes, Cooper, & Rhodes (1978) [4].

$$\theta^* = Minimise\, \theta_k$$

$$Sub\ \ to$$

$$\sum_{j=1}^{n} y_{rj}\lambda_j - s_r^+ = y_{rk};\ r = 1,2,3,\ldots,s$$

$$\sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = \theta_k x_{ik};\ i = 1,2,3,\ldots,m$$

$$s_r^+ \geq 0,\ s_i^- \geq 0,\ \ and\ \ \lambda_j \geq 0;\ j = 1,2,3,\ldots,n.$$

Where s_r^+ and s_i^- are input and output slacks. The DMU_k is said to be efficient if and only if $\theta^* = 1$ and all slacks must be zero i.e. $s_r^+ = 0$, $s_i^- = 0$. If $\theta^* = 1$, but all slacks are not zero. Then DMU under evaluation is week efficient, and if $\theta^* < 1$, then the DMU_k under evaluation is inefficient.

BCC model

Banker, Charnes, & Cooper (1984) [1] extended the CCR model in variable returns to scale process is well known as BCC model. The mathematical formulation is given as:

$$\theta^* = Minimise\, \theta_k$$

$$s/t$$

$$\sum_{i=1}^{n} y_{rj}\lambda_j - s_r^+ = y_{rk}\ ;\ r = 1,2,3,\ldots,s$$

$$-\sum_{j=1}^{n} x_{ij}\lambda_j + s_i^+ = -\theta_k x_{ik}\ ;\ i = 1,2,3,\ldots,m.$$

$$\sum_{j=1}^{n} \lambda_j = 1;\ j = 1,,2\ ,3,\ldots,n$$

$$\lambda_j \geq 0\ and\ \ s_r^+ \geq 0\ ,\ s_i^- \geq 0.$$

Where s_r^+ and s_i^- are input and output slacks. θ_k is the efficiency score of k^{th} DMU and lie between 0 and 1.

The primary difference between CCR and BCC model is the treatment of returns to scale. The CCR bases the evaluation on constant returns to scale while BCC model allows variable returns to scale and measures only pure technical efficiency for each DMU. That is, for a DMU to be considered as CCR efficient, it must be both scale and pure technically efficient.

Results

The offensive and defensive efficiency scores of the pooled data is indicated season wise in Tables 3, 4, 5, 6 and 7. DEA frontier 4.1 version software was used to determine the efficiency of the teams. First technical efficiency results are shown. Technical efficiency (TE) relates to the productivity of inputs. The technical efficiency of a team is a comparative measure of how well it actually processes inputs to achieve its outputs. Second pure technical efficiency (PTE) results are expressed. It is a measure of technical efficiency without scale efficiency and purely reflects the managerial performance to organize the inputs in the production process. Thus, PTE measure is used as an index to capture managerial performance. Finally, the results considering scale efficiency (SE) are shown. The ratio of TE to PTE provides SE measure. The measure of SE provides the ability of the management to choose the optimum size of the football team. The operating size of the football club reflects the composition of the team whose quality is generally related to the budget available.

Table 3: 2012-13 season

DMU	Offensive efficiency			Defensive efficiency			Position in league
	TE	PTE	SE	TE	PTE	SE	
Arsenal	0.94	0.95	0.99	0.95	1.00	0.95	Q
Aston Villa	0.91	1.00	0.91	0.29	0.83	0.35	
Chelsea	0.97	0.99	0.98	1.00	1.00	1.00	Q
Everton	0.77	0.81	0.95	0.58	0.84	0.70	
Fulham	0.79	0.94	0.84	0.56	1.00	0.56	
Liverpool	1.00	1.00	1.00	0.94	1.00	0.94	
Manchester City	1.00	1.00	1.00	1.00	1.00	1.00	Q
Manchester United	1.00	1.00	1.00	0.84	1.00	0.84	C
Newcastle United	0.77	0.82	0.94	0.37	0.94	0.40	
Norwich City	0.93	1.00	0.93	0.53	0.82	0.65	
Queens Park Rangers	0.71	1.00	0.71	0.46	1.00	0.46	R
Reading	0.83	1.00	0.83	0.30	0.93	0.33	R
Southampton	0.79	0.88	0.89	0.44	0.98	0.45	
Stoke City	0.74	1.00	0.74	0.78	1.00	0.78	
Sunderland	1.00	1.00	1.00	0.81	1.00	0.81	
Swansea City	1.00	1.00	1.00	0.63	0.91	0.69	Q
Tottenham Hotspur	1.00	1.00	1.00	0.64	1.00	0.64	Q
West Bromwich Albion	0.77	0.92	0.84	0.49	0.90	0.55	
West Ham United	0.74	0.86	0.86	0.70	0.97	0.73	
Wigan Athletic	0.86	0.93	0.93	0.36	1.00	0.36	R

