Starting Pitcher Rotation in the Chinese Professional Baseball League based on AHP and TOPSIS

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***Abstract*—**The rotation of starting pitchers is a strategic issue which has a significant impact on the performance of a professional team. Choosing an optimal starting pitcher from among many alternatives is a multi-criteria decision-making (MCDM) problem. In this study, a model using the Analytic Hierarchy Process (AHP) and Technique for Order Performance by Similarity to the Ideal Solution (TOPSIS) is proposed with which to arrange the starting pitcher rotation for teams of the Chinese Professional Baseball League. The AHP is used to analyze the structure of the starting pitcher selection problem and to determine the weights of the criteria, while the TOPSIS method is used to make the final ranking. An empirical analysis is conducted to illustrate the utilization of the model for the starting pitcher rotation problem. The results demonstrate the effectiveness and feasibility of the proposed model.

***Keywords*—**AHP, TOPSIS, starting pitcher rotation, CPBL

I. Introduction

The Chinese Professional Baseball League (CPBL) is the first professional sports league in Taiwan. The CPBL includes four teams, each of which plays 120 games in a regular season (March through early October) and 5 games per week, not including the pre-season and the post-season playoffs [4, 8]. In professional baseball the starting pitcher usually rests three or four days after pitching a game, before pitching another. Therefore, every team must have four or five starting pitchers on their rosters in the CPBL. These pitchers, and the sequence in which they pitch, is known as the rotation. In modern baseball leagues, like Major League Baseball and Nippon Professional Baseball, a five-man rotation is the most common. For the purpose of starting pitcher rotation, the team manager and pitcher coach have to judge the abilities of their own starting pitchers. They arrange a sequence for when each starting pitcher will pitch in light of their judgment.

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The deciding on the rotation of professional baseball starting pitchers is a complicated decision-making problem including many quantitative attributes.

It is regarded as a kind of multi-attribute or multi-criteria decision making (MADM/MCDM) problem. The purpose of this study is to develop a method which will help the manager or pitcher coach arrange the rotation for starting pitchers in Taiwan's domestic professional baseball sector. The Analysis Hierarchy Process (AHP) and the Technique for Order Performance by Similarity to the Ideal Solution (TOPSIS) provide decision makers with a way to transform subjective judgments into objective measures. One of the main advantages of the AHP method is that it is relatively easy to use and understand, and can effectively handle both qualitative and quantitative data. AHP involves the principles of decomposition, pair-wise comparisons, priority vector generation and synthesis [10]. Due to its mathematical simplicity and flexibility, AHP has been a favorite decision tool for research in many fields, such as engineering, food, business, ecology, health, government and sports [11-12]. AHP and the TOPSIS approach are applied in order to arrange the rotation of starting pitchers in Taiwan's professional baseball teams. This is done according to their relative closeness coefficients calculated based on the criteria most critical that will allow a starting pitcher to help the team win the game. We hope that this analysis will provide useful information for professional baseball team managers or pitching coaches to help them arrange the rotation of their own starting pitchers.

The rest of the paper is organized as follows. In the next section, the methodology for evaluation is discussed. Section 3 will focus on empirical analysis to find the rotation of starting pitchers in the CPBL. In the final section, some conclusions are drawn and remarks made in regards to future study.

II. Methodology

The evaluation procedure consists of several steps. Detailed descriptions of each step are given in the following subsections.

A. *AHP method*

The analytic hierarchy process (AHP) was introduced by Saaty in 1971 [10-13] and has since become one of the most extensively used multiple criteria/attribute decision making (MCDM/MADM) methods. This study applied AHP to determine the weight of each criteria performance measurement. The procedures involved in the AHP typically include several steps, from defining the unstructured problem, stating the objectives, and determining the relative weights of the decision elements, to obtaining an overall rating for the alternatives [10]. In this study, the criteria weights are determined using the following steps:

Step 1: Establish a pair-wise comparison matrix

Decision elements are compared pair-wise and assigned relative scales by decision makers or experts. Each of the paired elements will be compared in matrices through a questionnaire. Saaty recommended the use of a nine-point scale to express preferences with options including equally, moderately, strongly, very strongly, to extremely preferred (with pair-wise weights from 1 to 9, respectively) [10-12]. After each element is compared, a paired comparison matrix is established. If there are n objects, denoted by $O_1, O_2, O_3, ..., O_n$, compared in pairs according to their relative weights, denoted by $w_1, w_2, w_3, ..., w_n$, respectively, the pair-wise comparisons can be represented in the form of a matrix [10-12].

