VOL. 2, NO. 11, November 2011 ISSN 2079-8407
Journal of Emerging Trends in Computing and Information Sciences

http://www.cisjournal.org

A MCDM Approach for Evaluating Bowlers Performance in IPL

Pabitra Kumar Dey [1], Dipendra Nath Ghosh [2] , Abhoy Chand Mondal [3]

[1]Department of Computer Application
Dr. B.C Roy Engineering College, Fuljhore, Durgapur-713206, West Bengal, India.

[2]Department of Computer Science and Engineering
Dr. B.C Roy Engineering College, Fuljhore, Durgapur-713206, West Bengal, India

[3]Department of Computer Science
The University of Burdwan, Burdwan-713104, West Bengal, India

{dey_pabitra@yahoo.co.in, ghoshdipen2003@yahoo.co.in, abhoy_mondal@yahoo.co.in}

ABSTRACT

Cricket is one of the most popular sports among every class of people. The contribution of individual team members to the overall team performance is more easily quantifiable in cricket and the performance evaluation of a player is a very critical issue. Indian Premier League T20 cricket tournament dataset has been considered to measure the performance evaluation of bowlers (Fast Bowler and Spinner). The study measures the performance of Fast-bowlers and Spinners of IPL (I, II and III) based on their economy rate, bowling average, bowling strike rate and other different criterion and evaluate their rankings according to their performances with the help of AHP and TOPSIS. Finally, evaluate performance of all players who played in all three IPL (I, II and III) by using AHP-TOPSIS and AHP-COPRAS and provide their rankings.

Keywords: *IPL, Performance Measurement, MCDM, AHP, TOPSIS, COPRAS, Ranking.*

1. INTRODUCTION

Relative to other team games cricket is one of the most popular games in the world. The use of analytical methods is very useful in cricket. Cricket is bat and ball game played between two teams having eleven players each. The game of cricket got a new dimension when the Indian Premier League (IPL), a competition of twenty over-a-side featuring eight teams named after various Indian cities/states started in 2008. The teams were franchisee driven and the players were selected through competitive bidding from a pool of available players. Due to its tremendous popularity media gives more preferences to this game in India. It is a sport in which statistics feature heavily **[1]** and these statistics give clear picture of each and every facet and players of cricket. The Board of Control of Cricket in India (BCCI) organizes the IPL Twenty-Twenty cricket tournament in each year.

Elderton **[5]** used the first statistical analysis of cricket data to demonstrate some of the fundamental aspects of Statistics. The performance of consistency in cricket and applied the geometrical distribution to model cricket scores based on results from test cricket by Wood **[6]**. Optimal batting strategies using dynamic programming model developed by Clarke **[2]**. Alternative batting averages when batsman remains not-out in one-day cricket are proposed by Kimber and Hansford & Damodaran **[3, 4]**. Norman and Clark & Ovens and Bukeit applied mathematical modeling approach to optimize the batting order of a team **[7, 8]**. Another area where several analytic works has been done is the rescheduling of the target for a rain truncated match, for the team batting second by Duckworth-Lewis **[11]** ,Jayadevan **[10],** Gurram and Narayanan **[9]** etc. Lemmer **[14]** discussed the performance of cricketers in the first T−20 world cup, Vig **[15]** studied the implications of having two cricket leagues in India viz. Indian Cricket League (ICL) and Indian Premier League (IPL), Ramani **[16]** reported IPL as a "…distorted form of commodity and consumer excess". Staden **[17]** developed a performance measure for cricketers in Twenty-20 cricket considering data from IPL-I. Several other research activities relate to players performance in IPL and their valuation in auction, some of such works are Parker, Burns and Natarajan **[18]** Rastogi and Deodhar **[12]** and Depken and Rajasekhar **[13]**. Hemant Saikia and et.al.**[32]** used Bayesian classification model to measure the performance of all rounders in IPL.

IPL T-20 cricket tournament dataset of session I, II and III has been considered to evaluate the bowlers' (fast-bowlers and spinners) performances separately for three sessions. We here select such players who played at least 3 matches, bowled for at least 8 overs and got minimum of 1 wicket in a particular IPL session. Different criterion such as Bowling Economy Rate (**Econ**), Average (**Avg**), Strike Rate (**SR**), total Wickets (**Wkts**), Over bowled (**Overs**) and no. of Matches played (**Mts**) have been considered for evaluating the bowlers' performances with the help of **AHP-TOPSIS** and to know their rank. Finally, the overall performances and rankings are produced for the bowlers who played all three versions of IPL with the help of **AHP-TOPSIS** and **AHP-COPRAS** separately in this study.

The paper is organized as follows: Indian Premier League and Bowlers' criterions for performance evaluation have been discussed in Section 2. Section 3 focuses on the basic concepts of MCDA and different techniques with IPL bowling analysis. Finally, section 4 concludes the paper.

2. INDIAN PREMIER LEAGUE AND BOWLERS' CRITERIONS

In cricket basically two types of bowlers are there. One is Fast bowler who bowled at high speed and to induce it to bounce off the pitch in an erratic fashion or move sideways through the air factors which make it difficult for the batsman to hit the ball cleanly and another is spin bowler who bowled with rapid rotation so that when it bounces on the pitch it will deviate and thus making it difficult for the batsman to hit the ball easily. The IPL is a game under the so-called Twenty20 (or T20) format of cricket. In April 2008, BCCI initiated the Indian Premier League, a Twenty-20 cricket tournament to be played among eight domestic teams, named after eight Indian states or cities but owned by franchise. The franchise formed their teams by competitive bidding from a collection of Indian and international players and the best of Indian up-and-coming talents. Team owners bid for the services of cricketers for a total of US $42 million. Each team can purchase a maximum of eight overseas players; though, only four can be considered in first eleven. The franchisees bid for the salaries that they are ready to offer to the players. Each player has a base price fixed by the IPL authorities and there is no upper limit. However, the salary offer is valid for three years only. As three seasons of IPL are already completed and from the next version of IPL two other teams join the league so the salary offer to the available cricketers are supposed to undergo substantial change. Such change should be related to the performance of cricketers in the yester seasons of IPL in domestic and international tournaments.

Previously evaluation of bowling performance has been done by taking two or three major attributes such as bowling average, economy rate and strike rate by some statistical method. In this study for performance measure of bowlers six different attributes are taken to be considered such as bowling economy rate, bowler's average, bowler's strike rate, no. of wickets has been taken, total no. of over bowled and total no. of matched played during one particular session of IPL.

The definitions of different attributes are as follows:

Economy Rate (***Econ***) = (Number of Runs/ Number of Over) (1)

Average (***Avg***) = (Number of Runs/ Number of Wickets) (2)

Strike Rate (***SR***) = (Number of Balls/ Number of Wickets) (3)

These three attributes are negative attributes since lower value of these attributes gives more preference to bowler performance. Other attributes are no. of Wickets (***Wkts***) taken, no. of Over (***Overs***) bowled during one IPL session and no. of Matches (***Mts***) played by a bowler in a series. These three attributes of bowlers are positive attribute since higher value of these gives more preference to bowler performance.

