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Selection of Cricket Players Using Analytical Hierarchy Process

Kamble A.G[1, +], R.Venkata Rao[2], Kale A.V[3], Samant S.P[4]

[1]Sinhgad Institute of Technology, Lonavala, Dist: Pune, Maharashtra -410401, India.

[2]S.V.National Institute of Technology, Ichchanath, Surat, Gujarat-395007,India.

[3]SVSS College of Engineering and Research, Nagpur, Maharastra-441110, India

[4]Sinhgad Institute of Business Administration and Computer Application, Lonavala, Pune, Maharashtra - 410401, India

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Abstract. Cricket team needs to be more flexible, balanced and diversified. Each player has his/her own characteristics. In choosing the right player, there is not always a single definite attribute for selection. Selectors have to take into account a number of attributes. Optimality of the team changes with the change in different attributes for selecting the optimal team players. This paper, presents a cricket team players selection procedure from a set six level players in complex situations using analytic hierarchy process. The proposed method helps to evaluate and ranks the players. One example is included to illustrate the approach.

Keywords: Optimization, Cricket player, Team selection, Analytic hierarchy process etc.

1. Introduction

The game of cricket in India is like a religion. People are fascinated with this game like anything. They play, watch and support the national team fanatically. The common folk, even, keeps a tab on the selection of the team for various tour be it bi- lateral or multi- lateral. In India, Board of cricket control of India (BCCI) is the apex body which selects the national team and the selection is done by a panel of experts coming from various regions of the country and is headed by a chief selector, deputed by BCCI.

Many researchers have applied various models to predict the selection of the team like integer optimization, simulation and modeling, fuzzy genetic support system and dynamic programming. Gerber H. et al. [1] have used the integer programming model for the limited over team selection. S. Siva Sathya et al. [2] have applied the genetic algorithm to select an optimal cricket team. D. Strand et al. [3] have used the fuzzy genetic support model in selecting an optimal team. Clarke [4] represents a good illustration of the mathematical approaches to analyses of sport. He employs a dynamic programming approach to analyze optimal scoring rates in one day cricket. This paper predicts the team to be selected for the forthcoming tournaments using analytical hierarchical process (AHP).

2. AHP

It is a simple decision-making tool to deal with complex, unstructured and multi-attribute problems which was developed by T.L Saaty [5,6]. The most creative of decision making that has an important effect on the outcome is modeling the problem. Identification of the decision hierarchy is the key to success in using AHP. This process is essentially the formalization of a complex problem using a hierarchical structure and it is a multi-criteria decision-making approach that employs pair wise comparisons. AHP can efficiently deal with tangible as well as non-tangible attributes, especially where the subjective judgments of different individuals constitute an important part of the decision process. The main procedure of AHP using geometric mean method is as follows [7]:

Step 1: Determine the objective and evaluation attributes. Develop a hierarchical structure with a objective at the top level, the attributes at the second level and the alternatives at the third level.

[+] Corresponding author. *E-mail address*: avi_nash1000@yahoo.co.in. Tel: +91-9422984326

Step 2: Find out the relative importance of different attributes with respect to the goal or objective.

- Construct a pair wise comparison matrix using a scale of relative importance. The judgments are entered using the fundamental scale of the AHP given by V Jayakumar et al. [8] as given in Table1. An attribute compared with itself is always assigned the value 1, so the main diagonal entries of the pair wise comparison matrix are all 1. Assuming M attributes, the pair-wise comparison of attribute i with attribute j yields a square matrix $B_{M \times M}$ where a_{ij} denotes the comparative importance of attribute i with respect to attribute j. In the matrix, $b_{ij} = 1$ when i = j and $b_{ji} = 1/b_{ij}$.
- Find the relative normalized weight (w_j) of each attribute by calculating the geometric mean of i^{th} row and normalizing the geometric means of rows in the comparison matrix. This can be represented in equation (1) and (2). The geometric mean method of AHP is used to find out the relative normalized weights of the attributes because of its simplicity and easiness to find out the maximum eigen value and to reduce the inconsistency in judgments.

$$GM_j = [\prod_{j=1}^{M} b_{ij}]^{1/M} \quad (1)$$

$$w_j = GM / \sum_{j=1}^{M} GM_j \quad (2)$$

- Calculate matrices A3 and A4 such that A3 = A1 x A2 and A4=A3 /A2,
- where $A2 = [w_1, w_2, \ldots, w_j]^T$ and A1= Decision matrix
- Find out the maximum eigen value λ_{max} i.e. the average of matrix A4.
- Calculate the consistency index CI = (λ_{max} - M)/(M - 1). The smaller the value of CI, the smaller is the deviation from the consistency and M is matrix size.
- Obtain the random index (RI) for the number of attributes used in decision making. Table 2 helps the user for this purpose.
- Calculate the consistency ratio, CR = CI/RI. Usually, a CR of 0.1 or less is considered as acceptable as it reflects an informed judgment that could be attributed to the knowledge of the analyst about the problem under study.