$$A = \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{w_n} \\ \vdots & \vdots & \vdots & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots & \frac{w_n}{w_n} \end{bmatrix} = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix} \quad (1)$$

Step 2: Estimate the relative weights of the decision elements

After a comparison matrix has been established, the priorities (the relative weights of the decision elements) of the element can be compared based on the computation of the eigenvalues and eigenvectors with the formula below, where E is the eigenvector and $\lambda_{\max}$ is the largest eigenvalue of E:

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

$$A \cdot E = \lambda_{\max} \cdot E \quad (3)$$

The entry of the eigenvector presents the relative weight of different decision elements.

Step 3: Test for the consistency of the judgment matrix

The consistency of the judgments ensures the transitivity of preference that decision makers demonstrated during the series of pair-wise comparisons. Thus, the quality of the decision from the weight determination process is strongly related to the consistency. Transitivity of preference implies that if P_1 is preferred to P_2, and P_2 is preferred to P_3, then P_1 is preferred to P_3. This consistency property can be examined by the consistency ratio and consistency index. The consistency index (CI) and consistency ratio (CR) can be obtained with the following equations [10-12]:

$$CI = \frac{\lambda_{\max} - n}{n - 1} \quad (4)$$

$$CR = \frac{CI}{RI}, \quad (5)$$

where n is the number of items being compared in the matrix, and RI is a random index, the average consistency index of randomly generated pair-wise comparison matrices of similar size, as shown in table 1. The threshold CR value is 0.10 [10-12]. When the calculated CR values exceed the threshold, it is an indication of inconsistent judgment in which case the decision makers would need to revise the original values in the pair-wise comparison matrix.

TABLE I
RANDOM INDEX (RI)

Order of matrix	1	2	3	4	5
RI	0.00	0.00	0.58	0.90	1.12
Order of matrix	6	7	8	9	10
RI	1.24	1.32	1.41	1.45	1.49
Order of matrix	11	12	13	14	15

B. TOPSIS method

The technique for order performance by similarity to the ideal solution (TOPSIS), which is the concept of distance measures, was initially presented by Hwang and Yoon [9, 14]. The ideal solution (also called the positive ideal solution) is a solution that maximizes the benefit criteria/attributes and minimizes the cost criteria/attributes, whereas a negative ideal solution (also called the anti-ideal solution) maximizes the cost criteria/attributes and minimizes the benefit criteria/attributes [14-15].

Suppose a MCDM/MADM problem has m alternatives ($A_1, A_2, ..., A_m$), and n decision criteria/attributes ($C_1, C_2, ..., C_n$). Each alternative is evaluated with respect to the n criteria/attributes. All the values/ratings assigned to the alternatives with respect to each criterion form a decision matrix denoted by $X = (x_{ij})_{m \times n}$. Let $W = (w_1, w_2, ..., w_n)$ be the relative weight vector of the criteria, satisfying $\sum_{j=1}^n w_j = 1$.

The TOPSIS method can now be expressed in a series of steps as follows:

Step 1: Normalize the decision matrix $X = (x_{ij})_{m \times n}$ by calculating r_{ij} which represents the normalized criteria/attribute value/rating.

$$r_{ij} = x_{ij} / \sum_i x_{ij}, \quad \forall i, j,$$

where $i = 1, 2, ..., m$ and $j = 1, 2, ..., n$. (6)

Step 2: Calculate the weighted normalized decision matrix $V = (v_{ij})_{m \times n}$

$$v_{ij} = r_{ij} \cdot w_j,$$

where $i = 1, 2, ..., m$ and $j = 1, 2, ..., n$ and (7) where w_j is the relative weight of the j^{th} criterion or attribute, and $\sum_{j=1}^{n} w_j = 1$.

