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Analyzing the edge of professional Taiwanese baseball league starting pitchers using the Entropy and TOPSIS method

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A new approach to the complex problem of objectively evaluating the edge of a professional baseball starting pitcher is proposed to avoid judgments resulting from subjective opinions. The method not only ameliorates the subjectivity of the topic but also provides the means to rank starting pitchers in Taiwan. Entropy and the Technique for Order Performance by Similarity to the Ideal Solution (TOPSIS) are used to evaluate the edge of a starting pitcher.Entropy is a measure of uncertainty in the information formulated using probability theory. It indicates that a broad distribution represents more uncertainty than a sharply peaked one. TOPSIS is a practical and useful technique for the ranking and selection of a number of externally determined alternatives through distance measures. The data employed in this paper were obtained from the official website of the Chinese Professional Baseball League (CPBL) in Taiwan. Furthermore entropy is used to determine the objective weight for each pitch skill while TOPSIS is used to rank starting pitchers based on their pitching skill in the CPBL. The results demonstrate our method to be both objective and efficient. The twelve starting pitchers can be evaluated given alternatives corresponding to each criterion and given a ranking. Results indicate that Christopher Lee Mason is ranked first among starting pitchers of the CPBL in the 2010 season.

Key words: Chinese Professional Baseball League, starting pitcher, entropy, TOPSIS.

INTRODUCTION

Evaluation of the edge of professional baseball starting pitchers is a decision-making problem for a complicated system including many quantitative attributes. It is regarded as a kind of multi-attribute or multi-criteria decision making (MADM/MCDM) problem (Chen et al., 2011; 2012). Empirical analysis shows that a pitcher's skills significantly impact theperformanceof their own team, while decreasing the batting average of the

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opponent team (Chen and Chen, 2009; Gould and Winter, 2009; Singell, 1993). The function of pitchers is to prevent the other team form scoring runs (Gould and Winter, 2009). Pitchers are typically divided into two types: “starters” and “relief” pitchers. Starting pitchers typically start the game and continue until they get tired or into trouble, at which point the relief pitcher is called in to finish the game (Gould and Winter, 2009; Morris, 2004). Over the long history of baseball, starting pitchers have been considered much more important than relief pitchers. Starters pitch many more innings over the course of a season. Normally, teams select their best pitchers for starters (Chen and Chen, 2009; Chen et al., 2011; Chen et al., 2012; Lewis, 2003; Sparks and Abrahamson, 2005). In Taiwan, baseball has been ferociously popular for over half a century. The first professional sports league, the Chinese Professional Baseball League (CPBL) held its inauguration game on March 17th, 1990 (Chen and Chen, 2009; Morris, 2004). In the CPBL, team managers or pitching coaches usually judge the abilities of their starting pitchers based on their own subjective judgment which easily leads to the making of incorrect decisions. Consequently, using an objective method to assess starting pitchers is a better way to help managers or coaches judge their abilities.

Past researches on starting pitcher selection using multi-criteria decision making ((MADM / MCDM) first utilize answers obtained from questionnaires posed to professionals (coaches, players and scholars) to provide weights for selection criteria, and then apply Analytic Hierarchy Process (AHP) to determine the rotation of starting pitchers, and the weights of evaluation criteria to select the best starting pitchers. However, the opinions of these professionals are not easily accessible, thus the conspicuous lack of relevant research in this area and so the purpose of this paper is to evaluate the edge of a starting pitcher in Taiwan’s domestic professional baseball sector. Technique for Order Performance by Similarity to the Ideal Solution (TOPSIS) is a major decision-making technique within the Asian Pacific area (Shih et al., 2007), and entropy is a method to determine objective weights (Deng et al., 2000). In recent years, both entropy and TOPSIS methods have been successfully applied for decision making in a number of areas like tourism (Zhang et al., 2010), organization behavior (Milani et al., 2008), computer aided engineering (Jeeand Kang, 2000), automobile industry (Fazlollahtabar, 2010), emergency logistics operations (Sheu, 2010) and safety management (Yang et al., 2009). The high flexibility of this concept means that it is able to accommodate further extension to make better choices in various areas. However as of yet, no one has applied TOPSIS and entropy in the sports area. This is the motivation for our study. Entropy and the TOPSIS approach are applied in order to rank professional baseball league starting pitchers in Taiwan’s professional domestic baseball sector. This is done according to their relative closeness coefficients based on the criteria most critical towards winning the game. We hope that this analysis will provide useful and objective information for professional baseball team to evaluating their own starting pitchers.The rest of the paper is organized as follows. In the next section, the methodology for evaluation is given. Section 3 will focus on empirical analysis to find the edge of starting pitchers in the CPBL. In the final section, some conclusions are drawn and remarks made as regards future study.