In twenty-twenty cricket the economy rate of bowler is the most powerful criteria followed by bowlers' average and bowlers' strike rate. No. of wickets is also a very important criteria for measuring the performance of bowler. Total no. of overs and no. of matches played is also important for judging the bowlers performance. If a bowler played only one match and bowled one or two overs and also got one or more wickets then he was best in his performance for that particular match but he may not be performed good enough for the whole series. So, players who satisfied all the following three conditions were selected in the training dataset:

1) The bowler who played at least 3 matches in an IPL session.
2) The bowler who bowled at least 5 overs in an IPL session.
3) The bowler who took at least 1 wicket during an IPL session.

3. MULTIPLE CRITERIA DECISION ANALYSIS (MCDA)

MCDA provides an approach that is able to handle a large amount of variables and alternatives assessed in various ways and consequently offer valuable assistance to the decision maker in mapping out the problem. A typical MCDA problem consists of a decision matrix with i number of alternatives and j number of criterions. Additionally, a set of weighting factors p_j are introduced to represent the relative significance of criteria in a particular application. The final goal of MCDA is to classify and/or rank the alternatives. The steps of MCDA are as follows:

1) Establish the decision objectives (goals) and identify the decision maker(s).
2) Identify the alternatives.
3) Identify the criteria (attributes) that are relevant to the decision problem.
4) For each of the criteria assign scores to measure the performance of the alternatives against each of these and construct an evaluation (decision) matrix.
5) Standardize the raw scores of decision matrix.
6) Determine a weight for each criterion to reflect how important it is to the overall decision.
7) Compute an overall assessment measure for each decision alternative.
8) Perform a sensitivity analysis to assess the robustness of the preference ranking.

3.1 Calculation of weights between criterions by AHP:

The pair-wise comparison method and the hierarchical model were developed in 1980 by T.L.Saaty in the context of the Analytical Hierarchy Process (AHP) **[19, 20]**. AHP is an approach for decision making that involves

structuring multiple choice criteria into a hierarchy, assessing the relative importance of these criteria, comparing alternatives for each criterion and determining an overall ranking of the alternatives **[21]**. AHP helps to capture both subjective and objective evaluation measures, providing a useful mechanism for checking the consistency of the evaluation measures and alternatives suggested by the team thus reducing bias in decision making **[22]**. Some of its applications include technology Choice **[24]** and vendor selection of a telecommunications system **[23]**.

The steps for implementing the AHP process for weighting the criterion are as follows:

Step 1: Perform Pair-wise Comparison (Saaty nine-point preference scale is adopted for constructing the pair-wise comparison matrix).

Table 1: Saaty's nine-point preference scale

Scale	Compare factor of i and j
1	Equally Important
3	Weakly Important
5	Strongly Important
7	Very Strongly Important
9	Extremely Important
2,4,6,8	Intermediate value between adjacent

Let A represents $n \times n$ pair-wise comparison matrix:

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ a_{21} & 1 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & 1 \end{bmatrix} \quad (4)$$

Step 2: Normalize the raw score by Geometric Mean as given below:

$$w_i = \frac{\left(\prod_{j=1}^{n} a_{ij}\right)^{1/n}}{\sum_{i=1}^{n}\left(\prod_{j=1}^{n} a_{ij}\right)^{1/n}} \qquad i, j = 1,2,...n \quad (5)$$

Step 3: Perform Consistency check.

Step 3a: Let C denotes a n-dimensional column vector describing the sum of the weighted values for the importance degrees of the attributes, then

$$C = [C_i]_{nx1} = AW^T, \qquad i = 1,2,...,n \quad (6),$$

where

$$AW^T = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ a_{21} & 1 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & 1 \end{bmatrix} [w_1, \ w_2, \ \dots, \ w_n] = \begin{bmatrix} c_1 \\ c_2 \\ \dots \\ c_n \end{bmatrix} \quad (7)$$

Step 3b: To avoid inconsistency in the pair-wise comparison matrix, Saaty **[19]** suggested the use of the maximum eigen value λ_{max} to calculate the effectiveness of judgment. The maximum eigen value λ_{max} can be determined as follows:

$$\lambda_{max} = \frac{\sum_{i=1}^{n} c.v_i}{n}, \qquad i = 1,2,...,n \quad (8)$$

Step 3c: With λ_{max} value, a consistency index (CI) can then be estimated by

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (9)$$

Step 3d: Consistency ratio (CR) can be used as a guide to check the consistency

$$CR = \frac{CI}{RI} \quad (10)$$

, where RI denotes the average random index with the value obtained by different orders of the pair-wise comparison matrices are shown in table 2. For consistent the value of CR ≤ 0.10.

Table 2: Table of random Index

Matrix Order	1,2	3	4	5	6	7	8
R.I.	0	0.52	0.89	1.12	1.26	1.36	1.41
Matrix Order	9	10	11	12	13	14	
R.I.	1.46	1.49	1.52	1.54	1.56	1.58	

The weight of several criterions is calculated with the help of AHP pair-wise comparison is shown in the table 3 and also satisfies the consistency checking of pair-wise comparison matrix.

Table3: Pair-wise comparison table between criterions

	MTS	OVERS	WKTS	AVG	SR	ECON
MTS	1.0000	1.0000	0.3333	0.2000	0.2500	0.1667
OVERS	1.0000	1.0000	0.5000	0.2500	0.3333	0.2500
WKTS	3.0000	2.0000	1.0000	0.5000	1.0000	0.5000
AVG	5.0000	4.0000	2.0000	1.0000	1.0000	1.0000
SR	4.0000	3.0000	1.0000	1.0000	1.0000	1.0000
ECON	6.0000	4.0000	2.0000	1.0000	1.0000	1.0000

	G.M.	W	Vector	Lamda
MTS	0.3749	0.0522	0.3154	6.0405
OVERS	0.4673	0.0651	0.3928	6.0354
WKTS	1.0699	0.1490	0.9080	6.0942
AVG	1.8493	0.2575	1.5531	6.0307
SR	1.5131	0.2107	1.2868	6.1070
ECON	1.9064	0.2655	1.6053	6.0468
Sum->	7.1809	1.0000	6.0613	36.3545

$\lambda_{max} = 6.0591, \quad C.I. = 0.0118, \quad C.R. = 0.0094 < 0.1$

From AHP the weights of different criterions are as follows:

Weight of MTS $= W_{MTS} = 0.0522$,
Weight of OVERS $= W_{OVERS} = 0.0651$,
Weight of AVG $= W_{AVG} = 0.2575$,
Weight of WKTS $= W_{WKTS} = 0.1490$,
Weight of SR $= W_{SR} = 0.2107$,
Weight of ECON $= W_{ECON} = 0.2655$.