Step 3: Determine the ideal (A^*) and negative ideal (A^-) solutions:

$$A^* = \{v_1^*, v_2^*, ..., v_n^*\} \text{ where } v_j^* = \max_i(v_{ij}), \quad (8)$$

$$A^- = \{v_1^-, v_2^-, ..., v_n^-\} \text{ where } v_j^- = \min_i(v_{ij}). \quad (9)$$

Step 4: Calculate the Euclidean distances of each alternative from the positive ideal solution and the negative ideal solution, respectively:

$$d_i^* = \sqrt{\sum_{i=1}^{n}(v_{ij} - v_j^*)^2} \quad i = 1, 2, ..., m, \quad (10)$$

$$d_i^- = \sqrt{\sum_{i=1}^{n}(v_{ij} - v_j^-)^2} \quad i = 1, 2, ..., m. \quad (11)$$

Step 5: Calculate the relative closeness of each alternative to the ideal solution. The relative closeness of the alternative A_i with respect to A^* is defined as CC_i

$$CC_i = d_i^- / (d_i^* + d_i^-) \quad i = 1, 2, ..., m. \quad (12)$$

Step 6: Rank the alternatives according to the relative closeness to the ideal solution. The bigger the CC_i, the better the alternative A_i. The best alternative is the one with the greatest relative closeness to the ideal solution.

C. Data

The data employed in this study were obtained from the official CPBL website (http://www.cpbl.com.tw), a website that has collected and posted records of every CPBL baseball game in 2010. We selected five alternatives for each team from the official CPBL website in 2011. If an alternative is a rookie or is playing for the first time in the CPBL, then we instead use the data obtained from minor league websites in Taiwan or foreign baseball league websites. Every alternative chosen has played in one of the top five started games for his team. The empirical analysis commonly cited statistics for starting pitchers are innings pitched per game, earned run average (ERA), strikeouts per 9 innings pitched (K/9), and walks plus hits per inning pitched (WHIP) [1, 4-6], all of which are included in this study. The calculation is carried out using AHP and TOPSIS, where parameters used as criteria are familiar to all fans. Only these four statistics are used: innings pitched per game (IPG), earned run average (ERA), strikeouts per 9 innings (K/9) and walks plus hits per inning pitched (WHIP). We calculate the IPG, ERA, K/9 and WHIP for all starting pitchers using the following formulas:

IPG=*Innings Pitched/games*

ERA=9 × (*Earned Run Allowed/Innings Pitched*)

K/9 = 9 × (*Strikeouts/Innings Pitched*)

WHIP = (*Walks + Hits*)*/Innings Pitched.*

III. Empirical Analysis for Starting Pitcher Rotation in the CPBL

An application of the procedure for calculating the starting pitcher rotation of teams in the CPBL is shown below.

A. Alternative starting pitcher rotation of teams in the CPBL

A brief description of four teams' starting pitcher rotation is set forth below. The names of each team's starting pitchers in the CPBL are shown in Table 1. Each team, including the Brother Elephants, Uni Lions, Lamigo Monkeys and Sinon Bulls, had five pitchers selected as alternatives. As can be seen in Table 1, most pitchers can pitch more than 5 innings per game, except for 6 players, include Fong-Sin Wang (Monkeys), Jyun-Rong Pan (Lions), Sung-Wei Tseng (Elephant), Ryan Cullen (Elephant), Chi-Wei Lin (Bulls) and Wen-bin Yu (Bulls). All of them had been a relief pitcher for their respective teams in the previous season.

TABLE I
PITCHING INFORMATION FOR EACH TEAM'S ROTATION OF ALTERNATIVE PITCHERS IN 2010

Pitcher's name	IPG	ERA	WHIP	K/9	Team
Ken Ray	6.20	2.32	1.25	7.10	Monkeys
Wang, Fong-Sin	3.10	2.60	1.32	5.57	Monkeys
Huang, Qin-Zhi	5.00	3.50	1.21	3.40	Monkeys
Steve Hammond	6.20	3.07	1.07	6.59	Monkeys
Adrian Burnside	5.00	5.34	1.66	6.30	Monkeys
Pan, Wei-Lun	6.20	3.19	1.13	4.75	Lions
Danel Reichert*	6.20	3.95	1.23	7.05	Lions
Wang, Jing-Ming	5.20	3.83	1.43	6.16	Lions
Pan, Jyun-Rong	2.20	6.48	1.77	4.15	Lions
Jesus Sanchez	6.20	2.82	1.09	5.50	Lions
Orlando Roman	6.10	3.03	1.19	6.62	Elephant
Yeh, Ting-Jen	5.10	3.86	1.73	5.96	Elephant
Tseng, Sung-Wei*	3.00	5.31	1.44	2.23	Elephant
Lee,Jin-Mu	4.00	3.77	1.31	3.39	Elephant
Ryan Cullen	1.60	1.95	0.93	8.99	Elephant
Lin, Ying-Chieh	5.10	2.69	1.20	6.55	Bulls
Yang, Chien-Fu	5.00	2.33	1.14	5.35	Bulls
Lin, Chi-Wei	4.20	3.23	1.27	7.00	Bulls
Yu, Wen-bin	1.60	4.82	1.92	3.96	Bulls
Luo,Jheng-Long*	5.00	1.90	1.29	5.60	Bulls