Step 3: The next step is to compare the alternatives pair wise with respect to how much better in satisfying each of the attributes. It is nothing but ascertaining how well each alternative serves each attribute. If there is N number of alternatives, then there will be M number of N x N matrices of judgments since there are M attributes. Construct pair wise comparison matrices using a scale of relative importance. The judgments are entered using the fundamental scale of the AHP. The steps are same as in step 2.

In AHP model, both the relative and absolute modes of comparison can be performed. The relative mode can be used when decision makers have prior knowledge of the attributes for different alternatives to be used or when objective data of the attributes for different alternatives to be evaluated is not available. The absolute mode is used when data of the attributes for different alternatives to be evaluated are readily available. In the absolute mode, CI is always equal to 0 and complete consistency in judgments exists since the exact values are used in the comparison matrices.

Table 1 Relative importance of scale

Intensity of importance	Verbal scale	Description
1	Equal importance	Two activities contribute equally to the objective.
3	Weak importance of one over another	Experience and judgment slightly favor one activity over another.
5	Essential or strong importance	Experience and judgment strongly favor one activity over another.
7	Demonstrated importance	An activity is strongly favored and its dominance demonstrated in practice.
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of affirmation.
2,4,6,8	Intermediate values between the two adjacent judgments	When compromise is needed.

Table2 Random index (RI) values

Attributes	3	4	5	6	7	8	9	10	
RI	0.52	0.89	1.11	1.25		1.35	1.4	1.45	1.49

Step 4: The next step is to obtain the overall or composite performance scores for the alternatives by multiplying the relative normalized weight (w_j) of each attribute (obtained in Step 2) with its corresponding normalized weight value for each alternative (obtained in Step 3) and making summation over all the attributes for each alternative.

It may be added here that some selection problems can effectively deal mainly with quantitative attributes. However, there exists some difficulty in the case of qualitative attributes. In the case of a qualitative attributes (i.e. quantitative values are not available); a ranked value judgments on a fuzzy conversion scale is adopted. By using fuzzy set theory, the value of the attributes can be first decided as linguistic terms, converted into corresponding fuzzy numbers and then converted to the crisp scores. Chen and Hwang [9] had proposed a numerical approximation system to systematically convert linguistic terms to their corresponding fuzzy numbers. It contains eight conversion scales and in the present work, an 11-point scale is considered for better understand and representation. Table 3 is suggested which represents the material selection attributes on a qualitative scale using fuzzy logic, corresponding to the fuzzy conversion scale as shown in Fig. 1 and helps the users in assigning the values. Once a qualitative attribute is represented on a scale then the normalized values of the attribute assigned for different alternatives are calculated in the same manner as that for quantitative attributes. Now, an example is considered to demonstrate and validate the AHP for the selection of right cricket players for a cricket team.

Table 3 Conversion of linguistic terms into fuzzy score

Linguistic term	Fuzzy score
Low	0.115
Below average	0.295
Average	0.495
Above average	0.695
High	0.895

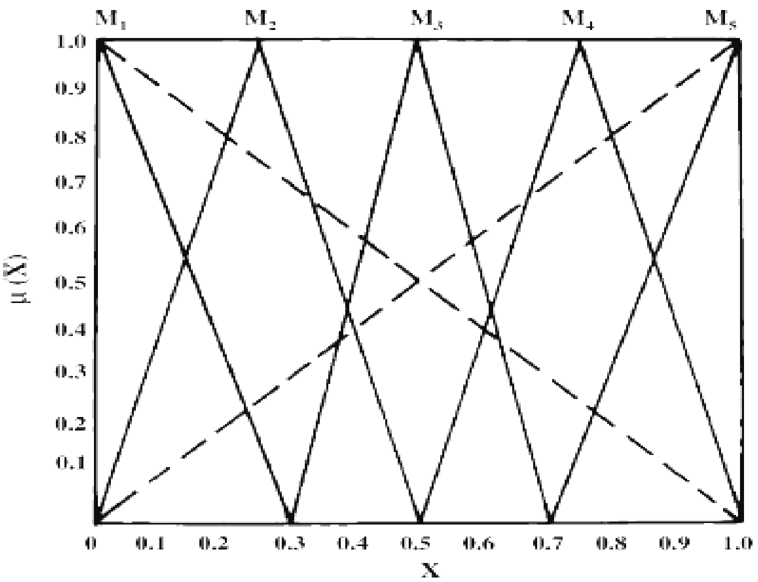

Figure 1 Linguistic term to fuzzy number conversion (5- point scale)