3.2. Performance evaluation of Fast-Bowlers & Spinners by TOPSIS:

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), known as one of the most classical MCDM methods, was first developed by Hwang and Yoon **[26]**, is based on the idea that the chosen alternative should have the shortest distance from the positive ideal solution and on the other side the farthest distance of the negative ideal solution. In the process of TOPSIS, the performance ratings and the weights of the criteria are given as exact values. Abo-sinna and Amer **[25]** extend TOPSIS approach to solve multi-objective nonlinear programming problems. Jahanshahloo et al. **[27]** extend the concept of TOPSIS to develop a methodology for solving multi-criteria decision-making problems with interval data.

The steps of TOPSIS method are as follows:

Step 1: TOPSIS begins with a decision matrix having n criteria/attributes and m alternatives. The decision matrix is represented as

$$D = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \dots & \dots & \dots & \dots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \qquad (11)$$

Step 2: Obtain the normalized decision matrix by

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, \qquad j = 1, 2, \dots, n \qquad (12)$$

Step 3: Construct the weighted normalized matrix v_{ij}. This is calculated by multiplying each column of the matrix r_{ij} by the weight w_j, which is calculated by AHP. So, $v_{ij} = w_j . r_{ij}$ (13)

Step 4: Obtain the 'ideal' (best) and 'negative-ideal' (worst) solutions. The 'ideal' (best) and 'negative-ideal' (worst) solutions can be expressed as

$$v_j^+ = \left\{ \left(\max_i v_{ij} \mid j \in J \right), \left(\min_i v_{ij} \mid j \in J' \right) \mid i = 1, 2, \dots, m \right\}$$
$$= \left\{ v_1^+ \quad v_2^+ \quad \dots \quad v_n^+ \right\} \qquad (14)$$

$$v_j^- = \left\{ \left(\min_i v_{ij} \mid j \in J \right), \left(\max_i v_{ij} \mid j \in J' \right) \mid i = 1, 2, \dots, m \right\}$$
$$= \left\{ v_1^- \quad v_2^- \quad \dots \quad v_n^- \right\} \qquad (15)$$

,where J= (j =1, 2, ..., n)/j is associated with the beneficial attributes and J' =(j =1, 2, ..., n)/j is associated with the non-beneficial attributes.

Step 5: Determine the separation distance between the alternatives. The separation of each alternative from the 'ideal' solution is given by

$$S_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^+ \right)^2}, \quad i = 1, 2, \dots, m \qquad (16)$$

The separation from the 'negative-ideal' solution is denoted by

$$S_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^- \right)^2}, \quad i = 1, 2, \dots, m \qquad (17)$$

Step 6: Calculate the relative closeness to the ideal solution, which can be expressed as

$$C_i = \frac{S_i^-}{\left(S_i^+ + S_i^- \right)}, \qquad i = 1, 2, \dots, m \qquad (18)$$

Step 7: Rank the alternatives according to C_i values in descending order.

Table 4: Ranking of Fast-bowlers according their performance in IPL-III (2010)

Name	Mts	Overs	Runs	Wkts	Avg	SR	Econ	Result	Rank
KA Pollard	14	37	274	15	18.3	14.8	7.41	0.9427	**1**
SL Malinga	13	49	344	15	22.9	19.6	7.02	0.9313	**2**
RJ Harris	8	30.4	233	14	16.6	13.1	7.6	0.9207	**3**
Zaheer Khan	14	48.2	376	15	25.1	19.3	7.78	0.9174	**4**
R Vinay Kumar	14	46.1	396	16	24.8	17.3	8.58	0.9121	**5**
DE Bollinger	8	31	207	12	17.3	15.5	6.68	0.9106	**6**
DW Steyn	15	59	406	15	27.1	23.6	6.88	0.9034	**7**
SK Trivedi	11	35.3	260	11	23.6	19.4	7.32	0.8883	**8**
IK Pathan	14	46.2	426	15	28.4	18.5	9.19	0.8858	**9**
RP Singh	12	42	370	13	28.5	19.4	8.81	0.8789	**10**
AB Dinda	7	23.1	152	9	16.9	15.4	6.56	0.8739	**11**
WPUJC Vaas	6	22	139	9	15.4	14.7	6.32	0.8734	**12**
A Symonds	16	53	372	12	31	26.5	7.02	0.8614	**13**
SW Tait	8	31.1	264	10	26.4	18.7	8.47	0.8590	**14**
SE Bond	8	31	224	9	24.9	20.7	7.23	0.8581	**15**
Harmeet Singh	8	24	174	8	21.8	18	7.25	0.8547	**16**
P Sangwan	8	31	258	9	28.7	20.7	8.32	0.8421	**17**
JH Kallis	16	57	476	13	36.6	26.3	8.35	0.8383	**18**
MF Maharoof	7	24	206	8	25.8	18	8.58	0.8379	**19**
A Nehra	4	14	96	6	16	14	6.86	0.8356	**20**
JA Morkel	14	47.4	405	11	36.8	26	8.5	0.8250	**21**
T Thushara	4	14.3	101	5	20.2	17.4	6.97	0.8187	**22**
CK Langeveldt	3	11	88	5	17.6	13.2	8	0.8184	**23**
L Balaji	7	23.2	207	7	29.6	20	8.87	0.8146	**24**
Jaskaran Singh	6	14	139	6	23.2	14	9.93	0.8105	**25**
P Kumar	12	45	380	10	38	27	8.44	0.8103	**26**
UT Yadav	7	24	184	6	30.7	24	7.67	0.8026	**27**
JD Unadkat	3	10.2	85	4	21.3	15.5	8.23	0.8020	**28**
DP Nannes	9	34.1	224	7	32	29.3	6.56	0.8020	**29**
SR Watson	6	22	184	6	30.7	22	8.36	0.8015	**30**
JM Kemp	5	7.2	54	3	18	14.7	7.36	0.8011	**31**
RS Bopara	10	13	127	5	25.4	15.6	9.77	0.8009	**32**
J Theron	7	24	187	6	31.2	24	7.79	0.8008	**33**
I Sharma	7	25	236	7	33.7	21.4	9.44	0.7973	**34**
AB McDonald	4	14	138	5	27.6	16.8	9.86	0.7908	**35**
AD Mathews	14	37.3	314	8	39.3	28.1	8.37	0.7875	**36**
B Sharma	5	10	94	3	31.3	20	9.4	0.7648	**37**
SJ Srivastava	8	27	255	6	42.5	27	9.44	0.7519	**38**
LR Shukla	4	12	106	3	35.3	24	8.83	0.7518	**39**
MM Patel	4	13	118	3	39.3	26	9.08	0.7361	**40**
R Sathish	12	8	81	2	40.5	24	10.1	0.7252	**41**
R Bhatia	5	16	132	3	44	32	8.25	0.7131	**42**
MR Marsh	3	10	88	2	44	30	8.8	0.7055	**43**
J Sharma	3	8	89	2	44.5	24	11.1	0.7027	**44**
AB Agarkar	7	22	203	4	50.8	33	9.23	0.6932	**45**
DJ Bravo	10	26.1	228	4	57	39.3	8.71	0.6563	**46**
S Sreesanth	6	19	191	3	63.7	38	10.1	0.6201	**47**
Iqbal Abdulla	3	8.3	61	1	61	51	7.18	0.5851	**48**
R McLaren	10	34	270	4	67.5	51	7.94	0.5799	**49**
MS Gony	3	8	92	1	92	48	11.5	0.4606	**50**
S Tyagi	6	15.5	159	1	159	95	10	0.0449	**51**

