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Analytical Evaluation of Performance of Cricket Squad by ANP-DEA †

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Abstract: Different sports have a different fan base and in addition to this, there is a lot of craze, enthusiasm, and zeal among people mainly youngsters. Cricket is one among them which has tremendous popularity not only among youngsters but also among all age groups. This will create a kind of pressure among the team members to perform well in every game as well as on the selectors to select the best players for the opening, middle orders, wicketkeeping, and bowling from the pool of players. As the game cannot be won by a single player or by openers or others as well, rather it is a collective effort of all the members of the team. So, it is necessary and one of the most important tasks to choose the players wisely so that they play well in their respective position. In this study, we try to formulate a model using MCDM (Multicriteria Decision Making Techniques) which evaluates not only the performance of the players but also the performance of different sets (i.e., openers, middle orders, wicket-keepers, and bowlers) and for this, we propose a novel ANP-DEA (Analytic Network Process—Data Envelopment Analysis) Technique and evaluate the best and worst performing set and their performance evaluation. A case study is done to properly visualize the proposed model.

Keywords: Cricket; MCDM; ANP; DEA; Performance Evaluation

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1. Introduction

Cricket is one of the most popular sports in the world was originated in England in the 16th century and become its national game. As this game is not that much popular in Europe as in other countries like India, Sri Lanka, West Indies, and Australia. This game rather than just comprises of a single individual, is basically a game of many people which includes players, authorities, and selection committees [5,6]. As choosing a team is one of the challenging tasks for the higher authorities because there should be a proper balance and trade-off between the players whether they are batsmen, bowlers, or wicketkeepers. For earning a place in the playing eleven, each player should do their best. As the authorities can choose only the 11 players in the team and so other 3–4 members as the supporting member so that if any player gets injured, he/she got a chance to play and provide support to the team in absence of players [8]. Choosing a team is a cumbersome task that depends on many factors not only related to the physical health of the players but also their mental health is taken into account. The selection boards like ICC (International Cricket Conference) leave no way out to develop new ways and programs which help in producing teams that are suitable for playing national and international games [13,14]. This is a good combination of different types of players coming from different states with different abilities which contributes to the performance of the team [16]. While playing the game of cricket, there are basically different sets of players that are playing which come under openers, middle orders, wicket-keepers, and bowlers [17,19] and it is necessary for the team management for the proper trade-off between these players [24,25]. As the selection of the players within these sets is a cumbersome task that basically involves a lot of different criteria like No. of matches played, Runs Scored, Wickets Taken, Batting and Bowling Strike Rate, and other criteria [26]. So, in view of catering to all the criteria and for proper analysis of the problem we are using Multi-Criteria Decision Making Techniques here. In this paper, we are using the hybrid model ANP -DEA. ANP (Analytical Network Process) is basically an extension of AHP (Analytical Hierarchy Process) which is developed by Saaty in 1980 [2]. In ANP, we are using a network in place of an element hierarchy. As the interdependency of criteria is not considered in AHP [22,23] or many other MCDM techniques, the main reason behind using ANP as in real-life scenarios all issues are somehow interlinked with each other [11,20]. To rank the DMUs or here we can say players we are using DEA [1,7], the non-parametric technique for performance evaluation based on multiple inputs and outputs [4,18]. There are different models of DEA based on the need of the users, i.e input oriented or output oriented. Moreover, through DEA, we are not only recognizing the efficient DMUs [9,12] but it also tells us how to make inefficient DMUs close to the efficient DMUs [10,21] and makes a recommendation based on this. As in this paper we are dealing with choosing the best set of players for the team by taking into account the different criteria, so here we first analyze each set i.e., openers, middle orders, wicket-keepers, and bowlers using ANP based on the different criteria and importance of criteria according to the experts of the cricket and based on the weights that we get from ANP, we analyze the importance of each set and then finally find out the optimal players that may be selected for playing in the team by using DEA ranking scheme.

2. Methodology

First, we need to find the sets which contribute more in terms of other sets that we described above using ANP. Here we are taking 5 criteria i.e., No. of Matches, Batting Innings, Bowling Innings, Catches Taken & Stumps Made and 4 sub criteria's that belong to the Batting Innings and 4 to the Bowling Innings. Batting Innings sub-criteria are Not Out, Runs Scored, Batting Avg., and Batting Strike Rate. Bowling Innings sub-criteria are Maiden Bowled, Wickets Taken, Bowling Economy Rate and Bowling Strike Rate. The prototype of the ANP diagram is shown in Figure 1. For doing the pair-wise comparison, we have designed the questionnaire which was filled by the experts who are doing research in this. Different scores are assigned by the researchers based on the Saaty scale as shown in Table 1.

Table 1. Description of Saaty Scale.