3. Example

Selecting the players from among large number of alternative available in a cricket team is a big problem for BCCI. Therefore an example is considered for selecting the cricket player from among six players, four cricket selection attributes were identified and these are: batsman (Bt), bowler (Bl), all rounder (Ar) and wicket keeper (Wk). All the attributes were expressed in linguistic terms as given in Table 3. The quantitative and qualitative data of the attributes is given in Table 4 and Table 5.

Table 4 Qualitative attributes data of cricket players

Alternative Players	Player Name	Attributes			
		Bt	Bl	Ar	Wk
(a)	M. S. Dhoni	High	Low	High	High
(b)	Virendra Sehwag	High	Average	Above Average	Low
(c)	Sachin Tendulkar	High	Average	Above Average	Low
(d)	Gautam Gambhir	High	Low	Low	Low
(e)	Harbhajan Singh	Average	High	Above Average	Low
(f)	Ashish Nehra	Low	Above Average	Below Average	Low

Bt: Batsman; Bl: Bowler; Ar: All rounder; Wk: Wicket keeper

Now various steps of the proposed procedure are carried out as described below [10]:

Step 1: The objective is to select right cricket players from amongst the number of available players. The player selection attributes are identified and these are batsman, bowler, all rounder and wicket keeper. The numbers of alternative players are six.

Table 5 Objective data of cricket player selection attributes

Alternative Players	Player Name	Attributes			
		Bt	Bl	Ar	Wk
(a)	M. S. Dhoni	0.895	0.115	0.895	0.895
(b)	Virendra Sehwag	0.895	0.495	0.695	0.115
(c)	Sachin Tendulkar	0.895	0.495	0.695	0.115
(d)	Gautam Gambhir	0.895	0.115	0.115	0.115
(e)	Harbhajan Singh	0.495	0.895	0.695	0.115
(f)	Ashish Nehra	0.115	0.695	0.295	0.115

Step 2: Finding out the relative importance of different factors with respect to the objective:

- Here, all are beneficial factors and hence higher values of these attributes are desired.

To make comparative judgments, the relative importance of all possible pairs of attributes with respect to the overall objective of selecting the right cricket team is decided on consensus judgment for each pair and their judgments are arranged into a matrix. The matrix, $A1_{4\times4}$, of pair-wise comparison judgments on the attributes is shown below. The judgments are entered using the fundamental scale of the AHP as given in table 1.

$$A1_{4\times4} = \begin{array}{c} \\ Bt \\ Bl \\ Ar \\ Wk \end{array} \begin{array}{c} \begin{array}{cccc} Bt & Bl & Ar & Wk \end{array} \\ \begin{bmatrix} 1 & 1/2 & 3 & 1/3 \\ 2 & 1 & 5 & 1/3 \\ 1/3 & 1/5 & 1 & 1/7 \\ 3 & 3 & 7 & 1 \end{bmatrix} \end{array}$$

- The next step is to find out the relative normalized weight (w_i) of each attributes by calculating the geometric mean of the i^{th} row and normalizing the geometric means of rows in the comparison matrix:

$$GM_1 = (1 \times 1/2 \times 3 \times 1/3)^{1/4} = 0.840$$
$$GM_2 = (2 \times 1 \times 5 \times 1/3)^{1/4} = 1.351$$
$$GM_3 = (1/3 \times 1/5 \times 1 \times 1/7)^{1/4} = 0.312$$

$$GM_4 = (3 \times 3 \times 7 \times 1)^{1/4} = 2.817$$

and $\sum_{j=1}^{4} GM_j = 5.32$

The weights are calculated using equation (2) and these are:

$w_1 = 0.1578$; $w_2 = 0.2540$; $w_3 = 0.0586$ and $w_4 = 0.5295$.