Table 5: Ranking of Spinners according their performance in IPL-III (2010)

Name	Mts	Overs	Runs	Wkts	Avg	SR	Econ	Result	Rank
PP Ojha	16	58.5	429	21	20.43	16.81	7.29	0.8080	**1**
A Mishra	14	53	363	17	21.35	18.71	6.85	0.7844	**2**
Harbhajan Singh	15	53.3	377	17	22.18	18.88	7.05	0.7745	**3**
A Kumble	16	63.2	407	17	23.94	22.35	6.43	0.7618	**4**
M Muralitharan	12	48	329	15	21.93	19.2	6.85	0.7588	**5**
R Ashwin	12	48	293	13	22.54	22.15	6.1	0.7350	**6**
SB Jakati	11	38	291	13	22.38	17.54	7.66	0.7216	**7**
V Sehwag	14	5.4	23	3	7.67	11.33	4.06	0.6956	**8**
CRD Fernando	5	19	138	7	19.71	16.29	7.26	0.6686	**9**
PD Collingwood	8	14.5	101	5	20.2	17.8	6.81	0.6472	**10**
PP Chawla	14	49	367	12	30.58	24.5	7.49	0.6434	**11**
M Kartik	10	39	253	9	28.11	26	6.49	0.6332	**12**
BJ Hodge	4	5	41	2	20.5	15	8.2	0.6033	**13**
AP Dole	3	11	112	5	22.4	13.2	10.18	0.6007	**14**

TM Dilshan	6	8.1	70	3	23.33	16.33	8.57	0.5943	**15**
SK Warne	14	50	381	11	34.64	27.27	7.62	0.5932	**16**
SK Raina	16	23.5	178	6	29.67	23.83	7.47	0.5879	**17**
KP Pietersen	7	10	77	3	25.67	20	7.7	0.5844	**18**
Yuvraj Singh	14	23	152	5	30.4	27.6	6.61	0.5697	**19**
AG Murtaza	3	12	91	3	30.33	24	7.58	0.5470	**20**
R Sharma	6	20.4	167	5	33.4	24.8	8.08	0.5403	**21**
ST Jayasuriya	4	9	68	2	34	27	7.56	0.5076	**22**
S Ladda	5	15	143	4	35.75	22.5	9.53	0.5074	**23**
S Narwal	5	15.4	185	5	37	18.8	11.81	0.4944	**24**
CH Gayle	9	16	152	4	38	24	9.5	0.4904	**25**
YK Pathan	14	34	246	5	49.2	40.8	7.24	0.3857	**26**
DL Vettori	3	11.4	97	2	48.5	35	8.31	0.3733	**27**
RR Powar	7	23	160	3	53.33	46	6.96	0.3235	**28**
RG Sharma	16	19	153	2	76.5	57	8.05	0.1654	**29**

In 2010 (IPL - III), it is clear that top three fast-bowlers are foreigners whereas India's best fast bowler Zaheer Khan is in rank 4 followed by India's another bowler R.Vinay Kumar. In the case of spinners top 4 bowlers are Indian and PP.Ojha is in 1st rank followed by A.Mishra followed by Harbhajan Singh and followed by A.Kumble.

In 5th position one of the best spinners M.Murlitharan is placed. From this analysis it is very much clear that Indian spinners do better than Indian Fast Bowlers. The performance and rank of fast bowlers and spinners of IPL-III are shown in the table 4 and 5 respectively.

Table 6: Ranking of Fast-Bowlers according their performance in IPL-II (2009)

Player	Mts	Overs	Runs	Wkts	Avg	SR	Econ	Result	Rank
Singh, RP	16	59.4	417	23	18.13	15.57	6.99	0.9399	**1**
Nehra, A	13	51	346	19	18.21	16.11	6.78	0.9124	**2**
Malinga, SL	13	49.3	312	18	17.33	16.5	6.3	0.9066	**3**
Patel, MM	11	34.5	241	16	15.06	13.06	6.92	0.8741	**4**
Pathan, IK	14	50.2	389	17	22.88	17.76	7.73	0.8619	**5**
Sangwan, P	13	46.4	360	15	24	18.67	7.71	0.8354	**6**
Nannes, DP	13	49.3	372	15	24.8	19.8	7.52	0.8334	**7**
Abdulla, YA	9	28	241	14	17.21	12	8.61	0.8250	**8**
Balaji, L	13	37.2	316	13	24.31	17.23	8.46	0.8045	**9**
Morkel, JA	12	40	328	13	25.23	18.46	8.2	0.8036	**10**
Bhatia, R	8	21.4	146	10	14.6	13	6.74	0.8002	**11**
Bravo, DJ	11	33.1	259	11	23.55	18.09	7.81	0.7893	**12**
Kumar, P	13	49.4	394	13	30.31	22.92	7.93	0.7828	**13**
Sharma, I	11	43	297	11	27	23.45	6.91	0.7780	**14**
Symonds, A	8	24	160	7	22.86	20.57	6.67	0.7472	**15**
Vinay Kumar, R	11	32.2	271	9	30.11	21.56	8.38	0.7394	**16**
Mascarenhas, AD	5	19.2	132	6	22	19.33	6.83	0.7370	**17**
Zaheer Khan	6	21	142	6	23.67	21	6.76	0.7321	**18**
Maharoof, MF	3	10	65	4	16.25	15	6.5	0.7304	**19**
Trivedi, SK	7	20	152	6	25.33	20	7.6	0.7264	**20**
Akhil, B	6	11	80	4	20	16.5	7.27	0.7222	**21**
Lee, B	5	20	111	5	22.2	24	5.55	0.7218	**22**
Oram, JDP	11	15.3	133	5	26.6	18.6	8.58	0.7106	**23**
Tyagi, S	8	19	136	5	27.2	22.8	7.16	0.7096	**24**
Sreesanth, S	7	23	192	6	32	23	8.35	0.6986	**25**
Harwood, SM	3	10	73	3	24.33	20	7.3	0.6971	**26**
Edwards, FH	6	23.2	154	5	30.8	28	6.6	0.6899	**27**
Gony, MS	7	17	172	5	34.4	20.4	10.12	0.6730	**28**
Nanda, C	3	8	57	2	28.5	24	7.13	0.6715	**29**
Salvi, AM	5	17	134	4	33.5	25.5	7.88	0.6713	**30**
Harris, RJ	8	31	230	6	38.33	31	7.42	0.6649	**31**
Shukla, LR	9	14	100	3	33.33	28	7.14	0.6621	**32**
Steyn, DW	3	9	62	2	31	27	6.89	0.6595	**33**
Kulkarni, DS	8	26	206	5	41.2	31.2	7.92	0.6419	**34**
Ryder, JD	5	17	115	3	38.33	34	6.76	0.6300	**35**
Agarkar, AB	11	31	284	6	47.33	31	9.16	0.6207	**36**
Appanna, KP	5	12	87	2	43.5	36	7.25	0.5954	**37**
Dinda, AB	9	24	193	4	48.25	36	8.04	0.5915	**38**