Intensity	Description	Scale Value
Equal	A is equally important as B.	1–2
Moderate	A is a little more important than B.	3–4
Strong	A is more important than B.	5–6
Very Strong	A is very much more important than B.	7–8
Extreme	A is extremely important than B.	9

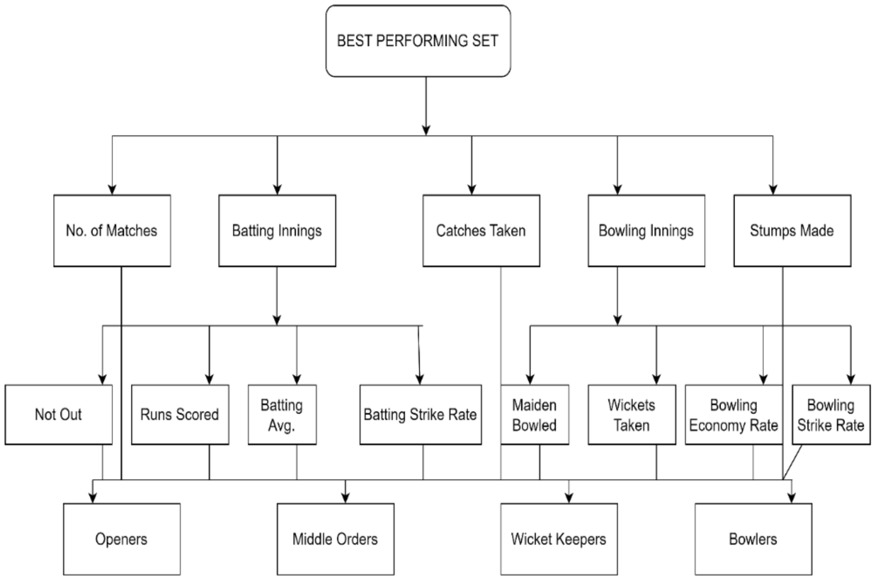

Figure 1. Prototype of ANP Diagram.

The algorithm for finding the best set of squads using ANP is as follows: -

1. The weights of the criteria's are determined without considering the interdependency between them and the weight of the criterion matrix is represented by J_1.
2. The weights of the sub—criteria's are determined without considering the interdependency between them and the weight of the sub criterion matrix is represented by J_2.
3. Now, interdependency among criteria is introduced and the weight of the criteria relative to each criterion is represented by J_3 and the final priority of the criteria is given by $J_5 = J_1 * J_3$.
4. Similarly, interdependency among sub-criteria is introduced and the weight of the sub-criteria relative to each sub-criterion is represented by J_4 and the final priority of the criteria is given by $J_6 = J_2 * J_4$.
5. The final priorities of the criteria are given by the multiplication of matrix $J_5 * J_6$.
6. The weights of the alternatives are given by the sum of the final priorities of each alternative that we get in Step 6.

The results that we get from the selection of the best set based on the criteria and subcriteria discussed above are as follows:—Table 2. shows the local and global weights of the criteria and subcriteria. Table 3. Shows the interdependency matrix and Table 4. and Table 5. shows the final priority matrix as well as the weights of the alternative.

Table 2. Local and Global weights of the criteria.

Criteria	Sub Criteria	Local Weights	Global Weights
Matches		0.053	0.053
Batting Innings	**Not Out**	0.06	0.01728
	Runs Scored	0.146	0.042048
	Batting Avg.	0.45	0.1296
	Batting Strike Rate	0.342	0.098496
Bowling Innings	**Maiden Bowled**	0.056	0.006608
	Wickets Taken	0.169	0.019942
	Bowling Economy Rate	0.429	0.050622
	Bowling Strike Rate	0.344	0.040592
Catches Taken		0.201	0.201
Stumps made		0.338	0.338

Table 3. Interdependency matrix.

	Matches	Not Out	Runs Scored	Batting Avg.	Batting Strike Rate	Maiden Bowled	Wickets Taken	BCR	BSR	Catches Taken	Stumps Made
Middle Orders	0.086	0.506	0.542	0.3	0.246	0.158	0.145	0.161	0.144	0.375	0.186
Wicket Keepers	0.172	0.233	0.121	0.139	0.492	0.128	0.098	0.12	0.116	0.315	0.08
Openers	0.434	0.213	0.28	0.484	0.215	0.086	0.067	0.067	0.056	0.207	0.624
Bowlers	0.307	0.046	0.055	0.075	0.046	0.626	0.688	0.65	0.682	0.1	0.107
	Matches	**Not Out**	**Runs Scored**	**Batting Avg.**	**Batting Strike Rate**	**Maiden Bowled**	**Wickets Taken**	**BCR**	**BSR**	**Catches Taken**	**Stumps Made**
Middle Orders	0.005	0.009	0.023	0.039	0.024	0.001	0.003	0.008	0.006	0.075	0.063
Wicket Keepers	0.009	0.004	0.005	0.018	0.048	0.001	0.002	0.006	0.005	0.063	0.027
Openers	0.023	0.004	0.012	0.063	0.021	0.001	0.001	0.003	0.002	0.042	0.211
Bowlers	0.016	0.001	0.002	0.01	0.005	0.004	0.014	0.033	0.028	0.02	0.036

Table 4. Final priority matrix.

