Asutosh College

Estd.1916

92, S.P.Mukherjee Road, Kolkata-26

AFFILIATED TO THE UNIVERSITY OF CALCUTTA

Department of Statistics

University Reg No : 012-1111-1006-19

University Roll No :193012-21-0396

Name :Saunak Mitra

College Roll No :867

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"RANKING SYSTEM OF TOP 98 FOOTBALL TEAMS IN EUROPE'S TOP 5 LEAGUES & TOP 100 STRIKERS OF THE LEAGUES OF THE YEAR 2017/2018"

A Project Submitted in Partial Fulfilment of the Requirements

for the Degree of

Bachelor of Science in Statistics

By

Saunak Mitra

Under the supervision of

Dr. Parthasarathi Bera

CONTENTS:

Summary:

The object of this research was to develop a rating system for all the clubs based on matches played, won, drawn, lost, goal scored, goals conceded, goal difference and points earned, and for the top 100 forward players/forwards based on the number of goals scored and assist provided by a player, in a particular season of football in Europe's top 5 leagues. The websites, Kaggle and Transfermarkt served as the sources for required data. Firstly, we devised a unique formula based on our subjective assessment of the game and the individual performances of the players. This was done with the help of analytic hierarchy process, otherwise known as AHP rating.

Principal Component Analysis is widely used in applied multivariate data analysis, and this article shows how to motivate student interest in this topic using football sports data. Here, principal component analysis is successfully used to rank all the clubs and top 100 forwards in the 2017/18 season of football in Europe's top 5 leagues. In particular, the principal component is seen to explain a substantial portion of the variation in a linear combination of some commonly used measures of football prowess.This application provides an excellent, elementary introduction to the topic of principal component analysis. The results thus revealed prove to be satisfactory and useful for those who intend to indulge further on the
subject.

Introduction:

The growth of sport analytics and the need for meaningful sport related statistics has emerged in recent decades due to the large volume of monetary resources that is increasingly being invested in a single player or team. The rise in player salaries and salary caps over the last 25 years provide ample evidence of the growth of sport analytics, with investors, franchises, clubs and other stakeholders wanting to determine the true value of their investment. For example, in the National Football League (NFL) there has been an increase of approximately 950% in player salaries since the 1980's, and an increase of 288% in salary cap since 1994 With global sports revenue estimated to grow by US$145.3 billion over the 2010 - 2015 period and winning teams earning significantly larger revenue than that of losing teams, there is a strong incentive for managers and coaching staff of sport teams to succeed. Given the large investment of resources and the stakes involved, coaches and managerial staff cannot solely rely on subjective views and personal beliefs to make team and player selection decisions. Solutions must be augmented with objective approaches by implementing analytical techniques.

It is important to distinguish sport analytics from collecting quantitative data. Quantitative data collection, in sport, is the measurement and storage of the behaviours or actions of a team or a player, while analytics is the use of data to inform decision makers. An early example of data collection within sports dates back to the 1850's with the publication of cricket averages in magazines.

Although the collection and recording of numerical data within sports has been conducted for quite some time, the application of
quantitative and statistical methods to this data is still in its infancy.

Due to the nature of human contest, sport lends itself to fluctuations and discrepancies in game outcomes, this in turn generates spectator interest. This outcome volatility is predominately due to variation in performance between individual players and teams. Therefore coaches, managers, fans, media and other interested parties utilise analytical approaches to understand the root of this variation, and handle and reduce its effect in order to produce 'better, more consistent results. Moreover these analytical techniques allow the user to rank and rate player and team performances. In general, sport rating systems provide an objective evaluation of a team or individual based on prior performances, and are implemented for player comparisons, improving the player/ team selection process and betting purposes.

The explosion in the sporting industry in terms of popularity and revenue is evident in football. Football has seen a huge global growth in revenue and transformed into a sporting juggernaut due to the telecast of the top seasonal leagues of European football in different countries. The top 5 European football leagues are Premier League (England), La Liga (Spain), Bundesliga (Germany), Serie A (Italy) and Ligue 1 (France). There are 20 teams in a league (18 in Bundesliga) and each team plays 38 matches (34 in case of Bundesliga) over a season. A match typically concludes in 90 minutes, which increases spectator appeal.

In this project, we would try to introduce the data set of all the teams and top 100 forwards in Europe's top 5 leagues, and we would try to introduce a ranking system for teams and forwards and try to rank them according to their ratings. We would use Z-Score Analysis and PCA (Principal Component Analysis) to find their ratings. Now, the teams and the players are ranked according to their ratings.

Methodology:

At the beginning, let us introduce some terminologies and variables used in our further computations and analysis for ranking the football teams and players.

Terminologies related to clubs :

1. **Matches played** : Each club team plays a total of 38 matches (34 in case of Bundesliga, since the total number of teams in the league is 18) in one season. So, each club plays twice with each of the other 19 clubs (17 in case of Bundesliga). Duration of a match is 90 minutes divided into two halves of 45 minutes each, with some added minutes due to wastage for various reasons.

2. **Win** : A club wins a match when it scores atleast one goal more than its opponent.

3. **Draw** : A club draws a match with its opponent when both the teams score same number of goals or doesn't score any goal.

4. **Loss** : A club loses a match when the opponent team scores atleast one goal more than the said club.

5. **Goals for** : It is total number of goals scored by various players of a particular club against the other 19 clubs (17 in case of Bundesliga)

6. **Goals against** : It is the total number of goals scored by players from the other 19 clubs (17 in case of Bundesliga) against a particular club.

7. **Goal difference** : It is the difference between the number of goals scored by a particular club and the number of goals scored against that club. It may a positive or a negative integer.

8. **Points** : A club earns 3 points for each win, loses 3 points of each loss and earns 1 point for each match drawn. The points column in the table shows the total number of points scored by each club after playing 38 matches (34 in case of Bundesliga).

Terminologies related to forward players :

1. **Matches played** : A player can play for a single club only in a particular season. A player can play atmost 38 matches (34 in case of Bundesliga) in a season

2. **Goals** : It is the number of times a player puts the ball at the back of the net.

3. **Assists** : It is the pass from a player to another player of the same team just before he scores a goal.

➢ Comparison by Diagrammatic Representation:-

Diagrams like graphs, charts, maps, pictures etc. are attractive and effective means for presentation of statistical data. It is more effective than tabular representation, being easily intelligible to a layman. Indeed, diagrams are almost essential whenever it is required to convey any statistical information to the general public. Diagrams are readily capable of revealing some features of the exhibited data.

Pie Chart: A pie chart is another appropriate diagram used for exhibiting the relativesizes of the different parts of a whole. In this case, a circle is partitioned into several sectors by drawing angles at the centre, the area of each sector indicating the corresponding percentage. In fact, the area enclosed by the circle is regarded as 100. Since the total angle at the centre is 360o, the desired angle for some particular category will be 3.6 times the relevant percentage. The diagram, thus constructed, is termed as pie diagram.

By using pie chart we can compare the relative contributions or importance of different categories to the study variable.

Bar Diagram: A bar chart or bar graph is a chart or graph that presents categorical data with rectangular bars with heights or lengths proportional to the values that they represent. The bars can be plotted vertically or horizontally. A vertical bar chart is sometimes called a column chart.

A bar graph shows comparisons among discrete categories. One axis of the chart shows the specific categories being compared, and the other axis represents a measured value. Some bar graphs present bars

clustered in groups of more than one, showing the values of more than one measured variable.

Box Plot: A box plot or boxplot is a method for graphically demonstrating the locality, spread and skewness groups of numerical data through their quartiles. In addition to the box on a box plot, there can be lines (which are called whiskers) extending from the box indicating variability outside the upper and lower quartiles, thus, the plot is also termed as the box-and-whisker plot and the box-and-whisker diagram. Outliers that differ significantly from the rest of the dataset may be plotted as individual points beyond the whiskers on the box-plot.

The spacings in each subsection of the box-plot indicate the degree of dispersion (spread) and skewness of the data, which are usually described using the five-number summary. In addition, the box-plot allows one to visually estimate various L-estimators, notably the interquartile range, midhinge, range, mid-range, and trimean. Box plots can be drawn either horizontally or vertically.

Methods Used for Ranking Teams and Strikers:-

Method I :

➢ Ranking Football Teams and Strikers Using Zscore

From the number of relevant variables defined above, after **subjective discussion**, we come to the conclusion that some variables deserve better recognition compared to others. Particularly so, in this form of the game. Therefore, we decided to choose three variables each, from league and player perspective, which, according to us is most influential for the result of the game.

● Most relevant variables related to League:-

❖ **Matches Played:**

Each club team plays a total of 38 matches (34 in case of Bundesliga, since the total number of teams in the league is 18) in one season. So, each club plays twice with each of the other 19 clubs (17 in case of Bundesliga). Duration of a match is 90 minutes divided into two halves of 45 minutes each, with some added minutes due to wastage for various reasons

So, the total number of matches played by a team in this season will be one of the key factors that will influence the ranking of the team.

- **Goal Difference:**

It is the difference between the number of goals scored by a particular club and the number of goals scored against that club. It may a positive or a negative integer .If it is positive and higher then the rating of the team would be higher and if it is negative and lower then the rating of the team would be lower . So, the goal difference of a team is also considered as a key factor which influence the ranking of the team.

- **Points Won:**

Another factor that can be considered as important as the previous two is the points won by a team . A club earns 3 points for each win, loses 3 points of each loss and earns 1 point for each match drawn. The points column in the table shows the total number of points scored by each club after playing 38 matches (34 in case of Bundesliga).The team having higher points wins the league so this factor is very important for ranking a team.

From our minimal understanding of the football league game and after referring to various similar works, we decided subjectively to apply the weightage to the variables as given below:

Matches played - 1; Goal Difference - 3; Points won - 2

And the weights are now combined in **product weighted measure** to rate the team in the following way:

Z score rating formula for Team : [{3*(Goal Difference)}+{2*(Points Won)}] /(Matches Played)

According to this Z score rating all the Teams are ranked . In this method, a Team with higher rating is a better team, so he will be ranked lower.

Now, moving on the player department, we repeated the same process and decided to focus on three most relevant variables that boosts up the ranking of a Player in league format.

- **Most Relevant Variables Related to Players :-**

  - **Matches Played:**

    A player can play for a single club only in a particular season. A player can play atmost 38 matches (34 in case of Bundesliga) in a season.The number of matches played by a player directly related to a player's rating because if a player got more matches to play then he obviously got chance to score more goals and assists comparatively to the player played less matches than him. So we consider number of matches played as a key factor for our ranking system.

  - **Goals:**

    It is the number of times a player puts the ball at the back of the net. The number of goals scored by a player obviously impacts on a player's rating because the number of goals by a player increased then the possibility of win of his team will increase that implies the contributions of a player for his team. So, the number of goals scored is impactful for a player's rating. That's why we take number of goals as a key factor for our player ranking system.

❖ Assists:

Another factor that can be considered as important as the previous two is the number of assists by a player. It is the pass from a player to another player of the same team just before he scores a goal. Assists are almost equally important like goal because an assist means a goal on your team scoreboard. Thus it also impacts on a player performance and rating. So, we consider assists as a key factor for our ranking system.