Ganguly, SC	13	12	97	2	48.5	36	8.08	0.5757	**39**
Flintoff, A	3	11	105	2	52.5	33	9.55	0.5576	**40**
Henriques, MC	4	12.1	107	2	53.5	36.5	8.79	0.5473	**41**
Kallis, JH	15	46	353	6	58.83	46	7.67	0.5311	**42**
Singh, VR	5	9	82	1	82	54	9.11	0.3487	**43**
Smith, DR	8	14	124	1	124	84	8.86	0.0515	**44**

Table 7: Ranking of Spinners according their performance in IPL-II (2009)

Player	Mts	Overs	Runs	Wkts	Avg	SR	Econ	Result	Rank
Kumble, A	16	59.1	347	21	16.52	16.9	5.86	0.9510	**1**
Ojha, PP	15	53.3	348	18	19.33	17.83	6.5	0.9169	**2**
Muralidaran, M	13	50	261	14	18.64	21.43	5.22	0.8833	**3**
Mishra, A	11	42	294	14	21	18	7	0.8704	**4**
Jakati, SB	9	29	217	13	16.69	13.38	7.48	0.8642	**5**
Sharma, RG	16	23	161	11	14.64	12.55	7	0.8540	**6**
Harbhajan Singh	13	44	256	12	21.33	22	5.82	0.8539	**7**
Warne, SK	13	50	365	14	26.07	21.43	7.3	0.8480	**8**
Amit Singh	5	17.3	95	9	10.56	11.67	5.43	0.8403	**9**
Chawla, PP	14	44.5	308	12	25.67	22.42	6.87	0.8350	**10**
van der Merwe, RE	10	34	248	9	27.56	22.67	7.29	0.7977	**11**
Raina, SK	14	27.4	164	7	23.43	23.71	5.93	0.7952	**12**
Hodge, BJ	12	20	161	7	23	17.14	8.05	0.7905	**13**
Kamran Khan	5	17.4	124	6	20.67	17.67	7.02	0.7902	**14**
Jayasuriya, ST	12	19	163	7	23.29	16.29	8.58	0.7857	**15**
Yuvraj Singh	14	20	142	6	23.67	20	7.1	0.7844	**16**
Vettori, DL	7	23.1	181	7	25.86	19.86	7.81	0.7822	**17**
Suman, TL	12	15	108	5	21.6	18	7.2	0.7801	**18**
Jadeja, RA	13	23.2	151	6	25.17	23.33	6.47	0.7799	**19**
Nayar, AM	13	12	84	4	21	18	7	0.7731	**20**
Pietersen, KP	6	13	85	4	21.25	19.5	6.54	0.7713	**21**
Mota, WA	8	9	61	3	20.33	18	6.78	0.7649	**22**
Powar, RR	9	21	132	5	26.4	25.2	6.29	0.7645	**23**
Duminy, J-P	13	17.3	93	4	23.25	26.25	5.31	0.7632	**24**
Botha, J	3	12	74	3	24.67	24	6.17	0.7497	**25**
Pathan, YK	13	35	243	7	34.71	30	6.94	0.7485	**26**
Shoaib Ahmed	8	17	152	5	30.4	20.4	8.94	0.7446	**27**
Venugopal Rao, Y	16	15	122	4	30.5	22.5	8.13	0.7409	**28**
Mendis, BAW	4	16	117	3	39	32	7.31	0.6943	**29**
Kartik, M	10	34	201	4	50.25	51	5.91	0.6217	**30**
Bansal, HS	7	22.5	192	3	64	45.67	8.41	0.5685	**31**
Gayle, CH	7	18.5	144	1	144	113	7.65	0.0445	**32**

In 2009 (IPL - II), two Indian players are in top positions for both (Fast-bowling & Spin) category. RP.Singh and A.Nehra of India took place 1st and 2nd position whereas Sl.Malinga was placed in the 3rd position in fast bowling category. A.Kumble and PP.Ojha are in 1st and 2nd places respectively from Indians and M.Murlitharan in 3rd position.

Although this IPL session-II played in South Africa, the Indian bowlers did better than South African bowlers in both the bowling categories. The performance and rank of fast bowlers and spinners of IPL-II are shown in the table 6 and 7 respectively.

Table 8: Ranking of Fast-Bowlers according their performance in IPL-I (2008)

Player	Mts	Overs	Runs	Wkts	Avg	SR	Econ	Result	Rank
Sohail Tanvir	11	41.1	266	22	12.09	11.23	6.46	0.9396	**1**
Maharoof, MF	10	36	249	15	16.6	14.4	6.92	0.8283	**2**
Sreesanth, S	15	51.1	442	19	23.26	16.16	8.64	0.8213	**3**
Watson, SR	15	54.1	383	17	22.53	19.12	7.07	0.8188	**4**
Morkel, JA	13	48	399	17	23.47	16.94	8.31	0.8028	**5**
Mahesh, VY	11	42.1	370	16	23.13	15.81	8.77	0.7846	**6**
Gony, MS	16	60	443	17	26.06	21.18	7.38	0.7810	**7**
Pathan, IK	14	53	350	15	23.33	21.2	6.6	0.7792	**8**
Umar Gul	6	22.3	184	12	15.33	11.25	8.18	0.7666	**9**
Kulkarni, DS	10	29.3	236	11	21.45	16.09	8	0.7323	**10**
Bravo, DJ	9	28.2	232	11	21.09	15.45	8.19	0.7321	**11**
Singh, RP	14	51.2	442	15	29.47	20.53	8.61	0.7217	**12**
Zaheer Khan	11	42	357	13	27.46	19.38	8.5	0.7142	**13**
Patel, MM	15	55	420	14	30	23.57	7.64	0.7044	**14**
Balaji, L	9	33	286	11	26	18	8.67	0.6962	**15**
Nehra, A	14	44.5	348	12	29	22.42	7.76	0.6895	**16**
Steyn, DW	10	38	252	10	25.2	22.8	6.63	0.6881	**17**
Trivedi, SK	15	48	399	13	30.69	22.15	8.31	0.6871	**18**
Pollock, SM	13	46	301	11	27.36	25.09	6.54	0.6820	**19**