B. AHP for weights of evaluation criteria

A professional baseball team manager, three coaches, and two experts were asked to contribute their professional experience to determine the relative importance of four individual performance measures: innings pitched per game performance, earned run average performance, strikeouts per 9 innings pitched performance and walks plus hits per inning pitched performance. The AHP method is used to determine the weights of the evaluation criteria. A questionnaire is used to determine the judgements of managers, coaches and experts. The question 'Which performance measures should be emphasized more in determining starting pitcher criteria, and how much more?' was asked, and a nine-point scale was used to do the pair-wise comparison. Eight questionnaires in this study were returned. Each one had to pass the consistency test. In the first step, Eq. (1) is used to construct the pair-wise comparison. In the second step, the eigenvector and eigenvalue are calculated using Eq. (2) and Eq. (3). In the third step, Eq. (4) and Eq. (5) are used to calculate the *CR* value and *CI* value. For the final step, we check whether the *CR* value passes the consistency test. If the *CR* value is less than 0.1, then the questionnaire passes the test. Otherwise, decision makers need to revise the original values in the pair-wise comparison matrix. All of the questionnaires pass the consistency test. The weights of each performance measure are obtained using the following steps:

Step 1: Construct a pair-wised comparison matrix;

All pair-wise comparisons are calculated based on the questionnaire responses from each manager, coach or expert by geometric means. The results are shown in table II.

TABLE II
COMPARISON MATRIX

	IPG	ERA	K/9	WHIP
IPG	1.000	2.420	0.802	1.180
ERA	0.413	1.000	0.887	0.305
K/9	1.247	1.127	1.000	0.494
WHIP	0.848	3.283	2.023	1.000

Step 2: Calculate the eigenvector and eigenvalue

An eigenvector and an eigenvalue are calculated using Eq. (2) and Eq. (3), respectively.

$$E = \begin{bmatrix} IPG \\ ERA \\ K/9 \\ WHIP \end{bmatrix} = \begin{bmatrix} 0.289 \\ 0.136 \\ 0.214 \\ 0.361 \end{bmatrix}, \quad \lambda_{\max} = 4.095 .$$

The eigenvector shows the weights of the different criteria. The WHIP, with a weight of 0.361, is the major factor affecting the rotation of starting pitchers in the CPBL, second is the IPG, third is the K/9 and fourth is the ERA.

Step 3: Calculate the *CR* value and *CI* value

The *CR* value and *CI* value are calculated using Eq. (4) and Eq. (5), respectively.

$$CI = \frac{4.095-4}{4-1} = 0.032$$

$$CR = \frac{0.032}{0.90} = 0.035 .$$

Since the *CR* value is less than 0.1, the comparison matrix is consistent.

C. TOPSIS for alternative pitchers

Hwang and Yoon originally proposed the order performance technique based on the similarity to the ideal solution (TOPSIS) in 1981, in which the chosen alternative should not only have the shortest distance from the positive ideal reference point (PIRP), but also have the longest distance from the negative ideal reference point (NIRP), to solve the MCDM problems [9, 13-14, 16]. We measured the performance of starting pitchers in each team with respect to each criterion. Table 3 shows each team's decision matrix of selection criteria.

TABLE III
DECISION MATRIX

Pitcher's name	IPG	ERA	WHIP	K/9	Team
Ken Ray	6.20	2.32	1.25	7.10	
Wang, Fong-Sin	3.10	2.60	1.32	5.57	
Huang, Qin-Zhi	5.00	3.50	1.21	3.40	Monkeys
Steve Hammond	6.20	3.07	1.07	6.59	
Adrian Burnside	5.00	5.34	1.66	6.30	
Pan, Wei-Lun	6.20	3.19	1.13	4.75	
Danel Reichert	6.20	3.95	1.23	7.05	
Wang, Jing-Ming	5.20	3.83	1.43	6.16	Lions
Pan, Jyun-Rong	2.20	6.48	1.77	4.15	
Jesus Sanchez	6.20	2.82	1.09	5.50	
Orlando Roman	6.10	3.03	1.19	6.62	
Yeh, Ting-Jen	5.10	3.86	1.73	5.96	
Tseng, Sung-Wei	3.00	5.31	1.44	2.23	Elephant
Lee,Jin-Mu	4.00	3.77	1.31	3.39	
Ryan Cullen	1.60	1.95	0.93	8.99	
Lin, Ying-Chieh	5.10	2.69	1.20	6.55	
Yang, Chien-Fu	5.00	2.33	1.14	5.35	
Lin, Chi-Wei	4.20	3.23	1.27	7.00	Bulls
Yu, Wen-bin	1.60	4.82	1.92	3.96	
Luo,Jheng-Long	5.00	1.90	1.29	5.60	