Matrix $A2_{4x1}$ is written as

$$A2_{4x1} = \begin{bmatrix} 0.1570 \\ 0.2540 \\ 0.0586 \\ 0.5295 \end{bmatrix}$$

Matrix $A3_{4x1}$ is calculated as $A3_{4x1} = A1_{4x4} \times A2_{4x1}$

$$A3_{4x1} = \begin{bmatrix} 0.6371 \\ 1.0391 \\ 0.2375 \\ 2.1751 \end{bmatrix}$$

And the matrix $A4_{4x1}$ is calculated as $A4_{4x1} = A3_{4x1} / A2_{4x1}$

$$A4_{4x1} = \begin{bmatrix} 4.0373 \\ 4.0900 \\ 4.0529 \\ 4.1078 \end{bmatrix}$$

- The maximum Eigen value λ_{max} i.e. the average of matrix $A4_{4x1}$ is calculated and is equal to λ_{max}= 4.072.
- The consistency index (CI) is calculated using (λ_{max} - M)/(M - 1), where M is matrix size and it is equal to 0.024 [i.e. (4.072 – 4) / (4 – 1)].
- The RI is obtained from Table 2 for four attributes used in the decision making in the present example and it is 0.89.
- The CR is calculated as CR = CI/RI and in the present example this ratio is 0.0269 which is less than the allowed CR of 0.1 and hence the value is acceptable. Thus, there is a good consistency in the judgments and decision matrix is right.

Table 6 Pair-wise comparison for the alternative players (for bowler only)

Players	(a)	(b)	(c)	(d)	(e)	(f)	Distributed weight	Idealized weight
(a)	1	0.2323	0.2323	1	0.1284	0.1654	0.0409	0.1284
(b)	4.3043	1	1	4.3043	0.5530	0.7122	0.1761	0.5530
(c)	4.3043	1	1	4.3043	0.5530	0.7122	0.1761	0.5530
(d)	1	0.2323	0.2323	1	0.1284	0.1654	0.0409	0.1284
(e)	7.7826	1.8080	1.8080	7.7826	1	1.2877	0.3184	1
(f)	6.0434	1.4040	1.4040	6.0434	0.7765	1	0.2473	0.7766

Step 3: The next step is to compare the alternative cricket players pair-wise with respect to how much better one is than the other in satisfying each of the four attributes. There are four 6 × 6 matrices of judgments since there are four attributes and six alternative cricket players are to be compared for each attributes. The matrices in Table 6 contain these judgments. The data related to the four attribute is given in Table 5. However, comparison of alternative cricket players is shown in Table 6 only with respect to bowler (a beneficial attributes) for demonstration purpose. Similar comparisons can be shown with respect to other three attributes which are again beneficial attributes. Since the exact values are used in these comparison matrices, CI is equal to 0 as there exists complete consistency in judgments.

In Table 6 both distributed and idealized weight vectors of the six alternatives are given. The idealized vector is obtained by dividing each element of the distributive vector by its largest element. The advantage of using idealized weights is that the ranking of the existing alternatives does not change even if a new alternative, identical to a non-optimal alternative is introduced.

Step 4: The next step is to multiply the relative normalized weight (w_i) of each cricket player attributes which is corresponding normalized weight value (distributed weight or idealized weight) for each alternative cricket player, and making summation over all the cricket player attributes for each alternative cricket player. The summed product is named as 'cricket player index (CPI)'. For example, for cricket player designated as (a), the CPI is: 0.1578 × 0.1855 + 0.2540 × 0.0409 + 0.0586 ×0.2639 + 0.5295 × 0.6086 =

0.37737

The cricket players are arranged in the descending order of their CPI. The results of the two ways of synthesizing are shown below:

Distributive mode	Ideal mode
(a) 0.377378	(a) 0.77850
(e) 0.161734	(e) 0.51543
(b) 0.127421	(b) 0.41177
(c) 0.127421	(c) 0.41177
(f) 0.122542	(f) 0.35583
(d) 0.083000	(d) 0.26592

From the above values of CPI, it is clear that the cricket player designated as (a) is the best choice for team selection for the given conditions. The second choice is (e), third choice is (b), fourth choice is (c), fifth choice is (f) and the last choice is (d). Therefore, the order of cricket players are (a)-(e)-(b)-(c)-(f)-(d) or (a)-(e)-(c)-(b)-(f)-(d) as choice (b) and (c) are having same values. Both the distributive mode and the ideal mode are indicating the same results. However, results presented in this paper are more dependable as there exists consistency in the judgments made regarding the relative importance of attributes. Further, exact values of attributes are used in this paper for comparing the alternative cricket player in satisfying each of the four attributes. Thus, the present method provides a more realistic cricket player selection procedure.

4. Conclusion

The proposed procedure is based on an AHP method and it helps in selection of a suitable cricket player from amongst a large number of available players for a cricket game. The methodology is capable of taking into account important requirements of game and it strengthens the existing procedure by proposing a logical and rational method of cricket player evaluation and selection.

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