METHODOLOGY OF EVALUATION

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

TOPSIS method

TOPSIS (technique for order performance by similarity to the ideal solution), the concept of distance measures, was initially presented by Hwang and Yoon (Olson, 2004; Shih, Shyur and Lee, 2007). 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 (Torlak et al., 2010). The so-called benefit criteria/attributes are those used for maximization, while the cost criteria/attributes are those for minimization. The best alternative is the one, which is the alternative closest to the ideal solution and farthest from the negative ideal solution (Olson, 2004; Torlak et al.,, 2010).

Suppose a MADM/MCDM problem has m alternatives ($A_1, A_2, ..., A_m$), and n 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 about the criteria, satisfying $\sum_{j=1}^{n} w_j = 1.$ Then the TOPSIS method can 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.

$r_{ij} = (1/x_{ij}) / \sqrt{\sum_{i-1}^{m} 1/x_{ij}^2}$ for the minimization objective, where $i = 1, 2, ..., m$ and $j = 1, 2, ..., n$, (1)

$r_{ij} = x_{ij} / \sqrt{\sum_{i-1}^{m} x_{ij}^2}$ for the maximization objective,
where $i = 1, 2, ..., m$ and $j = 1, 2, ..., n$. (2)

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 $j = 1, 2, ..., n$, (3)

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:

$$A^* = \left\{ v_1^*, v_2^*, ..., v_n^* \right\} \text{ where } v_j^* = \max_i (v_{ij}) , \quad (4)$$

$$A^- = \left\{ v_1^-, v_2^-, ..., v_n^- \right\} \text{ where } v_j^- = \min_i (v_{ij}) . \quad (5)$$

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

$$d_i^* = \sqrt{\sum_{i=1}^{n} (v_{ij} - v_j^*)^2} \quad i = 1, 2, ..., m , \quad (6)$$

$$d_i^- = \sqrt{\sum_{i=1}^{n} (v_{ij} - v_j^-)^2} \quad i = 1, 2, ..., m . \quad (7)$$

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

$$CC_i = d_i^- / (d_i^* + d_i^-) \quad i = 1, 2, ..., m , \quad (8)$$

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.

Entropy method

The importance coefficients in the MADM methods refer to a subjective and/or objective "weight"' given to each criterion. The entropy method is a way to generate objective weight and thus is often used for assessing weights in the TOPSIS method. The concept of information entropy was first introduced by Claude E. Shannon in 1948 (Deng et al., 2000; Milani et al., 2008).

Entropy is a measure of uncertainty in the information formulated using probability theory. It indicates that a broad distribution represents more uncertainty than a sharply peaked one. To determine objective weights by the entropy measure, the decision matrix in Eq. (9)

$$X = \begin{pmatrix} x_{11} & \cdots & x_{1m} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{nm} \end{pmatrix} \quad (9)$$

needs to be normalized for each criterion $C_j (j = 1, 2, ..., m)$ as

$$p_{ij} = x_{ij} / \sum_{i=1}^{n} x_{ij} \quad , \quad i = 1, 2, ..., n; j = 1, 2, ..., m . \quad (10)$$

As a consequence, a normalized decision matrix representing the relative performance of the alternatives is obtained as,

$$p = \begin{pmatrix} p_{11} & \cdots & p_{1m} \\ \vdots & \ddots & \vdots \\ p_{n1} & \cdots & p_{nm} \end{pmatrix} . \quad (11)$$

The amount of decision information contained in Eq. (11) and emitted from each criterion $C_j (j = 1, 2, ..., m)$ can thus be measured by the entropy value e_j as,

$$e_j = -k \sum_{i=1}^{n} p_{ij} \ln p_{ij} \quad , \quad (12)$$

where $k = 1 / \ln n$ is a constant which guarantees $0 \le e_j \le 1$.