	Matches	Not Out	Runs Scored	Batting Avg.	Batting Strike Rate	Maiden Bowled	Wickets Taken	BCR	BSR	Catches Taken	Stumps Made
Middle Orders	0.005	0.009	0.023	0.039	0.024	0.001	0.003	0.008	0.006	0.075	0.063
Wicket Keepers	0.009	0.004	0.005	0.018	0.048	0.001	0.002	0.006	0.005	0.063	0.027
Openers	0.023	0.004	0.012	0.063	0.021	0.001	0.001	0.003	0.002	0.042	0.211
Bowlers	0.016	0.001	0.002	0.010	0.005	0.004	0.014	0.033	0.028	0.020	0.036

Table 5. Weights of Alternatives.

	Weights
Middle Orders	0.255376
Wicket Keepers	0.188643
Openers	0.382447
Bowlers	0.16834

From Table 5, we analyze that the set of openers is the best set. Now for finding the efficiency of the openers, we take a dataset of IPL 2019 of Chennai Super king teams and evaluate the 17 players and using DEA, trying to find out the players which are a good fit for the team as the openers. In this we are using CCR- Input oriented model which is given by the following equations: -

$$\text{Max } E_i = \sum_{m=1}^{n} \theta_m O_{md} \quad (1)$$

$$\sum_{i=1}^{s} \lambda_i I_{id} = 1, \ i = 1,2....s \quad (2)$$

$$\sum_{m=1}^{n} \theta_m O_{mu} <= \sum_{i=1}^{s} \lambda_i I_{iu}, \ u = 1,2...k \quad (3)$$

$$\theta_m \text{ and } \lambda_i >= 0 \quad (4)$$

Here θ_m and λ_i are the weights associated with outputs and inputs respectively. m represents the no. of outputs (m = 1,2..n) and i represents the number of inputs (i = 1,2..s). d represents the DMU taken for evaluation and u represents the number of DMUs (u = 1,2…k).

In this study, the number of DMUs are 17. Here the number of inputs taken are 4 which are Matches Players, Batting Innings, Not Out, and Ball Faced and the number of outputs are also 4 which are Runs Scores, Batting Average, Batting Strike Rate, and

Catches Taken. After evaluation based on the model discussed above, we get the result as shown in Figure 2.

		Input-Oriented CRS	Sum of		Optimal Lambdas							
DMU No.	DMU Name	Efficiency	lambdas	RTS with Benchmarks								
1	SW Billings	1.000	1.000	Constant	1.000	SW Billings						
2	Imran Tahi	1.000	1.000	Constant	1.000	Imran Tahir						
3	M Vijay	1.000	1.000	Constant	1.000	M Vijay						
4	MM Sharm	0.000	0.000	Increasing								
5	Harbhajan	1.000	1.000	Constant	1.000	bhajan Singh						
6	AT Rayudu	0.701	0.810	Increasing	0.200	SR Watson	0.482	MS Dhoni	0.128	SN Thakur		
7	SR Watson	1.000	1.000	Constant	1.000	SR Watson						
8	KM Jadhav	0.717	0.786	Increasing	0.132	SR Watson	0.249	MS Dhoni	0.405	SN Thakur		
9	SK Raina	0.951	1.007	Decreasing	0.767	SR Watson	0.119	MS Dhoni	0.069	F du Plessis	0.051	SN Thakur
10	RA Jadeja	0.956	3.625	Decreasing	2.162	SW Billings	0.194	MS Dhoni	0.858	SN Thakur	0.411	MJ Santner
11	DJ Bravo	0.860	0.949	Increasing	0.166	MS Dhoni	0.783	SN Thakur				
12	MS Dhoni	1.000	1.000	Constant	1.000	MS Dhoni						
13	F du Plessis	1.000	1.000	Constant	1.000	F du Plessis						
14	DL Chahar	1.000	1.000	Constant	1.000	DL Chahar						
15	SN Thakur	1.000	1.000	Constant	1.000	SN Thakur						
16	DR Shorey	1.000	1.000	Constant	1.000	DR Shorey						
17	MJ Santner	1.000	1.000	Constant	1.000	MJ Santner						

Figure 2. DEA Results.

From Figure 2. we can conclude that DMUs with an efficiency score equal to 1 are regarded as efficient openers and DMUs with an efficiency score of less than 1 are efficient openers. Peers are considered as a benchmark for the insufficient openers like here for KM Jadhav, the peers are SR Watson, MS Dhoni, and SN Thakur, So, we can select among the efficient openers.

3. Conclusions

As team selection is one of the important tasks but besides this selection of players among a particular set is also important. The winning of the match also depends on teamwork and not only on a single player. So, each player should contribute as much as possible and should also work on themselves, and train themselves properly so that they can get a chance to play for the state, country, or any franchise. The mathematical formulation of the real-life problem is important as it gives us a clear and crisp. Here we have explored different sets of players and then choose the best set and among the best, we have chosen the best openers. Here by using ANP by discarding the disadvantages of AHP, we have compared the different sets and found out that the set containing Openers are contributing more to the team win according to the data received by the experts moreover when we go deep into the openers set, we find out the efficient and inefficient openers by using DEA CCR Input Oriented model. For Future work, we can consider other inputs too which are not taken in this research due to the limitation of Data and can also explore different models of DEA.

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