Again, from our minimal understanding of the football leagues and after referring to various similar works, we decided subjectively to apply the weightage to the player variables as given below:

Matches Played - 1; Goals - 1; Assists - 1

And the weights are now combined in **product weighted measure** to rate the players in the following way:

Z score rating formula for Players :
[{(Goals)+(Assists)}*(Goals)] /[Matches Played]

According to this Z Score rating all the players are ranked . In this method, a player with lower rating is a better player, so he will be ranked lower.

Method II :

Ranking the Football Clubs and Strikers with the help of Principal Component Analysis :

- **PCA** : PCA or Principal Component Analysis is an exploratory data analytic technique which provides a simpler and more parsimonious description of the covariance structure of a random vector. PCA is concerned fundamentally with the eigen structure of covariance matrices, that is, with their latent roots and eigen vectors.

- **Ranking the Football Clubs using the Principal Component Analysis**

  This analysis includes the **matches played, won, drawn, lost, goals for, goals against, goal difference and points** variables, for all teams who have played 38 matches in the respective leagues (34 in Bundesliga). Values for each of

  these variables were collected together into a $(8 \; x \; 1)^T$ column vector of the form (**Played, Won, Lost, Draw, Goals for, Goals against, Goal difference, Points**)^T for each of the batsmen. These we call the *PCA vectors*. Once data have been obtained, the $(8 \; x \; 8)$ sample correlation matrix associated with the sample PCA vectors is calculated for the correlation structure inherent in these variables. Since these variables are measured on very different scales, they must be standardized before PCA analysis. However, the process of finding the principal components by using the standardized variables is equivalent to finding

principal components by using the correlation matrix instead of the covariance matrix.

Once the correlation matrix for the PCA vectors is obtained (**Using 'R' Software**), we calculate the ordered eigenvalues correspond to the correlation matrix, and the total variability attributed to each.

Next, we make the scree plot diagram by plotting the ordered eigenvalues sequentially. All these further calculations are performed using **Minitab software**.

According to the theory of PCA, both from the **scree plot** and the table of **ordered eigenvalues**, we look for the highest eigenvalue which explains most of the total variability. The components of the corresponding eigenvector are used as the weights for rating formula. In the rating formula we combine the variables with their corresponding weights in a linear combination.

Formula : Played*(0.011) + Win*(0.421) + Draw*(-0.057) + Lost*(-0.406) + Goals for*(0.394) + Goal against*(-0.360) + Goal Difference*(0.430) + Points*(0.428)

• Ranking Strikers using the Principal Component Analysis

This analysis includes the **Matches, Goals, Assists** variables, for all strikers who have played in the Europe's top 5 leagues. Values for each of these variables were collected together into a $(3 \, x \, 1)^T$ column vector of the form $(\textbf{Matches, Goals, Assists})^T$ for each of the strikers. These we call the *PCA vectors*. Once data have been obtained, the (3 *x* 3) sample correlation matrix associated with the sample PCA vectors is calculated for the correlation structure inherent in these variables. Since these variables are measured on very different scales, they must be standardized before PCA analysis. However, the process of finding the principal components by using the standardized variables is equivalent to finding principal components by using the correlation matrix instead of the covariance matrix.

Once the correlation matrix for the PCA vectors is obtained

(**Using 'R' Software**), we calculate the ordered eigenvalues correspond to the correlation matrix, and the total variability attributed to each.

Next, we make the scree plot diagram by plotting the ordered eigenvalues sequentially. All these further calculations are performed using **Minitab software**.

According to the theory of PCA, both from the **scree plot** and the table of **ordered eigenvalues**, we look for the eigenvalue, in which the match component becomes negative, as the utility of a striker increases if and only if he makes more goal contribution (Goals and Assists) in lesser matches played . The components of the corresponding eigenvector are used as the weights for rating formula. In the rating formula we combine the variables with their corresponding weights in a linear combination.

Formula : Matches*(-0.311) + Goals*(0.710) + Assists*(0.632)

Analysis and Results:

Our main objective is to find out the best team and best Striker in European top 5 League in 2017-18 season . So we collect the league data of that year and used our ranking method to find out the best team and best striker of that season.

Studying and comparing data using graphical representation:

At first we intend to study the goals scored in each league and the goal contribution of that league to the total goals scored in top 5 leagues . To study this we use Bar diagrams and Pie chart of league data. We are also interested in the average points won by league winners(Bundesliga winner Bayern Munich,La liga winner Barcelona,Ligue 1 winner PSG,EPL winner Manchester city and Serie a winner Juventus) and a brief idea about points won by every team,for this case we use horizontal bar diagram and box plot diagram.

Next we want to study about the goal contributions of the strikers in top 5 league so we use box plot to get an idea about this.

Figure1,2:Pie chart and Bar Diagram of Goal Contribution of Each League in Europan Top 5 Leagues:-

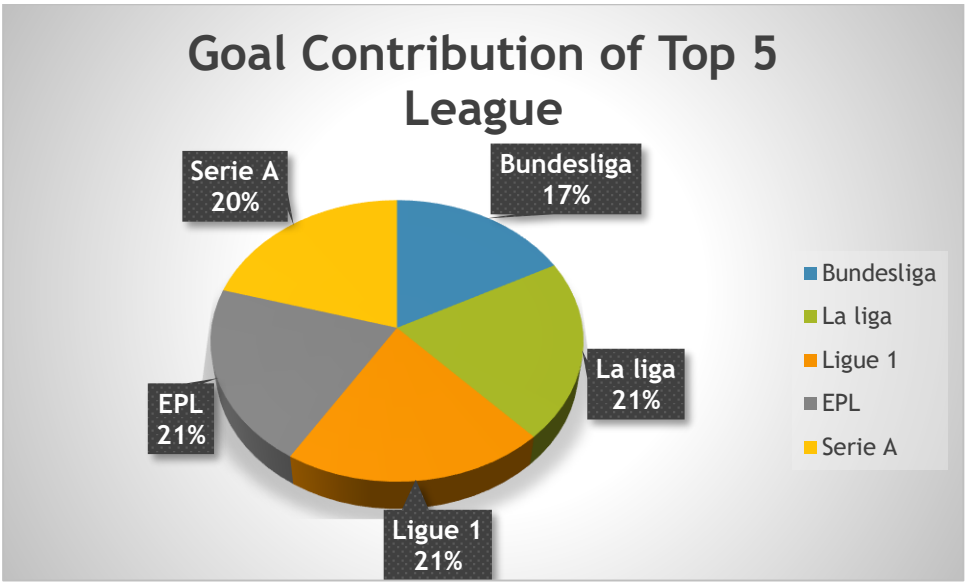


Fig.1

Fig.2

Figure 3,4:Horizontal Bar diagram of Average points won by Every League Winners and Box Plot of Points Won by Every Team in Top 5 League:-

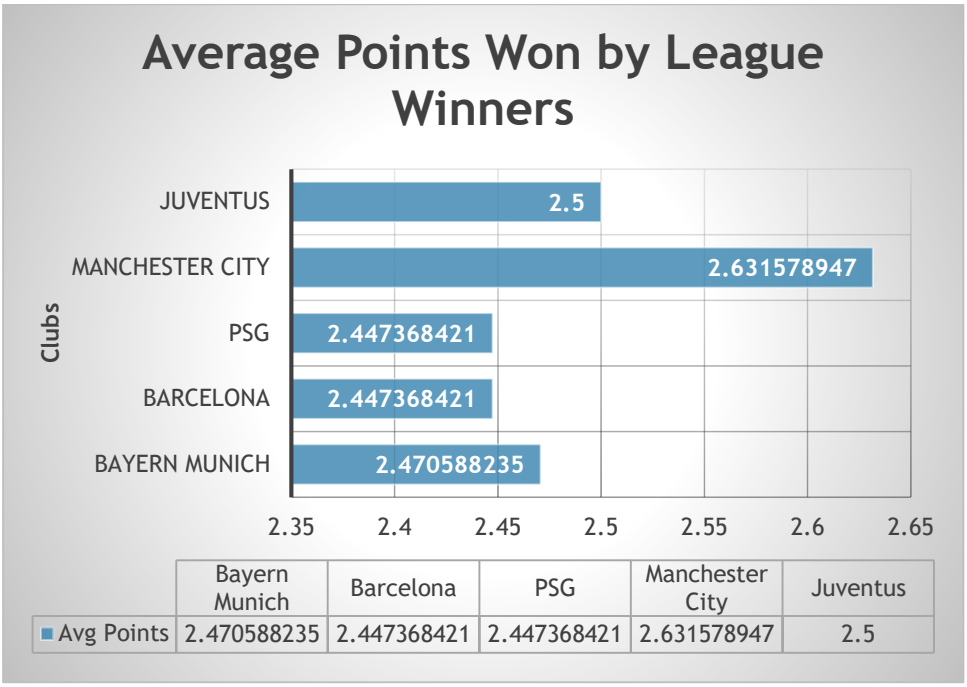


Fig.3

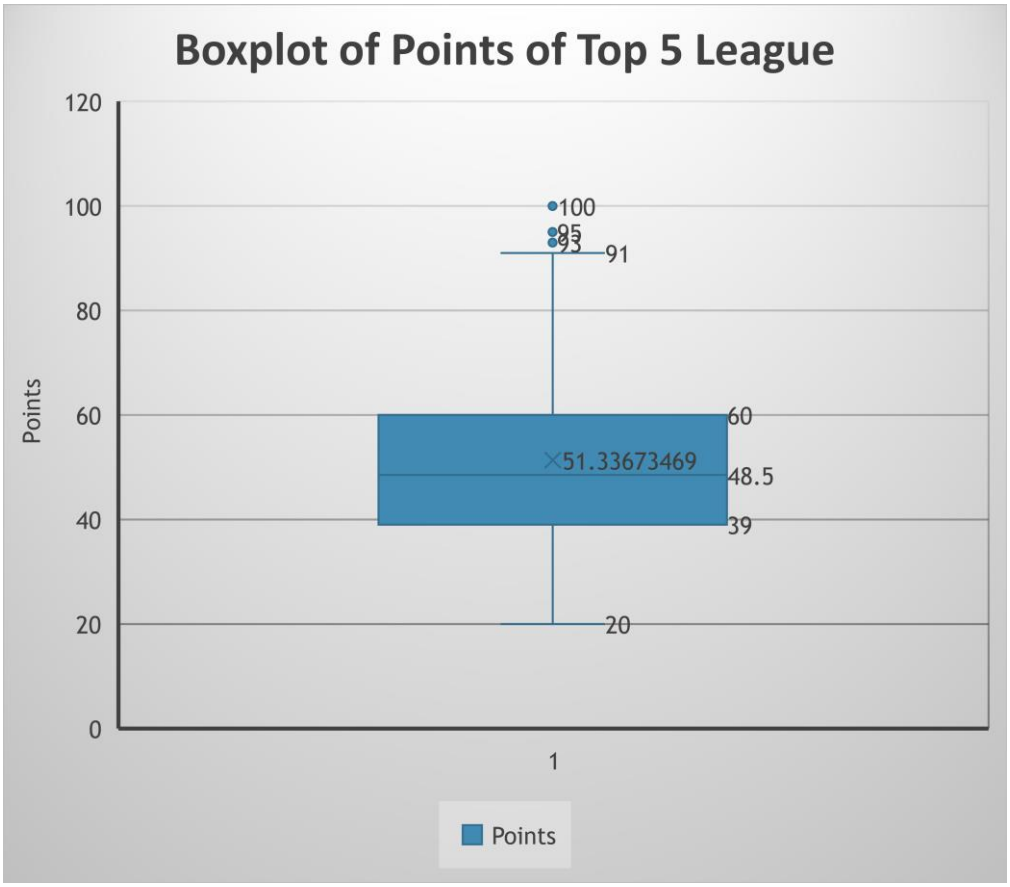


Fig.4

Figure 5: Box Plot of Goals Scored and Assists By Strikers of European Top 5 league:-