The degree of divergence (d_j) of the average intrinsic information contained by each criterion $C_j (j = 1, 2, ..., m)$ can be calculated as,

$$d_j = 1 - e_j , \quad (13)$$

where d_j represents the inherent contrast intensity of the criterion C_j. The more divergent the performance ratings $p_{ij} (i = 1, 2, ..., n)$ for the criterion C_j, the higher its corresponding , and the more important the criterion for the problem. This reflects that a criterion is less important for a specific problem if all alternatives have

Table 1. Pitching information for alternative pitchers in 2010.

Pitcher's name	GS	Wins	IP	ERA	WHIP	K/9	Team
Pan, Wei-Lun	29	11(3)	191.2(3)	3.193(10)	1.130(3)	3.906(12)	Lions
Jim Magrane	27	11(3)	192.0(2)	2.250(2)	1.100(2)	5.481(6)	Elephant
Orlando Roman	24	12(2)	162.2(6)	2.323(3)	1.240(9)	5.607(4)	Elephant
Kenneth Alan Ray	24	7(10)	154.0(7)	2.629(5)	1.440(11)	4.968(8)	Bears
Christopher Lee Mason	24	10(7)	166.1(4)	2.813(7)	1.210(7)	7.695(2)	Bears
Itsuki Shoda	24	11(3)	193.0(1)	3.031(8)	1.200(5)	4.986(7)	Bulls
Lin, Ying-Chieh	23	9(9)	147.1(8)	2.687(6)	1.210(6)	7.101(3)	Bulls
Yang, Chien-Fu	22	11(3)	143.0(9)	2.328(4)	1.150(4)	4.779(10)	Bulls
Wang, Jing-Ming	21	10(7)	124.2(11)	3.826(11)	1.440(12)	9.279(1)	Lions
Aaron James Rakers	18	4(12)	121.1(12)	4.153(12)	1.290(10)	4.905(9)	Bears
Carlos Castillo	17	14(1)	165.2(5)	2.173(1)	1.020(1)	4.302(11)	Elephant
Jerome Williams	16	7(10)	139.0(10)	3.107(9)	1.220(8)	5.508(5)	Lions
average	22	10	158.2	2.876	1.221	5.710	

Note: the (n) indicates ranking in terms of the criterion.

similar performance ratings for that criterion. If all the performance ratings against a criterion are the same, the criterion can be eliminated for the given situation on which a decision is to be based, because it transmits no information to the DM (Deng et al., 2000).

The objective weight for each criterion $C_j\,(j=1,2,...,m)$ is thus given by,

$$w_j = d_j / \sum_{k=1}^{m} d_k \,. \tag{14}$$

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. The most 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) (Chen and Chen, 2009; Lewis, 2003; Sparks and Abrahamson, 2005), all of which are included in this study. We want to formulate a simple model, one whose parameters are familiar to all fans, so only those four statistics are used: innings pitched (IP), earned run average (ERA), strikeouts per 9 innings (K/9) and walks plus hits per inning pitched (WHIP). We calculate the ERA, K/9 and WHIP for all starting pitchers using the following formulas:

ERA=9 × (*Earned Run Allowed/Innings Pitched*).
K/9＝9 × (*Strikeouts/Innings Pitched*).
WHIP＝(*Walks + Hits*)*/Innings Pitched.*

Empirical analysis for a starting pitcher of the CPBL

The procedure for calculating the edge of Taiwanese professional baseball league starting pitchers in the application cases is shown below.