Table 4: 2013-14 season

DMU	Offensive efficiency			Defensive efficiency			Position in league
	TE	PTE	SE	TE	PTE	SE	
Arsenal	1.00	1.00	1.00	0.97	1.00	0.97	Q
Aston Villa	0.89	1.00	0.89	0.52	0.95	0.55	
Cardiff City	1.00	1.00	1.00	0.46	1.00	0.46	R
Chelsea	0.97	0.99	0.98	1.00	1.00	1.00	Q
Crystal Palace	0.54	1.00	0.54	0.58	0.82	0.71	
Everton	1.00	1.00	1.00	0.85	0.96	0.88	Q
Fulham	0.89	1.00	0.89	0.29	0.92	0.32	R
Hull City	0.87	0.97	0.90	0.59	0.95	0.62	Q
Liverpool	1.00	1.00	1.00	0.48	0.85	0.57	Q
Manchester City	1.00	1.00	1.00	1.00	1.00	1.00	C
Manchester United	0.82	0.91	0.89	0.78	1.00	0.78	
Newcastle United	0.92	0.97	0.95	0.57	0.96	0.59	
Norwich City	0.98	1.00	0.98	0.72	1.00	0.72	R
Southampton	0.87	0.91	0.96	0.88	0.94	0.93	
Stoke City	1.00	1.00	1.00	0.50	0.89	0.57	
Sunderland	0.69	0.98	0.70	0.73	1.00	0.73	
Swansea City	0.79	0.94	0.84	0.48	1.00	0.48	
Tottenham Hotspur	0.75	0.86	0.87	0.86	0.98	0.87	Q
West Bromwich Albion	0.98	1.00	0.98	0.41	0.96	0.42	
West Ham United	0.99	1.00	0.99	0.88	1.00	0.88	

Table 5: 2014-15 season

DMU	Offensive efficiency			Defensive efficiency			Position in league
	TE	PTE	SE	TE	PTE	SE	
Arsenal	0.88	0.88	0.99	0.78	0.98	0.80	Q
Aston Villa	0.85	1.00	0.85	0.70	1.00	0.70	
Burnley	0.76	1.00	0.76	0.71	1.00	0.71	R
Chelsea	1.00	1.00	1.00	1.00	1.00	1.00	C
Crystal Palace	0.93	1.00	0.93	0.39	0.84	0.46	
Everton	0.82	0.92	0.88	0.67	1.00	0.67	
Hull City	0.86	1.00	0.86	0.57	0.84	0.69	R
Leicester City	0.96	1.00	0.96	0.55	0.86	0.64	
Liverpool	0.80	1.00	0.80	0.80	0.96	0.83	Q
Manchester City	1.00	1.00	1.00	0.95	1.00	0.95	Q
Manchester United	1.00	1.00	1.00	0.69	1.00	0.69	Q
Newcastle United	1.00	1.00	1.00	0.48	0.95	0.50	
Queens Park Rangers	0.80	0.93	0.87	0.34	0.83	0.41	R
Southampton	1.00	1.00	1.00	1.00	1.00	1.00	Q
Stoke City	1.00	1.00	1.00	0.54	0.93	0.59	
Sunderland	0.66	1.00	0.66	0.79	0.95	0.83	
Swansea City	1.00	1.00	1.00	0.89	1.00	0.89	
Tottenham Hotspur	0.99	1.00	0.99	0.52	0.89	0.58	Q
West Bromwich Albion	0.79	1.00	0.79	1.00	1.00	1.00	
West Ham United	1.00	1.00	1.00	0.61	0.96	0.63	Q