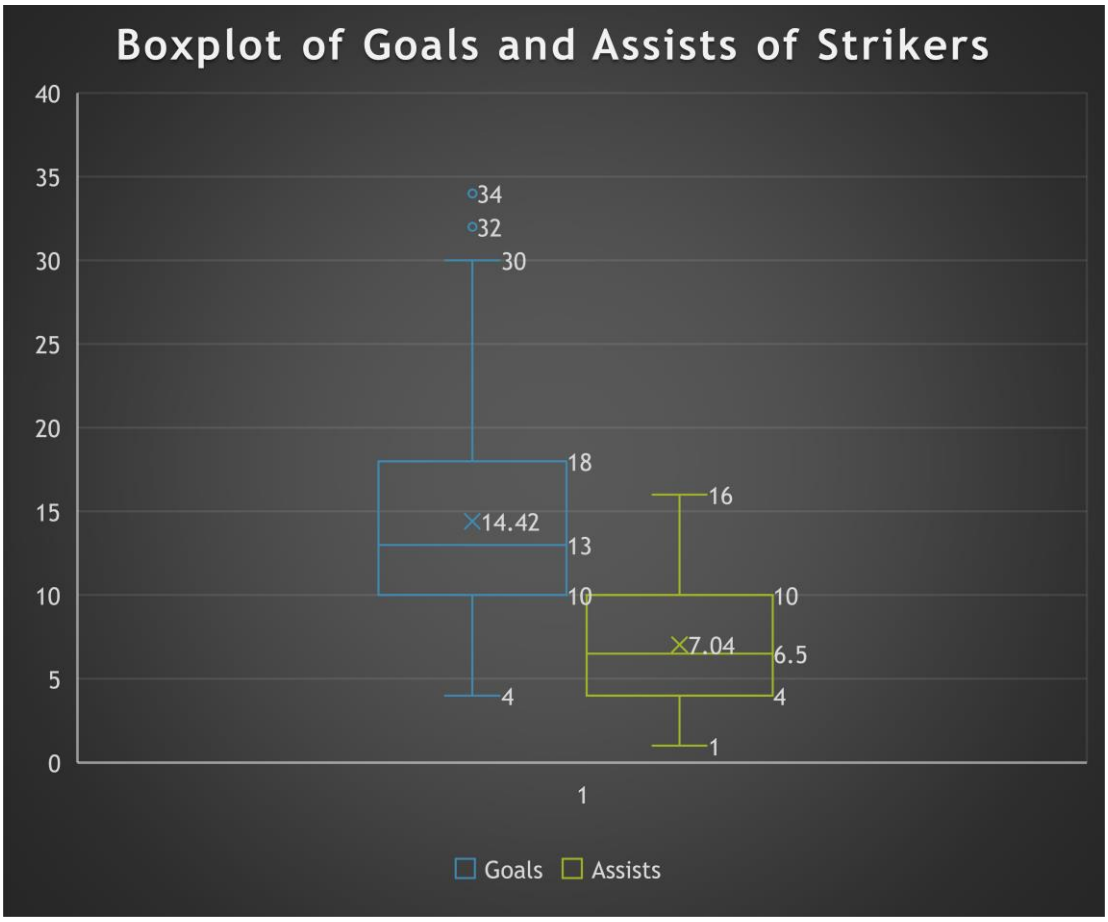


Fig.5

From figure 1 and 2 we can conclude that almost every league has same amount of contribution in total combined goals in top 5 league except “Bundesliga”because in this league total number of teams is 18 rather than 20.but the average goals scored is almost same as other leagues.

From figure 3 we can conclude that “Manchester City”(winner of EPL) has gained higher Average points among the winners of every league from European top 5 league.In figure 4 we observe that the mean and median of point gained by each team is 51.33 and 48.5 respectively.

In Figure 5 we observe that the mean and median of goals scored by strikers are 14.42 and 13 respectively and that of assists provided are 7.04 and 6.5 respectively.

1.1TABLE BASED ON Z-SCORE OF FOOTBALL TEAMS:

Rank	Team	Played	Win	Draw	Loss	Goals For	Goals Against	Goal Difference	Points	Zscore
1	Manchester City	38	32	4	2	106	27	79	100	11.5
2	Paris Saint-Germain	38	29	6	3	108	29	79	93	11.132
3	Bayern Munich	34	27	3	4	92	28	64	84	10.588
4	Barcelona	38	28	9	1	99	29	70	93	10.421
5	Juventus	38	30	5	3	86	24	62	95	9.8947
6	Napoli	38	28	7	3	77	29	48	91	8.5789
7	Real Madrid	38	22	10	6	94	44	50	76	7.9474
8	Lyon	38	23	9	6	87	43	44	78	7.5789
9	Liverpool	38	21	12	5	84	38	46	75	7.5789
10	Manchester United	38	25	6	7	68	28	40	81	7.4211
11	Monaco	38	24	8	6	85	45	40	80	7.3684
12	Tottenham	38	23	8	7	74	36	38	77	7.0526
13	Atletico Madrid	38	23	10	5	58	22	36	79	7
14	Lazio	38	21	9	8	89	49	40	72	6.9474
15	Marseille	38	22	11	5	80	47	33	77	6.6579
16	Roma	38	23	8	7	61	28	33	77	6.6579
17	Inter	38	20	12	6	66	30	36	72	6.6316
18	Valencia	38	22	7	9	65	38	27	73	5.9737
19	Chelsea	38	21	7	10	62	38	24	70	5.5789
20	Arsenal	38	19	6	13	74	51	23	63	5.1316
21	Schalke 04	34	18	9	7	53	37	16	63	5.1176
22	Hoffenheim	34	15	10	9	66	48	18	55	4.8235
23	Borussia Dortmund	34	15	10	9	64	47	17	55	4.7353
24	Atalanta	38	16	12	10	57	39	18	60	4.5789
25	AC Milan	38	18	10	10	56	42	14	64	4.4737
26	Bayer Leverkusen	34	15	10	9	58	44	14	55	4.4706
27	Villarreal	38	18	7	13	57	50	7	61	3.7632
28	Fiorentina	38	16	9	13	54	46	8	57	3.6316
29	Getafe	38	15	10	13	42	33	9	55	3.6053
30	Rennes	38	16	10	12	50	44	6	58	3.5263
31	Torino	38	13	15	10	54	46	8	54	3.4737
32	RasenBallsport Leipz	34	15	8	11	57	53	4	53	3.4706
33	Bordeaux	38	16	7	15	53	48	5	55	3.2895

34	Real Sociedad	38	14	7	17	66	59	7	49	3.1316
35	Real Betis	38	18	6	14	60	61	-1	60	3.0789
36	VfB Stuttgart	34	15	6	13	36	36	0	51	3
37	Nice	38	15	9	14	53	52	1	54	2.9211
38	Montpellier	38	11	18	9	36	33	3	51	2.9211
39	Eintracht Frankfurt	34	14	7	13	45	45	0	49	2.8824
40	Saint-Etienne	38	15	10	13	47	50	-3	55	2.6579
41	Burnley	38	14	12	12	36	39	-3	54	2.6053
42	Sampdoria	38	16	6	16	56	60	-4	54	2.5263
43	Celta Vigo	38	13	10	15	59	60	-1	49	2.5
44	Sevilla	38	17	7	14	49	58	-9	58	2.3421
45	Nantes	38	14	10	14	36	41	-5	52	2.3421
46	Borussia M.Gladbach	34	13	8	13	47	52	-5	47	2.3235
47	Hertha Berlin	34	10	13	11	43	46	-3	43	2.2647
48	Eibar	38	14	9	15	44	50	-6	51	2.2105
49	Werder Bremen	34	10	12	12	37	40	-3	42	2.2059
50	Leicester	38	12	11	15	56	60	-4	47	2.1579
51	Augsburg	34	10	11	13	43	46	-3	41	2.1471
52	Espanyol	38	12	13	13	36	42	-6	49	2.1053
53	Girona	38	14	9	15	50	59	-9	51	1.9737
54	Amiens	38	12	9	17	37	42	-5	45	1.9737
55	Deportivo Alaves	38	15	2	21	40	50	-10	47	1.6842
56	Newcastle United	38	12	8	18	39	47	-8	44	1.6842
57	Athletic Bilbao	38	10	13	15	41	49	-8	43	1.6316
58	Guingamp	38	12	11	15	48	59	-11	47	1.6053
59	Crystal Palace	38	11	11	16	45	55	-10	44	1.5263
60	Everton	38	13	10	15	44	58	-14	49	1.4737
61	Hannover 96	34	10	9	15	44	54	-10	39	1.4118
62	Angers	38	9	14	15	42	52	-10	41	1.3684
63	Genoa	38	11	8	19	33	43	-10	41	1.3684
64	Levante	38	11	13	14	44	58	-14	46	1.3158
65	Dijon	38	13	9	16	55	73	-18	48	1.1053
66	Bologna	38	11	6	21	40	52	-12	39	1.1053
67	Bournemouth	38	11	11	16	45	61	-16	44	1.0526
68	Leganes	38	12	7	19	34	51	-17	43	0.9211
69	Udinese	38	12	4	22	48	63	-15	40	0.9211
70	Mainz 05	34	9	9	16	38	52	-14	36	0.8824
71	Wolfsburg	34	6	15	13	36	48	-12	33	0.8824
72	Toulouse	38	9	10	19	38	54	-16	37	0.6842
73	West Ham	38	10	12	16	48	68	-20	42	0.6316
74	Watford	38	11	8	19	44	64	-20	41	0.5789
75	Brighton	38	9	13	16	34	54	-20	40	0.5263
76	SPAL 2013	38	8	14	16	39	59	-20	38	0.4211
77	Southampton	38	7	15	16	37	56	-19	36	0.3947