Alternative pitchers

A brief description of twelve starting pitchers is set forth below. Their names are shown in Table 1. Each team in the CPBL, including the Brothers Elephant, Uni Lions, La New Bears and Sinon Bulls, had three players selected as alternatives. As can be seen in Table 1, Pan has the most games started in the CPBL, 29 games. He pitched 191.2 innings and won 11 games in 2010. His ERA was 3.913, WHIP was 1.130 and K/9 was 3.906. Magrane, who pitched 192.0 innings for Brothers Elephant in 2010, won 11 games out of the 27 games he started. His performance can be summarized as follows: 2.250 ERA, 1.100 WHIP and 5.481 K/9. Roman who pitched for the Brothers Elephant won 12 games out of 24 games started and had an ERA of 2.323, WHIP of 1.240, and K/9 of 5.607 for 162.2 innings. Ray and Mason, who both played for the La New Bears, won 7 and 10 games, respectively, out of the 24 games they started in 2010 season. Ray's performance can be summarized as follows: 2.629 ERA, 1.440 WHIP and 4.968 K/9 out of 154.0 innings pitched. Masson pitched 166.1 innings, and his ERA was 2.813, WHIP was 1.210 and K/9 was 7.965. Shoda, Lin and Yang started 24 games, 23 games and 22 games, respectively. For the Sinon Bulls, and they won 11 games, 9 games and 11 games, respectively. Shoda had an ERA of 3.031, WHIP of 1.200 and K/9 of 4.986 out of 193.0 innings pitched. Lin pitched 147.1 innings, with an ERA of 2.687, WHIP of 1.210 and K/9 of 7.10. Yang's ERA performance was 2.328, WHIP was 1.150, K/9 was 4.779 out of 143.0 innings pitched. Wang pitched 124.2 innings and started 21 games for the Uni Lions. He won 10 games and his performance can be summarized as follows: 3.826 ERA, 1.440 WHIP and 9.279 time strikeouts

Table 2. Weights of the criteria.

Criteria	IP	ERA	WHIP	K/9	Total
weight	0.2538	0.2482	0.2581	0.2399	1.0000

per nine innings in 2010. Rakers only won 4 games but he started in 18 games forthe La New Bears in the season of 2010. He pitched 121.1 innings and his ERA was 4.153, WHIP was 1.290 and K/9 was 4.905.

Castillo, who has won the most games, started 18 games and won 14. Castillo had an ERA of 2.173 and his WHIP performance was 1.020 and K/9 was 4.302 in 2010. Williams only started in 16 games in 2010. His ERA performance was 3.107, with a WHIP of 1.220 and K/9 of 5.508, and he won 7 games for the Uni Lions.

On average, all starting pitchers in the CPBL started 22 times, received ten wins, pitched 158.2 innings, and their average ERA, WHIP and K/9 were 2.876, 1.221 and 5.710, respectively.

The weights of evaluation criteria

The entropy method is used to determine the weights of the evaluation criteria. In the first step, use Eq. (10) to normalize each criterion. In the second step, the entropic value is calculated using Eq. (12). In the third step, use Eq. (13) to calculate the degree of divergence of the average intrinsic information contained by each criterion. For the final step, the weight of each criterion is calculated using Eq. (14). Computations were done with the Excel and R software. Table 2 shows the weights for each criterion. The WHIP is the most important factor for starting pitchers in the CPBL, second is the IP, third is the ERA and fourth is the K/9. Additionally, in terms of values of the weights, the weights of the criterion obtained in this study are fairly even, between 0.2538 and 0.2399. These calculations are in discrepancy with figures attained by Chen et al. (2011) where the weight of WHIP is as high as 0.3610; while the weight of ERA is only 0.1360, where the weight of IP is 0.2880 and the weight of ERA is 0.1530. The reason for these differences lies in the fact that this study utilizes non-subjective weight calculation methods (entropy) while the previous studies use subjective group decision making method (AHP). Even though group opinions may produce more objective results, it may be due to the effects of group homogeneity that caused results to being more subjective.

TOPSIS for deriving the overall performance values of alternative pitchers

Hwang and Yoon (1981) originally proposed the order performance technique based on the similarity to the ideal solution (TOPSIS), 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 (Aydogan, 2010; Deng et al., 2000; Olson, 2004; Shanian and Savadogo, 2006; Torlak et al., 2010; Zhang et al., 2010). We measured the performance of starting pitchers with respect to each criterion. Table 3 shows the decision matrix of selection criteria.