Whether Eq. (6) is used to find the normalized decision matrix depends on whether the objective of the selection criterion is that of minimization or maximization. Table 4 shows the normalized decision matrix.

TABLE IV
NORMALIZED DECISION MATRIX

Pitcher's name	IPG	ERA	WHIP	K/9	Team
Ken Ray	0.067	0.033	0.047	0.063	
Wang, Fong-Sin	0.034	0.037	0.050	0.050	
Huang, Qin-Zhi	0.054	0.050	0.046	0.030	Monkeys
Steve Hammond	0.067	0.044	0.040	0.059	
Adrian Burnside	0.054	0.076	0.062	0.056	
Pan, Wei-Lun	0.067	0.046	0.042	0.042	
Danel Reichert	0.067	0.056	0.046	0.063	
Wang, Jing-Ming	0.056	0.055	0.054	0.055	Lions
Pan, Jyun-Rong	0.024	0.093	0.067	0.037	
Jesus Sanchez	0.067	0.040	0.041	0.049	
Orlando Roman	0.066	0.043	0.045	0.059	
Yeh, Ting-Jen	0.055	0.055	0.065	0.053	
Tseng, Sung-Wei	0.033	0.076	0.054	0.020	Elephant
Lee,Jin-Mu	0.043	0.054	0.049	0.030	
Ryan Cullen	0.017	0.028	0.035	0.080	
Lin, Ying-Chieh	0.055	0.038	0.045	0.058	
Yang, Chien-Fu	0.054	0.033	0.043	0.048	
Lin, Chi-Wei	0.046	0.046	0.048	0.062	Bulls
Yu, Wen-bin	0.017	0.069	0.072	0.035	
Luo,Jheng-Long	0.054	0.027	0.048	0.050	

Criteria are divided between maximization and minimization. The maximization criteria are IPG and K/9, and the minimization criteria are ERA and WHIP. The weighted normalized decision matrix is then calculated using Eq. (7). The weighted normalized decision matrix for each selection criterion is shown in Table 5.

TABLE V
WEIGHTED NORMALIZED DECISION MATRIX

Pitcher's name	IPG	ERA	WHIP	K/9	Team
Ken Ray	0.019	0.005	0.010	0.023	
Wang, Fong-Sin	0.010	0.005	0.011	0.018	
Huang, Qin-Zhi	0.016	0.007	0.010	0.011	Monkeys
Steve Hammond	0.019	0.006	0.009	0.021	
Adrian Burnside	0.016	0.010	0.013	0.020	
Pan, Wei-Lun	0.019	0.006	0.009	0.015	
Danel Reichert	0.019	0.008	0.010	0.023	
Wang, Jing-Ming	0.016	0.007	0.011	0.020	Lions
Pan, Jyun-Rong	0.007	0.013	0.014	0.013	
Jesus Sanchez	0.019	0.005	0.009	0.018	
Orlando Roman	0.019	0.006	0.010	0.021	
Yeh, Ting-Jen	0.016	0.007	0.014	0.019	
Tseng, Sung-Wei	0.009	0.010	0.012	0.007	Elephant
Lee,Jin-Mu	0.013	0.007	0.011	0.011	
Ryan Cullen	0.005	0.004	0.008	0.029	
Lin, Ying-Chieh	0.016	0.005	0.010	0.021	
Yang, Chien-Fu	0.016	0.005	0.009	0.017	
Lin, Chi-Wei	0.013	0.006	0.010	0.023	Bulls
Yu, Wen-bin	0.005	0.009	0.015	0.013	
Luo,Jheng-Long	0.016	0.004	0.010	0.018	

The positive (A^*) and negative (A^-) ideal solutions are determined using Eq. (8) and Eq. (9). The values are shown in Table VI.