78	Chievo	38	10	10	18	36	59	-23	40	0.2895
79	Strasbourg	38	9	11	18	44	67	-23	38	0.1842
80	Caen	38	10	8	20	27	52	-25	38	0.0263
81	Freiburg	34	8	12	14	32	56	-24	36	0
82	Lille	38	10	8	20	41	67	-26	38	-0.0526
83	Sassuolo	38	11	10	17	29	59	-30	43	-0.1053
84	Cagliari	38	11	6	21	33	61	-28	39	-0.1579
85	Crotone	38	9	8	21	40	66	-26	35	-0.2105
86	Hamburger SV	34	8	7	19	29	53	-24	31	-0.2941
87	West Bromwich Albi	38	6	13	19	31	56	-25	31	-0.3421
88	Troyes	38	9	6	23	32	59	-27	33	-0.3947
89	Huddersfield	38	9	10	19	28	58	-30	37	-0.4211
90	Swansea	38	8	9	21	28	56	-28	33	-0.4737
91	Stoke	38	7	12	19	35	68	-33	33	-0.8684
92	Deportivo La Coruna	38	6	11	21	38	76	-38	29	-1.4737
93	FC Cologne	34	5	7	22	35	70	-35	22	-1.7941
94	Malaga	38	5	5	28	24	61	-37	20	-1.8684
95	Metz	38	6	8	24	34	76	-42	26	-1.9474
96	Verona	38	7	4	27	30	78	-48	25	-2.4737
97	Las Palmas	38	5	7	26	24	74	-50	22	-2.7895
98	Benevento	38	6	3	29	33	84	-51	21	-2.9211

1.2.TABLE BASED ON Z-SCORES OF STRIKERS:

Rank	Club Name	Player Name	Matches	Goals	Assists	Zscore
1	Barcelona	Lionel Messi	36	34	14	45.33333
2	Liverpool	Mohamed Salah	36	32	11	38.22222
3	Lazio	Ciro Immobile	33	29	8	32.51515
4	PSG	Edinson Cavani	32	28	7	30.625
5	PSG	Neymar Jr.	20	19	13	30.4
6	Bayern Munich	Robert Lewandowski	30	29	2	29.96667
7	Real Madrid	Cristiano Ronaldo	27	26	5	29.85185
8	Barcelona	Luis Suarez	33	25	13	28.78788
9	Tottenham Hotspur	Harry Kane	37	30	3	26.75676
10	Inter Milan	Mauro Icardi	34	29	1	25.58824
11	Arsenal	Pierre-Emerick Aubameyang	29	23	7	23.7931
12	Manchester City	Sergio Aguero	25	21	6	22.68
13	Marseille	Florian Thauvin	35	22	11	20.74286
14	Manchester City	Raheem Sterling	33	18	15	18
15	Juventus	Paulo Dybala	33	22	5	18
16	Celta Vigo	Iago Aspas	34	22	5	17.47059
17	Lyon	Memphis Depay	36	19	13	16.88889
18	Atletico Madrid	Antoine Griezmann	32	19	9	16.625
19	Monaco	Radamel Falcao	26	18	5	15.92308
20	Lyon	Nabil Fekir	30	18	7	15
21	Sampdoria	Fabio Quagliarella	35	19	5	13.02857
22	Nice	Mario Balotelli	28	18	1	12.21429
23	Lyon	Mariano Diaz	34	18	5	12.17647
24	Real Madrid	Gareth Bale	26	16	3	11.69231
25	Celta Vigo	Maxi Gomez	36	18	5	11.5
26	Barcelona	Philippe Coutinho	32	14	12	11.375
27	Napoli	Dries Mertens	38	18	6	11.36842
28	Leicester City	Jamie Vardy	37	20	1	11.35135
29	Manchester United	Romelu Lukaku	34	16	7	10.82353
30	Angers	Karl Toko Ekambi	37	17	6	10.56757
31	Nice	Alassane Plea	35	16	6	10.05714
32	Valencia	Rodrigo	37	16	7	9.945946
33	Hoffenheim	Mark Uth	31	14	8	9.935484
34	Monaco	Kylian Mbappe	28	13	7	9.285714
35	Villarreal	Carlos Bacca	35	15	6	9

36	Liverpool	Roberto Firmino	37	15	7	8.918919
37	Juventus	Gonzalo Higuain	35	16	3	8.685714
38	Monaco	Rony Lopes	38	15	7	8.684211
39	Leipzig	Timo Werner	32	13	8	8.53125
40	Real Sociedad	Willian Jose	34	15	4	8.382353
41	Arsenal	Alexandre Lacazette	32	14	5	8.3125
42	Augsburg	Alfred Finnbogason	22	12	3	8.181818
43	Lazio	Luis Alberto	34	11	14	8.088235
44	Hoffenheim	Andrej Kramaric	34	13	8	8.029412
45	AS Roma	Edin Dzeko	36	16	2	8
46	Manchester City	Leroy Sane	32	10	15	7.8125
47	Hoffenheim	Serge Gnabry	22	10	7	7.727273
48	Bayern Munich	Sandro Wagner	25	12	4	7.68
49	Leicester City	Riyad Mahrez	36	12	11	7.666667
50	Manchester City	Gabriel Jesus	29	13	4	7.62069
51	Freiburg	Nils Petersen	32	15	1	7.5
52	Bayer Leverkusen	Kevin Volland	31	14	2	7.225806
53	Espanyol	Gerard Moreno	38	16	1	7.157895
54	Lyon	Bertrand Traore	31	13	4	7.129032
55	Augsburg	Michael Gregoritsch	32	13	4	6.90625
56	Metz	Nolan Roux	35	15	1	6.857143
57	Atalanta	Josip Ilicic	31	11	8	6.741935
58	Fiorentina	Giovanni Simeone	38	14	4	6.631579
59	Bayern Munich	Thomas Mueller	29	8	16	6.62069
60	Inter Milan	Ivan Perisic	37	11	11	6.540541
61	Real Sociedad	Mikel Oyarzabal	35	12	7	6.514286
62	Bordeaux	Malcom	35	12	7	6.514286
63	Lille	Nicolas Pepe	36	13	5	6.5
64	PSG	Angel Di Maria	30	11	6	6.233333
65	Manchester City	David Silva	29	9	11	6.206897
66	Torino	Iago Falque	37	12	7	6.162162
67	Chelsea	Alvaro Morata	31	11	6	6.032258
68	West Ham	Marko Arnautovic	31	11	6	6.032258
69	Getafe	Angel Rodriguez	33	13	2	5.909091
70	Valencia	Simone Zaza	33	13	2	5.909091
71	Bologna	Simone Verdi	34	10	10	5.882353
72	Liverpool	Sadio Mane	29	10	7	5.862069
73	Tottenham Hotspur	Heung-min Son	37	12	6	5.837838
74	Hertha Berlin	Salomon Kalou	31	12	3	5.806452
75	Tottenham Hotspur	Christian Eriksen	37	10	11	5.675676
76	Chelsea	Eden Hazard	34	12	4	5.647059
77	Napoli	Jose Callejon	38	10	11	5.526316

78	Bayern Munich	James Rodriguez	23	7	11	5.478261
79	Sampdoria	Duvan Zapata	31	11	4	5.322581
80	Borrusia M'gladbach	Thorgan Hazard	34	10	8	5.294118
81	Manchester City	Kevin De Bruyne	37	8	16	5.189189
82	Levante	Jose Luis Morales	35	10	8	5.142857
83	Lazio	Sergej Milinkovic-Savic	35	12	3	5.142857
84	Tottenham Hotspur	Dele Alli	36	9	11	5
85	Nantes	Emiliano Sala	36	12	3	5
86	Arsenal	Aaron Ramsey	24	7	10	4.958333
87	Alaves	Munir El Haddadi	33	10	6	4.848485
88	Athletic Bilbao	Raul Garcia	34	10	6	4.705882
89	Bayer Leverkusen	Leon Bailey	30	9	6	4.5
90	Wolfsburg	Daniel Didavi	30	9	6	4.5
91	Manchester United	Alexis Sanchez	31	9	6	4.354839
92	Rennais	Benjamin Bourigeaud	37	10	6	4.324324
93	Napoli	Lorenzo Insigne	37	8	10	3.891892
94	Marseille	Dimitri Payet	31	6	13	3.677419
95	Manchester United	Paul Pogba	27	6	10	3.555556
96	Saint-Etienne	Jonathan Bamba	34	7	9	3.294118
97	Valencia	Dani Parejo	34	7	8	3.088235
98	Real Madrid	Karim Benzema	32	5	11	2.5
99	PSG	Goncalo Guedes	34	5	11	2.352941
100	Juventus	Douglas Costa	31	4	12	2.064516

1.3CORRELATION MATRIX OF THE 8-VARIABLES OF FOOTBALL TEAMS:

	Played	Win	Draw	Loss	Goals For	Goals Against	Goal Difference	Points
Played	1	0.12946	-0.01634	0.134191	0.074638	0.109925	0	0.131789
Win	0.12946	1	-0.31072	-0.85147	0.898459	-0.74955	0.947486	0.987973
Draw	-0.01634	-0.31072	1	-0.16929	-0.20381	-0.04459	-0.11683	-0.16001
Loss	0.134191	-0.85147	-0.16929	1	-0.81258	0.827289	-0.9252	-0.91181
Goals For	0.074638	0.898459	-0.20381	-0.81258	1	-0.54889	0.924124	0.899912
Goals Against	n0.109925	-0.74955	-0.04459	0.827289	-0.54889	1	-0.82663	-0.78568
Goal Difference	0	0.947486	-0.11683	-0.9252	0.924124	-0.82663	1	0.964978
Points	0.131789	0.987973	-0.16001	-0.91181	0.899912	-0.78568	0.964978	1

Eigenanalysis of the Correlation Matrix

Eigenvalue	5.3188	1.2355	0.9894	0.3880	0.0683	0.0000	-0.0000	-0.0000
Proportion	0.665	0.154	0.124	0.049	0.009	0.000	-0.000	-0.000
Cumulative	0.665	0.819	0.943	0.991	1.000	1.000	1.000	1.000

Eigenvectors

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
Played	0.011	0.528	0.806	-0.170	-0.055	-0.174	0.085	-0.038
Win	0.421	0.189	-0.024	-0.032	0.385	0.460	-0.163	-0.632
Draw	-0.057	-0.713	0.584	0.208	-0.019	0.289	-0.131	-0.051
Loss	-0.406	0.289	-0.050	-0.113	-0.404	0.668	-0.325	0.147
Goals For	0.394	0.145	-0.008	0.586	-0.455	-0.221	-0.472	-0.039
Goals Against	-0.360	0.255	0.019	0.753	0.333	0.150	0.320	0.026
Goal Difference	0.430	-0.019	-0.014	0.050	-0.459	0.328	0.701	0.057
Points	0.428	0.080	0.070	0.001	0.397	0.224	-0.167	0.755