Table 6: 2015-16 season

DMU	Offensive efficiency			Defensive efficiency			Position in league
	TE	PTE	SE	TE	PTE	SE	
AFC Bournemouth	0.89	0.93	0.96	0.40	0.98	0.41	
Arsenal	1.00	1.00	1.00	1.00	1.00	1.00	Q
Aston Villa	0.71	1.00	0.71	0.34	0.96	0.35	R
Chelsea	0.99	1.00	0.99	0.57	1.00	0.57	
Crystal Palace	0.72	0.81	0.89	0.49	1.00	0.49	
Everton	0.96	0.97	1.00	0.65	1.00	0.65	
Leicester City	1.00	1.00	1.00	0.70	0.82	0.85	C
Liverpool	0.97	0.98	1.00	0.66	1.00	0.66	
Manchester City	0.98	1.00	0.98	1.00	1.00	1.00	Q
Manchester United	0.99	0.99	0.99	1.00	1.00	1.00	Q
Newcastle United	0.83	0.87	0.95	0.42	0.90	0.47	R
Norwich City	1.00	1.00	1.00	0.35	1.00	0.35	R
Southampton	1.00	1.00	1.00	0.67	0.93	0.72	Q
Stoke City	0.87	1.00	0.87	0.59	1.00	0.59	
Sunderland	1.00	1.00	1.00	0.40	0.86	0.47	
Swansea City	0.86	0.94	0.91	0.56	1.00	0.56	
Tottenham Hotspur	1.00	1.00	1.00	0.68	0.87	0.78	Q
Watford	0.80	0.93	0.85	0.57	0.91	0.63	
West Bromwich Albion	0.98	1.00	0.98	0.67	1.00	0.67	
West Ham United	1.00	1.00	1.00	0.63	0.94	0.66	Q

Table 7: 2016-17 season

DMU	Offensive efficiency			Defensive efficiency			Position in league
	TE	PTE	SE	TE	PTE	SE	
AFC Bournemouth	0.94	1.00	0.94	0.64	1.00	0.64	
Arsenal	0.92	0.96	0.95	0.81	1.00	0.81	Q
Burnley	0.85	1.00	0.85	0.61	0.93	0.65	
Chelsea	1.00	1.00	1.00	1.00	1.00	1.00	C
Crystal Palace	0.87	0.99	0.87	0.39	0.91	0.43	
Everton	0.78	0.88	0.88	0.71	0.89	0.79	Q
Hull City	0.70	1.00	0.70	0.31	0.94	0.33	R
Leicester City	0.79	0.94	0.85	0.52	0.93	0.56	
Liverpool	0.79	0.83	0.96	0.91	1.00	0.91	Q
Manchester City	0.92	0.92	0.99	0.89	1.00	0.89	Q
Manchester United	0.62	0.81	0.76	0.97	1.00	0.97	Q
Middlesbrough	0.65	1.00	0.65	0.59	0.87	0.68	R
Southampton	0.82	1.00	0.82	0.83	0.96	0.87	
Stoke City	0.72	0.94	0.77	0.64	0.95	0.68	
Sunderland	1.00	1.00	1.00	0.37	0.94	0.39	R
Swansea City	0.74	0.88	0.85	0.49	0.98	0.50	
Tottenham Hotspur	0.91	1.00	0.91	1.00	1.00	1.00	Q
Watford	0.67	0.99	0.68	0.44	0.99	0.44	
West Bromwich Albion	1.00	1.00	1.00	0.39	1.00	0.39	
West Ham United	0.82	0.96	0.85	0.68	1.00	0.68	

It can be noticed from the efficiency scores that the cause of relegation for relegated teams was weak defense. In majority of the cases they were near to the efficient frontier or had attained global efficiency in attack. For example in case of Cardiff City (2013/14 season), the team was efficient in offense but performed poorly in defense conceding more than twice the goals than scored. It indicates that the defensive strategy they adopted was not apt or their defensive players were weak.