TABLE VI
POSITIVE AND NEGATIVE IDEAL SOLUTIONS

	IPG	ERA	WHIP	K/9
Positive ideal solution	0.019	0.004	0.008	0.029
Negative ideal solution	0.005	0.013	0.015	0.007

Next, the distance is calculated for each alternative using Eq. (10) and Eq. (11). These values are shown in Table 7. The closeness coefficient CC_i is determined using Eq. (12). The closeness coefficient values and ranks of all starting pitchers are also shown in Table 7. The AHP approach and TOPSIS approach identified Ken Ray of the Lamingo Monkeys as the best starting pitcher in the CPBL. Second place was Steve Hammond, also of the Lamingo Monkeys. Ray and Hammond were the best and second best starting pitchers in the Lamingo Monkeys. Danel Reichert, who was identified as the best starting pitcher in the Uni Lions, was ranked third in the CPBL. Orlando Roman was ranked fourth in CPBL. Roman was the best starting pitcher for the Brother Elephants. Lin, Ying-Chieh was the best starting pitcher for the Sinon Bulls. The starting pitcher rotation for each team in the CPBL as shown on the official website was quite different from the results obtained in this study. For example, in 2010, the Brother Elephants were the CPBL champions. Although Roman ranked first in our test results he was the fourth starting pitcher in the championship. The managers of the team selected Tseng to be the first starting pitcher in the opening game in 2011, but he was ranked fifth for his team and ranked eighteenth in the whole league. The managers of the Sinon Bulls and Uni Lions also chose players who ranked fourth in our test results as the starting pitchers in their opening game. This is surprising, because most managers would select the best pitcher for their team as the opening game starting pitchers , unless the best pitcher is injured or is not yet prepared for the game. However, in Taiwan, managers sometimes arrange starting pitchers for an opening game based on a special factor, which is nationality, on the premise that all of the starting pitchers have the same standard. Thus pitchers of Taiwanese nationality have a greater chance to be the starting pitcher for the opening game than those with non Taiwanese nationality.

TABLE VII
POSITIVE AND NEGATIVE IDEAL SOLUTIONS AND DISTANCE FOR EACH ALTERNATIVE, CLOSENESS COEFFICIENT AND RANK

Pitcher's name	d^*	d^-	CC_i	Rank	Team
Ken Ray	0.007	0.023	0.780	1(1)	
Wang, Fong-Sin	0.015	0.015	0.495	15(4)	
Huang, Qin-Zhi	0.019	0.014	0.426	16(5)	Monkeys
Steve Hammond	0.008	0.022	0.732	2(2)	
Adrian Burnside	0.013	0.017	0.570	14(3)	
Pan, Wei-Lun	0.014	0.019	0.575	12(4)	
Danel Reichert	0.008	0.022	0.743	3(1)	
Wang, Jing-Ming	0.011	0.018	0.622	11(3)	Lions
Pan, Jyun-Rong	0.023	0.007	0.223	19(5)	
Jesus Sanchez	0.011	0.020	0.640	6(2)	
Orlando Roman	0.008	0.022	0.728	4(1)	
Yeh, Ting-Jen	0.013	0.017	0.573	13(3)	
Tseng, Sung-Wei	0.025	0.006	0.200	18(5)	Elephant
Lee,Jin-Mu	0.020	0.011	0.358	17(4)	
Ryan Cullen	0.014	0.025	0.632	9(2)	
Lin, Ying-Chieh	0.009	0.020	0.690	5(1)	
Yang, Chien-Fu	0.012	0.018	0.590	10(4)	
Lin, Chi-Wei	0.010	0.019	0.664	7(2)	Bulls
Yu, Wen-bin	0.024	0.006	0.213	20(5)	
Luo,Jheng-Long	0.012	0.018	0.607	8(3)	

IV. CONCLUSION

Arranging the rotation of starting pitchers is a difficult problem which can be classified as a kind of MADM/MCDM problem for professional baseball team managers or coaches. Therefore, this study first applies AHP to calculate the weights for the criteria for determining starting pitchers. The performance of starting pitchers with respect to each criterion is then calculated by TOPSIS. Finally, all starting pitchers of the CPBL and for each team are ranked by AHP and TOPSIS. Using this methodology, the strategy is to have them waste their best horse on our worst horse so we can match our better horses against their lesser horses, it is to help team managers or coaches know the enemy and themselves so that they can create a matchup that is in their favor.

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