Smith, DR	4	11	83	5	16.6	13.2	7.55	0.6707	**20**
McGrath, GD	14	54	357	12	29.75	27	6.61	0.6707	**21**
Ganguly, SC	13	20	128	6	21.33	20	6.4	0.6630	**22**
Agarkar, AB	9	26	207	8	25.88	19.5	7.96	0.6589	**23**
Shukla, LR	13	11.6	124	6	20.67	12	10.33	0.6510	**24**
Dinda, AB	13	39	260	9	28.89	26	6.67	0.6418	**25**
Kumar, P	13	44.4	366	11	33.27	24.36	8.19	0.6355	**26**
Sharma, J	8	24.4	239	8	29.88	18.5	9.69	0.6217	**27**
Bhatia, R	9	22	183	6	30.5	22	8.32	0.5966	**28**
Vaas, WPUJC	5	17	145	5	29	20.4	8.53	0.5942	**29**
Singh, VR	13	48	420	11	38.18	26.18	8.75	0.5874	**30**
Lee, B	4	16	112	4	28	24	7	0.5848	**31**
Amarnath, P	6	22	236	7	33.71	18.86	10.73	0.5747	**32**
Mohammad Asif	8	32	296	8	37	24	9.25	0.5623	**33**
Ntini. M	9	35	242	7	34.57	30	6.91	0.5598	**34**
Hopes, JR	11	28	276	7	39.43	24	9.86	0.5313	**35**
Vinay Kumar, R	8	23	182	5	36.4	27.6	7.91	0.5285	**36**
Sangwan, P	7	24	215	5	43	28.8	8.96	0.4693	**37**
Kalyankrishna, D	3	8	87	2	43.5	24	10.88	0.4479	**38**
Sharma, I	13	42.1	329	7	47	36.14	7.8	0.4393	**39**
Oram, JDP	4	16	149	3	49.67	32	9.31	0.3839	**40**
Vijaykumar, DP	9	25.2	199	4	49.75	38	7.86	0.3763	**41**
Zoysa, DNT	3	11	99	2	49.5	33	9	0.3744	**42**
Bangar, SB	11	25	219	4	54.75	37.5	8.76	0.3341	**43**
Styris, SB	8	27	199	3	66.33	54	7.37	0.2042	**44**
Akhil, B	7	17.2	134	2	67	52	7.73	0.1842	**45**
Kallis. JH	11	34.2	311	4	77.75	51.5	9.06	0.1358	**46**
Salunkhe, D	6	8	78	1	78	48	9.75	0.0880	**47**

In 2008 (IPL – I), the best bowlers are foreigner in both the bowling categories. Two foreigners Sohail Tanvir and MF. Maharoof placed at 1st and 2nd position respectively and S.Sreesanth placed at 3rd position in fast-bowling category is shown in the table 8.

Two Indian bowlers PP.Chawla and A.Mishra followed Shane Warne in spin category is shown in the table 9. The performance of Indian bowlers was not so good in this IPL but the performance of Indian bowlers was very much accurate in IPL-II and IPL-III.

Table 9: Ranking of Spinners according their performance in IPL-I (2008)

Player	Mts	Overs	Runs	Wkts	Avg	SR	Econ	Result	Rank
Warne, SK	15	52	404	19	21.26	16.42	7.77	0.8883	**1**
Chawla, PP	15	46.5	389	17	22.88	16.53	8.31	0.8506	**2**
Mishra, A	6	20	138	11	12.55	10.91	6.9	0.7715	**3**
Fernando, CRD	5	20	160	10	16	12	8	0.7401	**4**
Ojha, PP	13	37	284	11	25.82	20.18	7.68	0.7247	**5**
Shahid Afridi	10	30	225	9	25	20	7.5	0.6890	**6**
Harbhajan Singh	3	10	82	5	16.4	12	8.2	0.6521	**7**
Pathan, YK	16	28.1	230	8	28.75	21.13	8.17	0.6484	**8**
Muralidaran M	15	58	404	11	36.73	31.64	6.97	0.6225	**9**
Raje, RR	6	16.2	137	5	27.4	19.6	8.39	0.6004	**10**
Yuvraj Singh	15	9	83	3	27.67	18	9.22	0.5727	**11**
Powar, RR	5	12	91	3	30.33	24	7.58	0.5491	**12**
Kumble, A	10	38.2	304	7	43.43	32.86	7.93	0.5044	**13**
Mohammad Hafeez	8	10	68	2	34	30	6.8	0.5041	**14**
Jayasuriya, ST	14	21	159	4	39.75	31.5	7.57	0.4922	**15**
Kartik, M	6	14.4	127	3	42.33	29.33	8.66	0.4600	**16**
Sehwag, V	14	11	133	3	44.33	22	12.09	0.4591	**17**
Shoaib Malik	7	8.3	85	2	42.5	25.5	10	0.4538	**18**
Gagandeep Singh	4	14	141	3	47	28	10.07	0.4267	**19**
Hussey, DJ	13	13	130	2	65	39	10	0.2585	**20**
Venugopal Rao, Y	11	14	137	2	68.5	42	9.79	0.2213	**21**
Joshi, SB	4	9.1	82	1	82	55	8.95	0.1274	**22**

3.3. Overall Performance Evaluation of Bowlers by COPRAS:

In 1996, Zavadskas, Kaklauskas created a method named COmplex PRoportional ASsessment (COPRAS) in **[28]**. It is used for multi-criteria evaluation of both maximizing and minimizing criteria values. This is the advantage of the method COPRAS over AHP method. This method assumes direct and proportional dependence of the significance and utility degree of investigated versions on a system of criteria adequately describing the alternatives and on values and weights of the criteria. Determination of significance, the priority order and utility degree of the alternatives is carried out in **[29].** Selection of contractor by using COPRAS and COPRAS-G was proposed by Zavadskas and et.al. **[30]**.

The procedure of the COPRAS method consists of the following steps:

Step 1: Selection of the available set most important attributes which describe alternatives.

Step 2: Preparing of the decision-making matrix X:

$$X = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1m} \\ x_{21} & x_{22} & \dots & x_{2m} \\ \dots & \dots & \dots & \dots \\ x_{n1} & x_{n2} & \dots & x_{nm} \end{bmatrix} \quad (19)$$

, where n = number of alternatives and m= number of attributes.

Step 3: Determining weights of the attributes q_j by AHP.