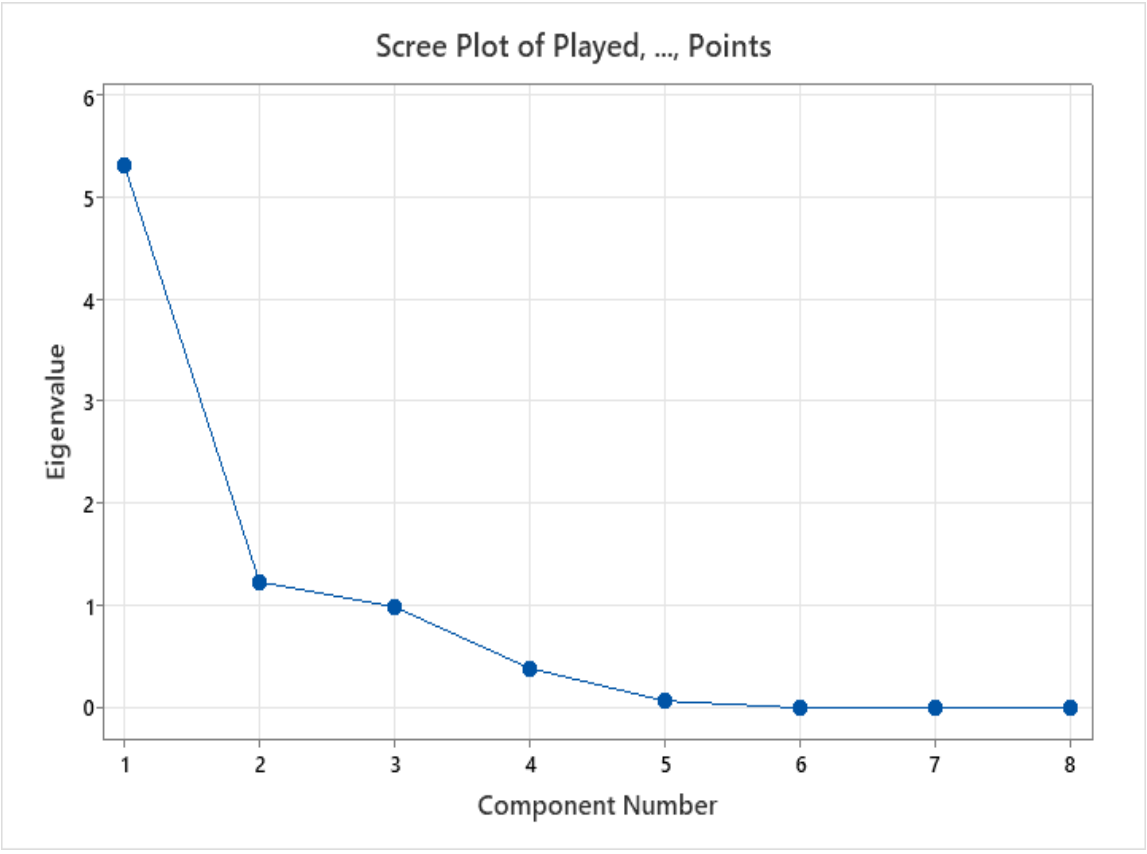


Fig.6

1.4Table based on PCA score of Football Teams :-

Rank	Team	Played	Win	Draw	Loss	Goals For	Goals Against	Goal Difference	Points	Zscore	PCA Score
1	Manchester City	38	32	4	2	106	27	79	100	11.5	121.664
2	Paris Saint-Germain	38	29	6	3	108	29	79	93	11.13158	116.953
3	Barcelona	38	28	9	1	99	29	70	93	10.42105	109.757
4	Juventus	38	30	5	3	86	24	62	95	9.894737	104.109
5	Bayern Munich	34	27	3	4	92	28	64	84	10.58824	99.586
6	Napoli	38	28	7	3	77	29	48	91	8.578947	90.075
7	Real Madrid	38	22	10	6	94	44	50	76	7.947368	81.898
8	Lyon	38	23	9	6	87	43	44	78	7.578947	78.254
9	Liverpool	38	21	12	5	84	38	46	75	7.578947	77.841
10	Monaco	38	24	8	6	85	45	40	80	7.368421	76.36
11	Manchester United	38	25	6	7	68	28	40	81	7.421053	76.339
12	Tottenham	38	23	8	7	74	36	38	77	7.052632	72.295
13	Atletico Madrid	38	23	10	5	58	22	36	79	7	71.725
14	Lazio	38	21	9	8	89	49	40	72	6.947368	70.94
15	Marseille	38	22	11	5	80	47	33	77	6.657895	68.769
16	Roma	38	23	8	7	61	28	33	77	6.657895	67.903
17	Inter	38	20	12	6	66	30	36	72	6.631579	67.218
18	Valencia	38	22	7	9	65	38	27	73	5.973684	60.411
19	Chelsea	38	21	7	10	62	38	24	70	5.578947	55.828
20	Arsenal	38	19	6	13	74	51	23	63	5.131579	50.447
21	Schalke 04	34	18	9	7	53	37	16	63	5.117647	46.003
22	Atalanta	38	16	12	10	57	39	18	60	4.578947	44.248
23	AC Milan	38	18	10	10	56	42	14	64	4.473684	43.722
24	Hoffenheim	34	15	10	9	66	48	18	55	4.823529	42.469
25	Borussia Dortmund	34	15	10	9	64	47	17	55	4.735294	41.611
26	Bayer Leverkusen	34	15	10	9	58	44	14	55	4.470588	39.037
27	Villarreal	38	18	7	13	57	50	7	61	3.763158	35.895
28	Fiorentina	38	16	9	13	54	46	8	57	3.631579	33.915
29	Rennes	38	16	10	12	50	44	6	58	3.526316	32.976
30	Getafe	38	15	10	13	42	33	9	55	3.605263	32.963
31	Torino	38	13	15	10	54	46	8	54	3.473684	32.244
32	Bordeaux	38	16	7	15	53	48	5	55	3.289474	29.957
33	RasenBallsport Leipz	34	15	8	11	57	53	4	53	3.470588	29.549
34	Real Betis	38	18	6	14	60	61	-1	60	3.078947	28.9
35	Real Sociedad	38	14	7	17	66	59	7	49	3.131579	27.757
36	Nice	38	15	9	14	53	52	1	54	2.921053	26.24

37	Montpellier	38	11	18	9	36	33	3	51	2.921053	25.791
38	VfB Stuttgart	34	15	6	13	36	36	0	51	3	24.121
39	Saint-Etienne	38	15	10	13	47	50	-3	55	2.657895	23.653
40	Eintracht Frankfurt	34	14	7	13	45	45	0	49	2.882353	23.093
41	Burnley	38	14	12	12	36	39	-3	54	2.605263	22.722
42	Sampdoria	38	16	6	16	56	60	-4	54	2.526316	22.172
43	Celta Vigo	38	13	10	15	59	60	-1	49	2.5	21.419
44	Sevilla	38	17	7	14	49	58	-9	58	2.342105	20.872
45	Nantes	38	14	10	14	36	41	-5	52	2.342105	19.588
46	Eibar	38	14	9	15	44	50	-6	51	2.210526	18.293
47	Borussia M.Gladbac h	34	13	8	13	47	52	-5	47	2.323529	17.877
48	Leicester	38	12	11	15	56	60	-4	47	2.157895	17.613
49	Espanyol	38	12	13	13	36	42	-6	49	2.105263	16.907
50	Hertha Berlin	34	10	13	11	43	46	-3	43	2.264706	16.873
51	Girona	38	14	9	15	50	59	-9	51	1.973684	16.127
52	Werder Bremen	34	10	12	12	37	40	-3	42	2.205882	15.892
53	Augsburg	34	10	11	13	43	46	-3	41	2.147059	15.319

54	Amiens	38	12	9	17	37	42	-5	45	1.973684	14.623
55	Guingamp	38	12	11	15	48	59	-11	47	1.605263	11.811
56	Deportivo Alaves	38	15	2	21	40	50	-10	47	1.684211	11.669
57	Newcastle United	38	12	8	18	39	47	-8	44	1.684211	11.544
58	Athletic Bilbao	38	10	13	15	41	49	-8	43	1.631579	11.275
59	Everton	38	13	10	15	44	58	-14	49	1.473684	10.639
60	Crystal Palace	38	11	11	16	45	55	-10	44	1.526316	10.388
61	Levante	38	11	13	14	44	58	-14	46	1.315789	8.748
62	Angers	38	9	14	15	42	52	-10	41	1.368421	8.395
63	Hannover 96	34	10	9	15	44	54	-10	39	1.411765	8.269
64	Genoa	38	11	8	19	33	43	-10	41	1.368421	7.649
65	Dijon	38	13	9	16	55	73	-18	48	1.105263	7.076
66	Bournemouth	38	11	11	16	45	61	-16	44	1.052632	5.648
67	Bologna	38	11	6	21	40	52	-12	39	1.105263	4.753
68	Leganes	38	12	7	19	34	51	-17	43	0.921053	3.487
69	Udinese	38	12	4	22	48	63	-15	40	0.921053	3.212
70	Mainz 05	34	9	9	16	38	52	-14	36	0.882353	2.794
71	Wolfsburg	34	6	15	13	36	48	-12	33	0.882353	2.635
72	West Ham	38	10	12	16	48	68	-20	42	0.631579	1.256
73	Toulouse	38	9	10	19	38	54	-16	37	0.684211	0.411
74	Watford	38	11	8	19	44	64	-20	41	0.578947	0.123
75	Brighton	38	9	13	16	34	54	-20	40	0.526316	-0.554
76	SPAL 2013	38	8	14	16	39	59	-20	38	0.421053	-1.718
77	Southampton	38	7	15	16	37	56	-19	36	0.394737	-2.33
78	Chievo	38	10	10	18	36	59	-23	40	0.289474	-3.076
79	Strasbourg	38	9	11	18	44	67	-23	38	0.184211	-4.138
80	Freiburg	34	8	12	14	32	56	-24	36	0	-5.09
81	Caen	38	10	8	20	27	52	-25	38	0.026316	-6.516
82	Sassuolo	38	11	10	17	29	59	-30	43	-0.10526	-6.733
83	Lille	38	10	8	20	41	67	-26	38	-0.05263	-6.83

84	Cagliari	38	11	6	21	33	61	-28	39	-0.15789	-8.125
85	Crotone	38	9	8	21	40	66	-26	35	-0.21053	-8.975
86	Hamburger SV	34	8	7	19	29	53	-24	31	-0.29412	-9.077
87	West Bromwich Albi o	38	6	13	19	31	56	-25	31	-0.34211	-10.939
88	Huddersfield	38	9	10	19	28	58	-30	37	-0.42105	-10.989
89	Troyes	38	9	6	23	32	59	-27	33	-0.39474	-11.591
90	Swansea	38	8	9	21	28	56	-28	33	-0.47368	-12.297
91	Stoke	38	7	12	19	35	68	-33	33	-0.86842	-15.789
92	Deportivo La Coruna	38	6	11	21	38	76	-38	29	-1.47368	-22.525
93	FC Cologne	34	5	7	22	35	70	-35	22	-1.79412	-23.896
94	Metz	38	6	8	24	34	76	-42	26	-1.94737	-28.152
95	Malaga	38	5	5	28	24	61	-37	20	-1.86842	-28.984
96	Verona	38	7	4	27	30	78	-48	25	-2.47368	-34.025
97	Las Palmas	38	5	7	26	24	74	-50	22	-2.78947	-37.7
98	Benevento	38	6	3	29	33	84	-51	21	-2.92105	-39.181

1.5CORRELATION MATRIX OF THE STRIKERS:

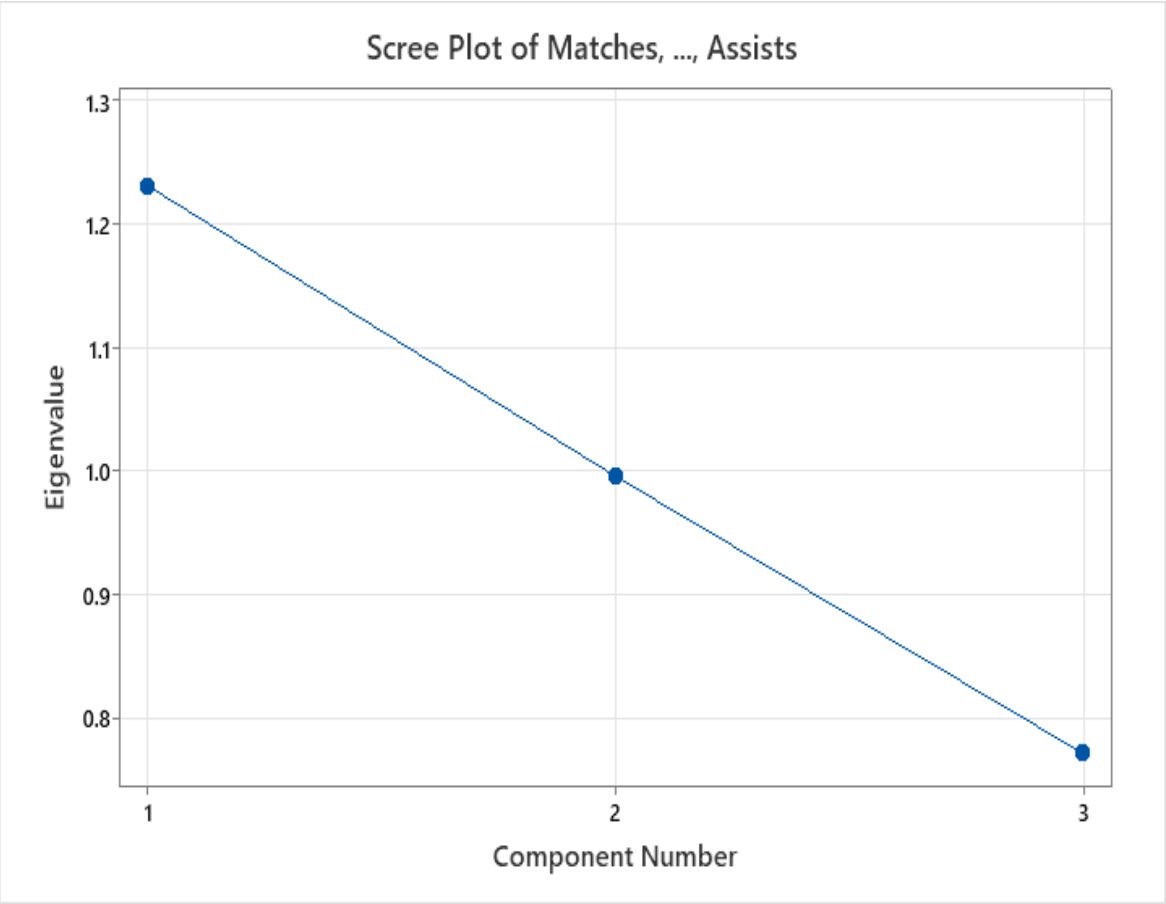
	Matches	Goals	Assists
Matches	1	0.103739	-0.00441
Goals	0.103739	1	-0.20494
Assists	-0.00441	-0.20494	1

Eigenanalysis of the Correlation Matrix

Eigenvalue	1.2315	0.9964	0.7721
Proportion	0.410	0.332	0.257
Cumulative	0.410	0.743	1.000

Eigenvectors

Variable	PC1	PC2	PC3
Matches	0.328	-0.892	-0.311
Goals	0.704	0.011	0.710
Assists	-0.630	-0.451	0.632



1.6PCA SCORES RANKING OF 100 EUROPEAN STRIKERS IN 2017/18 SEASON:

Rank	Club Name	Player Name	Matches	Goals	Assists	Zscore	PCA Score
1	Barcelona	Lionel Messi	36	34	14	45.33333	21.792
2	Liverpool	Mohamed Salah	36	32	11	38.22222	18.476
3	Barcelona	Luis Suarez	33	25	13	28.78788	15.703
4	PSG	Neymar Jr.	20	19	13	30.4	15.486
5	Lazio	Ciro Immobile	33	29	8	32.51515	15.383
6	PSG	Edinson Cavani	32	28	7	30.625	14.352
7	Real Madrid	Cristiano Ronaldo	27	26	5	29.85185	13.223
8	Bayern Munich	Robert Lewandowski	30	29	2	29.96667	12.524
9	Manchester City	Raheem Sterling	33	18	15	18	11.997
10	Arsenal	Pierre-Emerick Aubameyang	29	23	7	23.7931	11.735
11	Tottenham Hotspur	Harry Kane	37	30	3	26.75676	11.689
12	Marseille	Florian Thauvin	35	22	11	20.74286	11.687
13	Manchester City	Sergio Aguero	25	21	6	22.68	10.927
14	Inter Milan	Mauro Icardi	34	29	1	25.58824	10.648
15	Lyon	Memphis Depay	36	19	13	16.88889	10.51
16	Atletico Madrid	Antoine Griezmann	32	19	9	16.625	9.226
17	Juventus	Paulo Dybala	33	22	5	18	8.517
18	Celta Vigo	Iago Aspas	34	22	5	17.47059	8.206
19	Lyon	Nabil Fekir	30	18	7	15	7.874
20	Monaco	Radamel Falcao	26	18	5	15.92308	7.854
21	Barcelona	Philippe Coutinho	32	14	12	11.375	7.572
22	Bayern Munich	Thomas Mueller	29	8	16	6.62069	6.773
23	Manchester City	Leroy Sane	32	10	15	7.8125	6.628
24	Lazio	Luis Alberto	34	11	14	8.088235	6.084
25	Sampdoria	Fabio Quagliarella	35	19	5	13.02857	5.765
26	Lyon	Mariano Diaz	34	18	5	12.17647	5.366
27	Hoffenheim	Mark Uth	31	14	8	9.935484	5.355
28	Manchester United	Romelu Lukaku	34	16	7	10.82353	5.21
29	Real Madrid	Gareth Bale	26	16	3	11.69231	5.17
30	Monaco	Kylian Mbappe	28	13	7	9.285714	4.946
31	Bayern Munich	James Rodriguez	23	7	11	5.478261	4.769
32	Napoli	Dries Mertens	38	18	6	11.36842	4.754
33	Celta Vigo	Maxi Gomez	36	18	5	11.5	4.744
34	Nice	Mario Balotelli	28	18	1	12.21429	4.704
35	Hoffenheim	Serge Gnabry	22	10	7	7.727273	4.682
36	Angers	Karl Toko Ekambi	37	17	6	10.56757	4.355
37	Leipzig	Timo Werner	32	13	8	8.53125	4.334

38	Manchester City	David Silva	29	9	11	6.206897	4.323
39	Manchester City	Kevin De Bruyne	37	8	16	5.189189	4.285
40	Valencia	Rodrigo	37	16	7	9.945946	4.277
41	Leicester City	Riyad Mahrez	36	12	11	7.666667	4.276
42	Nice	Alassane Plea	35	16	6	10.05714	4.267
43	Arsenal	Aaron Ramsey	24	7	10	4.958333	3.826
44	Hoffenheim	Andrej Kramaric	34	13	8	8.029412	3.712
45	Augsburg	Alfred Finnbogason	22	12	3	8.181818	3.574
46	Liverpool	Roberto Firmino	37	15	7	8.918919	3.567
47	Villarreal	Carlos Bacca	35	15	6	9	3.557
48	Leicester City	Jamie Vardy	37	20	1	11.35135	3.325

49	Bayern Munich	Sandro Wagner	25	12	4	7.68	3.273
50	Monaco	Rony Lopes	38	15	7	8.684211	3.256
51	Inter Milan	Ivan Perisic	37	11	11	6.540541	3.255
52	Atalanta	Josip Ilicic	31	11	8	6.741935	3.225
53	Arsenal	Alexandre Lacazette	32	14	5	8.3125	3.148
54	Bologna	Simone Verdi	34	10	10	5.882353	2.846
55	Marseille	Dimitri Payet	31	6	13	3.677419	2.835
56	Manchester City	Gabriel Jesus	29	13	4	7.62069	2.739
57	Real Sociedad	Willian Jose	34	15	4	8.382353	2.604
58	Tottenham Hotspur	Christian Eriksen	37	10	11	5.675676	2.545
59	Liverpool	Sadio Mane	29	10	7	5.862069	2.505
60	Juventus	Gonzalo Higuain	35	16	3	8.685714	2.371
61	PSG	Angel Di Maria	30	11	6	6.233333	2.272
62	Napoli	Jose Callejon	38	10	11	5.526316	2.234
63	Manchester United	Paul Pogba	27	6	10	3.555556	2.183
64	Tottenham Hotspur	Dele Alli	36	9	11	5	2.146
65	Lyon	Bertrand Traore	31	13	4	7.129032	2.117
66	Real Sociedad	Mikel Oyarzabal	35	12	7	6.514286	2.059
67	Bordeaux	Malcom	35	12	7	6.514286	2.059
68	Chelsea	Alvaro Morata	31	11	6	6.032258	1.961
69	West Ham	Marko Arnautovic	31	11	6	6.032258	1.961
70	Augsburg	Michael Gregoritsch	32	13	4	6.90625	1.806
71	Borrusia M'gladbach	Thorgan Hazard	34	10	8	5.294118	1.582
72	Bayer Leverkusen	Kevin Volland	31	14	2	7.225806	1.563
73	Torino	Iago Falque	37	12	7	6.162162	1.437
74	AS Roma	Edin Dzeko	36	16	2	8	1.428
75	Freiburg	Nils Petersen	32	15	1	7.5	1.33
76	Levante	Jose Luis Morales	35	10	8	5.142857	1.271
77	Lille	Nicolas Pepe	36	13	5	6.5	1.194
78	Bayer Leverkusen	Leon Bailey	30	9	6	4.5	0.852

79	Wolfsburg	Daniel Didavi	30	9	6	4.5	0.852
80	Tottenham Hotspur	Heung-min Son	37	12	6	5.837838	0.805
81	Juventus	Douglas Costa	31	4	12	2.064516	0.783
82	Hertha Berlin	Salomon Kalou	31	12	3	5.806452	0.775
83	Sampdoria	Duvan Zapata	31	11	4	5.322581	0.697
84	Fiorentina	Giovanni Simeone	38	14	4	6.631579	0.65
85	Alaves	Munir El Haddadi	33	10	6	4.848485	0.629
86	Real Madrid	Karim Benzema	32	5	11	2.5	0.55
87	Manchester United	Alexis Sanchez	31	9	6	4.354839	0.541
88	Napoli	Lorenzo Insigne	37	8	10	3.891892	0.493
89	Chelsea	Eden Hazard	34	12	4	5.647059	0.474
90	Metz	Nolan Roux	35	15	1	6.857143	0.397
91	Athletic Bilbao	Raul Garcia	34	10	6	4.705882	0.318
92	Getafe	Angel Rodriguez	33	13	2	5.909091	0.231
93	Valencia	Simone Zaza	33	13	2	5.909091	0.231
94	Espanyol	Gerard Moreno	38	16	1	7.157895	0.174
95	Saint-Etienne	Jonathan Bamba	34	7	9	3.294118	0.084
96	PSG	Goncalo Guedes	34	5	11	2.352941	-0.072
97	Lazio	Sergej Milinkovic-Savic	35	12	3	5.142857	-0.469
98	Valencia	Dani Parejo	34	7	8	3.088235	-0.548
99	Rennais	Benjamin Bourigeaud	37	10	6	4.324324	-0.615
100	Nantes	Emiliano Sala	36	12	3	5	-0.78