In case of qualifying teams majority of them were either efficient in offensive or defense except Manchester City (2012/12), Southampton (2014/15) and Arsenal (2015/16). It can be said that a team efficient in both attack and defense cannot be winner always but they have used their available resources judiciously. These 3 teams attained global efficiency in attack as well as in defense indicating that their team management and combination was perfect. These teams can go ahead with the same strategy and team for the next season.

Table 8 displays the efficiency of 5 winning teams from different seasons. Apart from Manchester United and Leicester City the other three teams have defined the frontiers, that is, they were perfectly efficient in attack and defense. In the decomposition of technical efficiency rate into pure technical efficiency and scale efficiency we can detect the potential sources of inefficiency. Manchester United and Leicester City showed two types of inefficiencies i.e. technical efficiency and scale efficiency. Both the teams were pure technical efficient highlighting there was no wastage of resources but have chosen wrong tactics in defense.

Table 8: Efficiency of winning teams

Season	Champion	Offensive efficiency			Defensive efficiency		
		TE	PTE	SE	TE	PTE	SE
2012-13	Manchester United	1.00	1.00	1.00	0.84	1.00	0.84
2013-14	Manchester City	1.00	1.00	1.00	1.00	1.00	1.00
2014-15	Chelsea	1.00	1.00	1.00	1.00	1.00	1.00
2015-16	Leicester City	1.00	1.00	1.00	0.70	0.82	0.85
2016-17	Chelsea	1.00	1.00	1.00	1.00	1.00	1.00

Chelsea won the championship two times in 2014/15 and 2016/17 seasons as it achieved 100% efficiency in attack as well as in defense. Its defensive efficiency decreased in 2015/16 season conceding almost equal number of goals to that of goals scored.

Conclusion

Offensive and defensive scores hold a significant relationship with the final classification each season, as they are an indicator of overall performance of a team. It is also worth highlighting that to obtain points, there must be an almost perfect balance between attacking and defensive efficiency, although attaching efficiency proved more important in winning, while defensive efficiency should be more of a priority when it comes to teams aiming to avoid being relegated.

Inefficiency of the defense is higher than that of offence. The explanation could be found in the composition of the team or change in tactics, leading to overall technical efficiencies or pure technical inefficiencies rather than that of scale.

References

1. Banker RD, Charnes A, Cooper WW. Some models for estimating technical and scale inefficiencies in data envelopment analysis. Management science. 1984; 30(9):1078-1092.
2. Barros CP, Santos A. Les relations entre performance sportive *et al*. performance financiere: application au cas du football Portugais. Marketing and Football: Une Perspective International, 2005, 347-68.
3. Boscá JE, Liern V, Martínez A, Sala R. Increasing offensive or defensive efficiency? An analysis of Italian and Spanish football. Omega. 2009; 37(1):63-78.
4. Charnes A, Cooper WW, Rhodes E. Measuring the efficiency of decision making units. European journal of operational research. 1978; 2(6):429-444.
5. Espitia-Escuer M, García-Cebrián LI. Performance in sports teams: results and potential in the professional soccer league in Spain. Management Decision. 2006; 44(8):1020-1030.
6. Haas DJ. Technical efficiency in the major league soccer. Journal of Sports Economics. 2003; 4(3):203-215.
7. García-Sánchez IM. Efficiency and effectiveness of Spanish football teams: A three-stage-DEA approach. Central European Journal of Operations Research. 2007; 15(1):21-45.
8. Sala-Garrido R, Carrión VL, Esteve AM, Boscá JE. Analysis and evolution of efficiency in the Spanish soccer league (2000/01-2007/08). Journal of Quantitative Analysis in Sports, 2009, 5(1).
9. Villa G, Lozano S. Assessing the scoring efficiency of a football match. European Journal of Operational Research. 2016; 255(2):559-569.