Step 4: Normalization of the decision-making matrix $\overline{X}$ by

$$\overline{x_{ij}} = \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}}; \quad i = \overline{1,n} \quad and \; j = \overline{1,m} \quad (20)$$

Step 5: Calculation of the weighted normalized decision matrix $\hat{X}$. The weighted normalized values $\hat{x}_{ij}$ are calculated as:

$$\hat{x_{ij}} = \overline{x_{ij}}.q_j; \quad i = \overline{1,n} \quad and \quad j = \overline{1,m} \quad (21)$$

Step 6: Sums P_j of attributes values which larger values are more preferable (optimization direction is maximization) calculation for each alternative (line of the decision-making matrix): $P_j = \sum_{i=1}^{k} \hat{x}ij$ (22)

Step 7: Sums R_j of attributes values which larger values are more preferable (optimization direction is maximization) calculation for each alternative (line of the decision-making matrix):

$$R_j = \sum_{i=k+1}^{n} \hat{x}ij \quad (23)$$

Step 8: Calculation of the relative weight of each alternative Q_j:

$$Q_j = P_j + \frac{\sum_{j=1}^{n} R_j}{R_j \sum_{j=1}^{n} \frac{1}{R_j}} \quad (24)$$

Step 9: Calculation of the utility degree of each alternative:

$$N_j = \frac{Q_j}{Q_{\max}} 100\% \quad (25)$$

Table 10: Ranking of Bowler according their performance in IPL-I, II, III by AHP-TOPSIS & AHP-COPRAS

Player Name	Overall Actual Dataset							TOPSIS		Copras	
	Mts	Overs	Runs	Wkts	Avg	SR	Econ	Value	Rank	Value	Rank
PP Ojha	44	148.8	1061	50	21.22	17.86	7.13	0.9008	1	1.0003	1
A Mishra	31	115	795	42	18.93	16.43	6.91	0.8648	2	0.9864	2
A Kumble	42	160.5	1058	45	23.51	21.40	6.59	0.8167	4	0.9452	3
RP Singh	42	152.6	1229	51	24.10	17.95	8.05	0.8180	3	0.9444	4
IK Pathan	42	149.4	1165	47	24.79	19.07	7.80	0.8019	5	0.9194	5
A Nehra	31	109.5	790	37	21.35	17.76	7.21	0.7966	6	0.9104	6
Harbhajan Singh	31	107.3	715	34	21.03	18.94	6.66	0.7757	7	0.9089	7
M Muralitharan	40	156	994	40	24.85	23.40	6.37	0.7456	10	0.8979	8
SK Warne	42	152	1150	44	26.14	20.73	7.57	0.7619	8	0.8910	9
PP Chawla	43	140	1064	41	25.95	20.49	7.60	0.7498	9	0.8770	10
MF Maharoof	20	70	520	27	19.26	15.56	7.43	0.7187	12	0.8766	11
MM Patel	30	102.5	779	33	23.61	18.64	7.60	0.7285	11	0.8467	12
JA Morkel	39	135.4	1132	41	27.61	19.81	8.36	0.7061	13	0.8418	13
Zaheer Khan	31	111.2	875	34	25.74	19.62	7.87	0.6997	14	0.8215	14
SK Trivedi	33	103.3	811	30	27.03	20.66	7.85	0.6482	16	0.7867	15
L Balaji	29	93.4	809	31	26.10	18.08	8.66	0.6603	15	0.7858	16
DW Steyn	28	106	720	27	26.67	23.56	6.79	0.6227	17	0.7791	17
R Vinay Kumar	33	101.3	849	30	28.30	20.26	8.38	0.6223	18	0.7658	18
P Sangwan	28	101.4	833	29	28.72	20.98	8.21	0.6065	21	0.7517	19
P Kumar	38	138.8	1140	34	33.53	24.49	8.21	0.5411	25	0.7498	20
R Bhatia	22	59.4	461	19	24.26	18.76	7.76	0.6108	19	0.7488	21
DJ Bravo	30	87.4	719	26	27.65	20.17	8.23	0.6066	20	0.7487	22
AB Dinda	29	86.1	605	22	27.50	23.48	7.03	0.5754	23	0.7389	23
S Sreesanth	28	93.1	825	28	29.46	19.95	8.86	0.5835	22	0.7302	24
Yuvraj Singh	43	52	377	14	26.93	22.29	7.25	0.5426	24	0.7158	25
MS Gony	26	85	707	23	30.74	22.17	8.32	0.5278	26	0.6939	26
I Sharma	31	110.1	862	25	34.48	26.42	7.83	0.4549	29	0.6831	27
LR Shukla	26	37.6	330	12	27.50	18.80	8.78	0.5254	27	0.6613	28
YK Pathan	43	97.1	719	20	35.95	29.13	7.40	0.3890	30	0.6576	29
ST Jayasuriya	30	49	390	13	30.00	22.62	7.96	0.4850	28	0.6521	30
M Kartik	26	87.4	581	16	36.31	32.78	6.65	0.3452	32	0.6088	31
AB Agarkar	27	79	694	18	38.56	26.33	8.78	0.3376	33	0.5981	32
JH Kallis	42	137.2	1140	23	49.57	35.79	8.31	0.1979	34	0.5909	33
RR Powar	21	56	383	11	34.82	30.55	6.84	0.3575	31	0.5836	34

Finally, the overall performance of bowlers who played all three version of IPL and satisfied the conditions for selecting the players' i.e; the players who played at least 3 matches with minimum of 5 over bowled and took at least 1 wicket. At first the performances of bowlers are calculated according the procedure describe in the section 3.2. Then according the procedure of COPRAS the bowling performance of bowlers are calculated and their ranked is shown in the table 10. The result of AHP-TOPSIS and AHP-COPRAS of the bowlers are very similar which suggest that this study is very accurate to evaluate the bowlers' performance in IPL.

4. CONCLUSION

The salary of IPL cricket players are decided through auction. Thus, it is a matter of decision making from the part of the franchise to decide about which player to be bided for and at what cost by the performance of the players in IPL. Therefore, such a model can help a franchisee to take a decision. The paper seeks to highlight the tremendous scope that exists to improve and develop on the measures currently used to describe the performances of cricket players in general especially for bowlers. In 2010 session the Indian spinners have done better than the Indian fast-bowlers whereas in 2009 session Indian bowlers have done well in both the categories but in 2008 the top bowlers are foreigners in both categories. But in overall performance the Indian bowlers are very good and top 7 bowlers are Indians and in top 10 only two foreigners are there. The performance of 'Zaheer Khan', Indian one of the best bowler was not good enough during IPL. SK Warne & M. Muralitharan, the best spinners of the world did not get the rank in top 5 bowlers. AHP-TOPSIS and AHP-COPRAS give similar type result in overall performance of bowlers proof the accuracy of proposed technique. Similar approaches can be adopted to represent the performances of batsmen, all-rounder and wicket keepers too.