CONCLUSION:

SCATTERPLOT OF PCA SCORE VS Z-SCORE(FOOTBALL CLUBS):

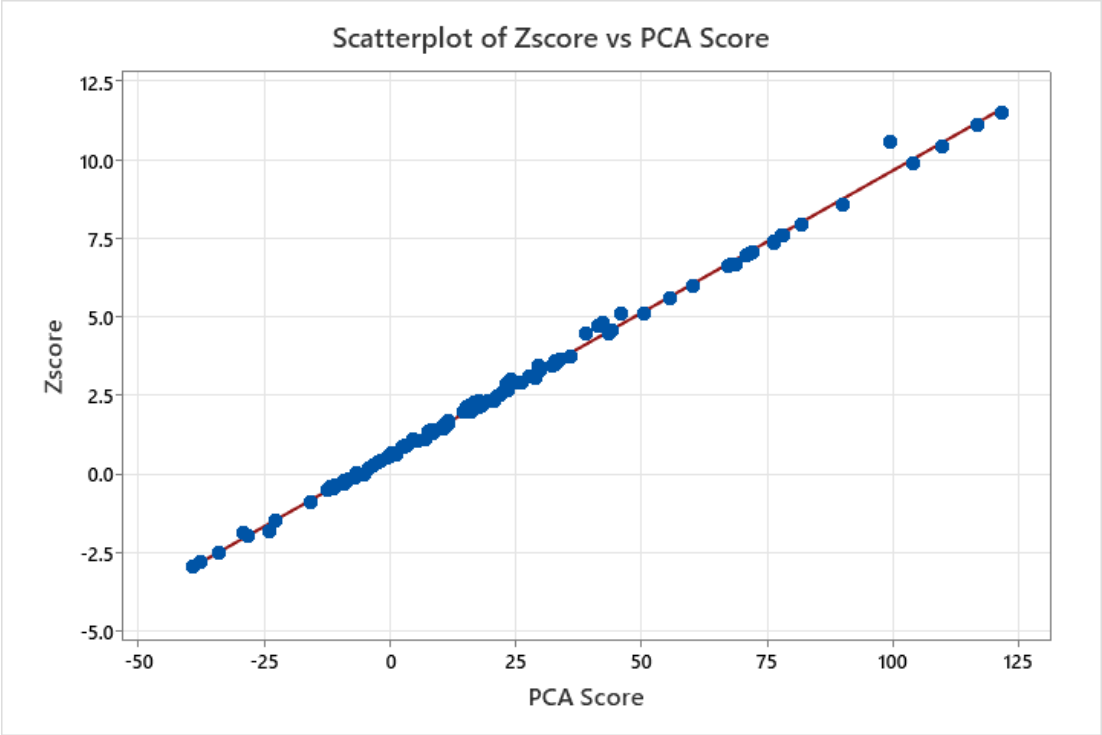


Fig.8

From this above stated Scatterplot, it is evident that the Z-Score of the top 100 European Football Clubs using the given data of matches played, won, lost, drawn, goals scored, goals conceded, goal difference and points won that has been calculated using the formula is positively and quite strongly correlated with the PCA Scores, which has been calculated from the very first set of eigen values in the Principal Component Ananlysis.In other words, it refers to that our self-made statistic is quite efficient in the analysis to rank the top 100 European Football Clubs.

SCATTERPLOT OF PCA SCORE VS Z-SCORE(STRIKERS):

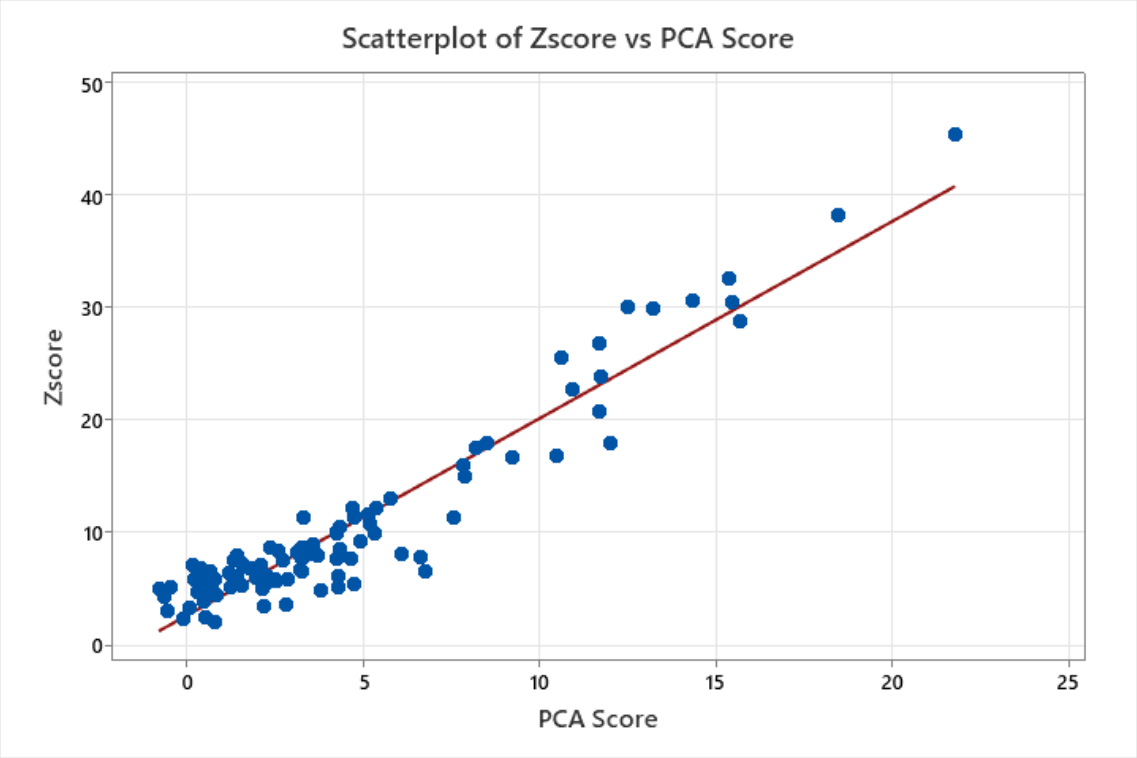


Fig.9

From this above stated Scatterplot, it is evident that the Z-Score of the top 100 Strikers in Top 5 European Leagues using the given data of matches played,goals scored, assists provided that has been calculated using the formula is positively and quite strongly correlated with the PCA Scores, which has been calculated from the set of eigen values in the Principal Component Ananlysis.In other words, it refers to that our self-made statistic is quite efficient in the analysis to rank the top 100 Strikers in Top 5 European Leagues.

REFERENCES:

➢ *Sources of Theory:-*

- **Principal Component Analysis,Second Edition by I.T.Jolliffe**
- **Aspects of Multivariate Statistical Theory by ROBB J.MUIRHEAD**
- ***http://www.journalijar.com/article/17892/principal-component-analysis-as-a-ranking-tool---a-case-of-world-universities./***

➢ *Software used :-*

- ***Rstudio***
- ***Minitab 21 Statistical Software***
- ***Microsoft Excel 2016***
- ***Microsoft Word 2016***

ASUTOSH COLLEGE

Estd.1916

92, S.P.Mukherjee Road, Kolkata-26

AFFILIATED TO THE UNIVERSITY OF CALCUTTA

CERTIFICATE

This is certify that the project paper entitled "**RANKING SYSTEM OF TOP 98 EUROPEAN TEAMS AND TOP 100 STRIKERS IN EUROPE'S TOP 5 LEAGUES IN THE YEAR 2017-18"** submitted by Saunak Mitra in partial fullfilment of the requirement for the Bachelor degree of Statistics (Honours) is based upon the result of benefited research work carried out by the investigator under my guidance and supervision.The results of the investigator reported in this project paper have not so far been submitted for any degree or diploma.

Dr. Parthasarathi Bera
Assistant professor
Department of statistics
Asutosh college
Kolkata- 26

DECLARATION :

I Saunak Mitra , a student of B.Sc sem-u6, Statistics Honors, of University of Calcutta, Registration no-012-1111-1006-19 Roll no-193012-21-0396 hereby declare that I have done this piece of project work entitled as " Ranking system of top 98 football teams in European top 5 leagues of the year 2017-18 & Ranking system of top 100 strikers in European Top 5 leagues of the year 2017-18." under the supervision of Dr. Parthasarathi Bera(Assistant professor, Department of Statistics , Asutosh College) as a part of B.Sc. Sem-6 examination according to the syllabus paper DSE-B2 T5.

I further declare that the piece of project work has not been published elsewhere for any degree or diploma or taken from any published project.

Signature

ACKNOWLEDGEMENT:

I am indebted to number of person for helping me in the preparation of this project.

Firstly, Dr. Apurba Roy , Vice- Principal ,Asutosh College, university of Calcutta. Without whose help I couldn't have been a part of this prestigious college.

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This project is not only a mere project. It is the memories spend with the whole department which has created a mutual understanding among us. There are many emotions related to this piece of work, especially respect and duty towards teachers and vice versa; educational attachment with my friends; social attachment with my college.