REFERENCES

[1] Alan C. Kimbert and Alan R. Hansford, "A Statistical Analysis of Batting in Cricket", J. R. Statist. Soc. A (1993) 156, Part 3, pp. 443-455.
[2] Clarke, S R (1988). "Dynamic programming in one-day cricket- optimal scoring rates," Journal of the Operational Research Society, 50, 536 – 545.
[3] Kimber, A C and Hansford, A R (1993). "A Statistical Analysis of Batting in Cricket," Journal of Royal Statistical Society, 156, 443 – 455.
[4] Damodaran, U (2006). "Stochastic Dominance and Analysis of ODI Batting Performance: The Indian Cricket Team, 1989-2005," Journal of Sports Science and Medicine, 5, 503 – 508.
[5] Elderton, W P (1945). "Cricket scores and some skew correlation distribution," Journal of Royal Statistical Society (Series A), 108, 1 – 11.
[6] Wood, G H (1945). "Cricket scores and geometric progression," Journal of Royal Statistical Society, Series A (Statistics in Society) 108, 12 – 22.
[7] Norman, J and Clarke, S R (2004). "Dynamic programming in cricket: Batting on sticky wicket," Proceedings of the 7th Australasian Conference on Mathematics and Computers in Sport, 226 – 232.
[8] Ovens, M and Bukeit, B (2006). "A mathematical modeling approach to one day cricket batting orders," Journal of Sports Science and Medicine, 5, 495-502.
[9] Gurram, M and Narayanan, S (2004). "Comparison of the methods to reset targets for interrupted One-Day Cricket Matches," Proceedings of 7th Australasian Conference on Mathematics and Computers in Sport, 165 – 171.
[10] Jayadevan, V (2002). "A new method for the computation of targets scores in interrupted, limited over cricket matches," Current Science, 83, 577 – 586.
[11] Duckworth, F C and Lewis, A J (1998). "A fair method of resetting the target in interrupted one-day cricket matches," Journal of Operational Research Society, 49, 220 – 227.
[12] Rastogi, S K and Deodhar, S Y (2009). "Player pricing and valuation of cricketing attributes: Exploring the IPL Twenty-20 vision," Vikalpa, 34 (2), 15 – 23.
[13] Depken, C. A. and Rajasekhar, R., (2010) Open Market Valuation of Player Performance in Cricket: Evidence from the Indian Premier League (April 1, 2010). Available at SSRN: http://ssrn.com/abstract= 1593196
[14] Lemmer, H (2008). "An analysis of players' performances in the first cricket Twenty20 world cup series," South African Journal for Research in Sport, 30, 71 -77.
[15] Vig, A (2008). "Efficiency of sports league – The economic implications of having two in the Indian cricket market," Masters Project: The University of Nottingham.
[16] Ramani, S.(2008)"Cricket, Excesses and Market Mania,"Economic & Political Weekly,March 8,13-15.
[17] Staden, P J (2009). "Comparison of cricketers' bowling and batting performances using graphical displays," Current Science, 96, 764-766.
[18] Parker, D., Burns, P and Natarajan, H., (2008) "Player valuations in the Indian Premier League," Frontier Economics, October 2008, 1-17.
[19] Saaty, T. L., The Analytic Hierarchy Process, McGraw-Hill, New York, 1980.
[20] Saaty, T. L., "Priority Setting in Complex Problems," IEEE Transactions on Engineering Management, Vol.30, No.3, pp.140-155, 1983.
[21] Christos Douligeris and Ian J. Pereira, "A Telecommunications Quality Study Using the Analytic Hierarchy Process," IEEE Journal on Selected Areas in Communications, Vol. 12, No. 2, 1994.

[22] Lai, V.S., Trueblood, R.P. and Wong, B.K., "Software selection: a case study of the application of the analytical hierarchical process to the selection of a multimedia authoring system," Information & Management, Vol. 25, No. 2, 1992.
[23] Maggie, C.Y.Tam, and V.M. Rao Tummala, "An application of the AHP in vendor selection of a telecommunications system," Omega, Vol. 29, pp.171-182, 2001.
[24] Akkineni, V.S. and Nanjundasastry, S., "The Analytic Hierarchy Process for Choice of Technologies," Technological Forecasting and Social Change, Vol. 38, pp.151-158, 1990.
[25] M.A. Abo-Sinna, A.H. Amer, Extensions of TOPSIS for multi-objective large-scale nonlinear programming problems, Applied Mathematics and Computation 162 (2005) 243–256.
[26] C.L. Hwang, K. Yoon, Multiple Attribute Decision Making Methods and Applications, Springer, Berlin Heidelberg, 1981.
[27] G.R. Jahanshahloo, F. Hosseinzadeh Lotfi, M. Izadikhah, An algorithmic method to extend TOPSIS for decision-making problems with interval data, Applied Mathematics and Computation (2005).
[28] A.Kaklauskas, E.K. Zavadskas. (1996). Multicriteria Evaluation of Building (Pastatų sistemotechninis įvertinimas). Vilnius: Technika.
[29] Kaklauskas, E.K. Zavadskas, S. Raslanas, Multivariant design and multiple criteria analysis of building refurbishments, Energy and Buildings 37 (2005) 361–372.
[30] E.K. Zavadskas, A. Kaklauskas, Z. Turskis and J. Tamosaitiene, "Contractor Selection Multi-Attribute Model Applying COPRAS Method with Grey Interval Numbers, 20th EURO Mini Conference "Continuous Optimization and Knowledge-Based Technologies" (EurOPT-2008), pp. 241–247.
[31] IPL T-20 tournament statistics available in http://www.iplt20.com.
[32] Saikia, Hemanta and Bhattacharjee Dibojyoti, "A Bayesian Classification Model for Predicting the Performance of All-Rounders in the Indian Premier League, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1622060.

Author's Bibliography

Mr. Pabitra Kumar Dey is currently Assistant Professor in the department of Computer Application, Dr. B.C.Roy Engineering College, Durgapur-713206, W.B., India. He obtained B.Sc.(Mathematics Hons.) from The University of Burdwan in 2000 and M.C.A. degree from National Institute of Technology, Durgapur, W.B. in 2004 and M.Tech.(CST) from W.B.U.T. in 2011. He has about more than of 7 years of Teaching Experience and 3 years of Research Experience. He published 9 research papers in reputed journal and in the proceedings of IEEE conference. The broad area of his research interest is in "Soft Computing (Fuzzy logic, Rough Set,…), Multi Criteria Analysis, Decision Theory, etc."

Dr. Dipendra Nath Ghosh is currently Associate Professor in the department of Computer Science & Engineering, Dr. B.C.Roy Engineering College, Durgapur-713206, W.B., India. He obtained M.Sc. in Mathematics & M.C.A. from University of Burdwan and Ph.D. in Computer Science from that University in 2008. He has over 09 years of teaching experience and 06 years of research experience. He is guiding M.Tech. & Ph.D. students and has 15 research papers to his credit.

Dr. Abhoy Chand Mondal is currently Associate Professor of Department of Computer Science, Burdwan University, W.B., India. He received his B.Sc.(Mathematics Hons.) from The University of Burdwan in 1987, M.Sc. (Math) and M.C.A. from Jadavpur University, in 1989, 1992 respectively. He received his Ph.D. from Burdwan University in 2004. He has 1 year industry experience and 18 years of teaching and research experience. No. of journal paper more than 15.