……

Saunak Mitra

Student, Department of Statistics

Appendix:

❖ ***Codes used for this project work:-***
https://drive.google.com/file/d/1vXZxIkYpo01lqSwJ2kTSsxJqbIxsauPP/view?usp=sharing

- **Source of Team's Data :**
https://www.kaggle.com/datasets/suwadith/europes-top-5-league-tables-2009-2018

1.7TEAM'S DATA:

Rank	Team	Played	Win	Draw	Loss	Goals For	Goals Against	Goal Difference	Points
1	Bayern Munich	34	27	3	4	92	28	64	84
2	Schalke 04	34	18	9	7	53	37	16	63
3	Hoffenheim	34	15	10	9	66	48	18	55
4	Borussia Dortmund	34	15	10	9	64	47	17	55
5	Bayer Leverkusen	34	15	10	9	58	44	14	55
6	RasenBallsport Leipzig	34	15	8	11	57	53	4	53
7	VfB Stuttgart	34	15	6	13	36	36	0	51
8	Eintracht Frankfurt	34	14	7	13	45	45	0	49
9	Borussia M.Gladbach	34	13	8	13	47	52	-5	47
10	Hertha Berlin	34	10	13	11	43	46	-3	43
11	Werder Bremen	34	10	12	12	37	40	-3	42
12	Augsburg	34	10	11	13	43	46	-3	41
13	Hannover 96	34	10	9	15	44	54	-10	39
14	Mainz 05	34	9	9	16	38	52	-14	36
15	Freiburg	34	8	12	14	32	56	-24	36
16	Wolfsburg	34	6	15	13	36	48	-12	33

17	Hamburger SV	34	8	7	19	29	53	-24	31
18	FC Cologne	34	5	7	22	35	70	-35	22
Rank	Team	Played	Win	Draw	Loss	Goals For	Goals Against	Goal Difference	Points
1	Barcelona	38	28	9	1	99	29	70	93
2	Atletico Madrid	38	23	10	5	58	22	36	79
3	Real Madrid	38	22	10	6	94	44	50	76
4	Valencia	38	22	7	9	65	38	27	73
5	Villarreal	38	18	7	13	57	50	7	61
6	Real Betis	38	18	6	14	60	61	-1	60
7	Sevilla	38	17	7	14	49	58	-9	58
8	Getafe	38	15	10	13	42	33	9	55
9	Eibar	38	14	9	15	44	50	-6	51
10	Girona	38	14	9	15	50	59	-9	51
11	Espanyol	38	12	13	13	36	42	-6	49
12	Real Sociedad	38	14	7	17	66	59	7	49
13	Celta Vigo	38	13	10	15	59	60	-1	49
14	Deportivo Alaves	38	15	2	21	40	50	-10	47
15	Levante	38	11	13	14	44	58	-14	46
16	Athletic Bilbao	38	10	13	15	41	49	-8	43
17	Leganes	38	12	7	19	34	51	-17	43
18	Deportivo La Coruna	38	6	11	21	38	76	-38	29
19	Las Palmas	38	5	7	26	24	74	-50	22
20	Malaga	38	5	5	28	24	61	-37	20
Rank	Team	Played	Win	Draw	Loss	Goals For	Goals Against	Goal Difference	Points
1	Paris Saint-Germain	38	29	6	3	108	29	79	93
2	Monaco	38	24	8	6	85	45	40	80
3	Lyon	38	23	9	6	87	43	44	78
4	Marseille	38	22	11	5	80	47	33	77
5	Rennes	38	16	10	12	50	44	6	58
6	Bordeaux	38	16	7	15	53	48	5	55
7	Saint-Etienne	38	15	10	13	47	50	-3	55
8	Nice	38	15	9	14	53	52	1	54
9	Nantes	38	14	10	14	36	41	-5	52
10	Montpellier	38	11	18	9	36	33	3	51
11	Dijon	38	13	9	16	55	73	-18	48
12	Guingamp	38	12	11	15	48	59	-11	47
13	Amiens	38	12	9	17	37	42	-5	45
14	Angers	38	9	14	15	42	52	-10	41
15	Strasbourg	38	9	11	18	44	67	-23	38
16	Caen	38	10	8	20	27	52	-25	38
17	Lille	38	10	8	20	41	67	-26	38
18	Toulouse	38	9	10	19	38	54	-16	37
19	Troyes	38	9	6	23	32	59	-27	33
20	Metz	38	6	8	24	34	76	-42	26
Rank	Team	Played	Win	Draw	Loss	Goals For	Goals Against	Goal Difference	Points
1	Manchester City	38	32	4	2	106	27	79	100
2	Manchester United	38	25	6	7	68	28	40	81

3	Tottenham	38	23	8	7	74	36	38	77
4	Liverpool	38	21	12	5	84	38	46	75
5	Chelsea	38	21	7	10	62	38	24	70
6	Arsenal	38	19	6	13	74	51	23	63
7	Burnley	38	14	12	12	36	39	-3	54
8	Everton	38	13	10	15	44	58	-14	49
9	Leicester	38	12	11	15	56	60	-4	47
10	Newcastle United	38	12	8	18	39	47	-8	44
11	Crystal Palace	38	11	11	16	45	55	-10	44
12	Bournemouth	38	11	11	16	45	61	-16	44
13	West Ham	38	10	12	16	48	68	-20	42
14	Watford	38	11	8	19	44	64	-20	41
15	Brighton	38	9	13	16	34	54	-20	40
16	Huddersfield	38	9	10	19	28	58	-30	37
17	Southampton	38	7	15	16	37	56	-19	36
18	Swansea	38	8	9	21	28	56	-28	33
19	Stoke	38	7	12	19	35	68	-33	33
20	West Bromwich Albion	38	6	13	19	31	56	-25	31

Rank	Team	Played	Win	Draw	Loss	Goals For	Goals Against	Goal Difference	Points
1	Juventus	38	30	5	3	86	24	62	95
2	Napoli	38	28	7	3	77	29	48	91
3	Roma	38	23	8	7	61	28	33	77
4	Inter	38	20	12	6	66	30	36	72
5	Lazio	38	21	9	8	89	49	40	72
6	AC Milan	38	18	10	10	56	42	14	64
7	Atalanta	38	16	12	10	57	39	18	60
8	Fiorentina	38	16	9	13	54	46	8	57
9	Sampdoria	38	16	6	16	56	60	-4	54
10	Torino	38	13	15	10	54	46	8	54
11	Sassuolo	38	11	10	17	29	59	-30	43
12	Genoa	38	11	8	19	33	43	-10	41
13	Chievo	38	10	10	18	36	59	-23	40
14	Udinese	38	12	4	22	48	63	-15	40
15	Cagliari	38	11	6	21	33	61	-28	39
16	Bologna	38	11	6	21	40	52	-12	39
17	SPAL 2013	38	8	14	16	39	59	-20	38
18	Crotone	38	9	8	21	40	66	-26	35
19	Verona	38	7	4	27	30	78	-48	25
20	Benevento	38	6	3	29	33	84	-51	21

Source of Striker's Data :

- https://www.transfermarkt.co.in/statistik/topsc orer

1.8STRIKER'S DATA:

Club Name	Player Name	Matches	Goals	Assists
Barcelona	Lionel Messi	36	34	14
Liverpool	Mohamed Salah	36	32	11
Barcelona	Luis Suarez	33	25	13
Lazio	Ciro Immobile	33	29	8
PSG	Edinson Cavani	32	28	7
Tottenham Hotspur	Harry Kane	37	30	3
Marseille	Florian Thauvin	35	22	11
Manchester City	Raheem Sterling	33	18	15
PSG	Neymar Jr.	20	19	13
Lyon	Memphis Depay	36	19	13
Bayern Munich	Robert Lewandowski	30	29	2
Real Madrid	Cristiano Ronaldo	27	26	5
Inter Milan	Mauro Icardi	34	29	1
Arsenal	Pierre-Emerick Aubameyang	29	23	7
Atletico Madrid	Antoine Griezmann	32	19	9
Juventus	Paulo Dybala	33	22	5
Celta Vigo	Iago Aspas	34	22	5
Manchester City	Sergio Aguero	25	21	6
Barcelona	Philippe Coutinho	32	14	12
Lyon	Nabil Fekir	30	18	7
Lazio	Luis Alberto	34	11	14
Manchester City	Leroy Sane	32	10	15
Sampdoria	Fabio Quagliarella	35	19	5
Napoli	Dries Mertens	38	18	6
Manchester City	Kevin De Bruyne	37	8	16
Bayern Munich	Thomas Mueller	29	8	16
Celta Vigo	Maxi Gomez	36	18	5
Lyon	Mariano Diaz	34	18	5

Monaco	Radamel Falcao	26	18	5
Angers	Karl Toko Ekambi	37	17	6
Manchester United	Romelu Lukaku	34	16	7
Valencia	Rodrigo	37	16	7
Leicester City	Riyad Mahrez	36	12	11
Nice	Alassane Plea	35	16	6
Liverpool	Roberto Firmino	37	15	7
Monaco	Rony Lopes	38	15	7
Hoffenheim	Mark Uth	31	14	8
Inter Milan	Ivan Perisic	37	11	11
Leicester City	Jamie Vardy	37	20	1
Villarreal	Carlos Bacca	35	15	6
Leipzig	Timo Werner	32	13	8
Hoffenheim	Andrej Kramaric	34	13	8
Tottenham Hotspur	Christian Eriksen	37	10	11
Napoli	Jose Callejon	38	10	11
Monaco	Kylian Mbappe	28	13	7
Bologna	Simone Verdi	34	10	10

Tottenham Hotspur	Dele Alli	36	9	11
Manchester City	David Silva	29	9	11
Nice	Mario Balotelli	28	18	1
Real Madrid	Gareth Bale	26	16	3
Juventus	Gonzalo Higuain	35	16	3
Real Sociedad	Willian Jose	34	15	4
Arsenal	Alexandre Lacazette	32	14	5
Real Sociedad	Mikel Oyarzabal	35	12	7
Bordeaux	Malcom	35	12	7
Torino	Iago Falque	37	12	7
Atalanta	Josip Ilicic	31	11	8
Marseille	Dimitri Payet	31	6	13
AS Roma	Edin Dzeko	36	16	2
Fiorentina	Giovanni Simeone	38	14	4
Lille	Nicolas Pepe	36	13	5
Tottenham Hotspur	Heung-min Son	37	12	6
Borrusia M'gladbach	Thorgan Hazard	34	10	8
Levante	Jose Luis Morales	35	10	8
Napoli	Lorenzo Insigne	37	8	10
Bayern Munich	James Rodriguez	23	7	11
Espanyol	Gerard Moreno	38	16	1
Manchester City	Gabriel Jesus	29	13	4
Lyon	Bertrand Traore	31	13	4
Augsburg	Michael Gregoritsch	32	13	4

Chelsea	Alvaro Morata	31	11	6
PSG	Angel Di Maria	30	11	6
West Ham	Marko Arnautovic	31	11	6
Liverpool	Sadio Mane	29	10	7
Hoffenheim	Serge Gnabry	22	10	7
Arsenal	Aaron Ramsey	24	7	10
Freiburg	Nils Petersen	32	15	1
Metz	Nolan Roux	35	15	1
Bayer Leverkusen	Kevin Volland	31	14	2
Chelsea	Eden Hazard	34	12	4
Bayern Munich	Sandro Wagner	25	12	4
Rennais	Benjamin Bourigeaud	37	10	6
Alaves	Munir El Haddadi	33	10	6
Athletic Bilbao	Raul Garcia	34	10	6
Saint-Etienne	Jonathan Bamba	34	7	9
Manchester United	Paul Pogba	27	6	10
PSG	Goncalo Guedes	34	5	11
Real Madrid	Karim Benzema	32	5	11
Juventus	Douglas Costa	31	4	12
Getafe	Angel Rodriguez	33	13	2
Valencia	Simone Zaza	33	13	2
Lazio	Sergej Milinkovic-Savic	35	12	3
Augsburg	Alfred Finnbogason	22	12	3

Hertha Berlin	Salomon Kalou	31	12	3
Nantes	Emiliano Sala	36	12	3
Sampdoria	Duvan Zapata	31	11	4
Bayer Leverkusen	Leon Bailey	30	9	6
Manchester United	Alexis Sanchez	31	9	6
Wolfsburg	Daniel Didavi	30	9	6
Valencia	Dani Parejo	34	7	8