Use either Eq. (1) or Eq. (2) to find the normalized decision matrix depending on whether the objective of the selection criterion is that of minimization or maximization. Table 4 shows the normalized decision matrix.

Criteria are divided between maximization and minimization. Maximization criteria are IP and K/9, and minimization criteria are ERA and WHIP. Then the weighted normalized decision matrix is calculated using Eq. (3). The weighted normalized decision matrix for each selection criterion is shown in Table 5.

The positive (A^*) and negative (A^-) ideal solutions are determined using Eq. (4) and Eq. (5). The values are shownin Table 6.

Next, the distance of each alternative is calculated using Eq. (6) and Eq. (7). These values are shown in Table 7. The closeness coefficient CC_i is determined using Eq. (8). The starting pitchers' closeness coefficient value and his rank are also shown in Table 7. When the TOPSIS approach was employed, Christopher Lee Mason who played for the La New Bears was identified as the best starting pitcher in the CPBL. This finding is surprising, because in the 2010 season, Mason earned ten wins in 24 game starts and when pitching his IP, ERA, WHIP and K/9 performance were not the best in the CPBL, being only slightly better than average. On the other hand Carlos Castillo's performance of Wins, ERA and WHIP were ranked number one in the CPBL, but he ranked only sixth of overall starting pitchers. Castillo pitched 165.2 innings with 1.020 walks plus hits per inning and 2.173 ERA in the 2010 season. His performance for IP, WHIP and ERA were better than average, but his K/9 performance was lower than average. Lin, Ying-Chieh, ranked second place among all twelve starting pitchers, earning nine wins in 23 game starts but his performance of wins was lower than average.

Third place was Jim Magrane. In the 2010 season, Magrane earned eleven wins with an ERA of 2.250, WHIP of 1.100 and pitched 192.0 innings. His K/9 performance was 5.481, which ranked sixth place, lower than average. Wang Jing-Ming, a rookie in the CPBL, was ranked fourth place. His K/9 performance was the best out of all starting pitchers in the CPBL. Orlando Roman, who ranked fifth place, had twelve wins and ranked second place although his WHIP performance was 1.240, higher than average. Yang, Chieh-Fu was a member of the Chinese Taipei baseball team that was sent to the 2008 Beijing Olympic Games. He earned 11 wins in the 2010 season, and his ERA and WHIP were better than average. However, his IP and K/9 were both

Table 3. Decision matrix.

Pitcher's name	IP	ERA	WHIP	K/9
Pan, Wei-Lun	191.2	3.193	1.130	3.906
Jim Magrane	192.0	2.250	1.100	5.481
Orlando Roman	162.2	2.323	1.240	5.607
Kenneth Alan Ray	154.0	2.629	1.440	4.968
Christopher Lee Mason	166.1	2.813	1.210	7.695
Itsuki Shoda	193.0	3.031	1.200	4.986
Lin, Ying-Chieh	147.1	2.687	1.210	7.101
Yang, Chien-Fu	143.0	2.328	1.150	4.779
Wang, Jing-Ming	124.2	3.826	1.440	9.279
Aaron James Rakers	121.1	4.153	1.290	4.905
Carlos Castillo	165.2	2.173	1.020	4.302
Jerome Williams	139.0	3.107	1.220	5.508

Table 4. Normalized decision matrix.

Pitcher's name	IP	ERA	WHIP	K/9
Pan, Wei-Lun	0.1007	0.0925	0.0771	0.0568
Jim Magrane	0.1012	0.0652	0.0751	0.0797
Orlando Roman	0.0855	0.0673	0.0846	0.0815
Kenneth Alan Ray	0.0811	0.0761	0.0982	0.0722
Christopher Lee Mason	0.0875	0.0815	0.0826	0.1158
Itsuki Shoda	0.1017	0.0878	0.0819	0.0725
Lin, Ying-Chieh	0.0775	0.0779	0.0826	0.1032
Yang, Chien-Fu	0.0753	0.0675	0.0785	0.0695
Wang, Jing-Ming	0.0654	0.1109	0.0983	0.1349
Aaron James Rakers	0.0638	0.1203	0.0881	0.0713
Carlos Castillo	0.0870	0.0629	0.0696	0.0625
Jerome Williams	0.0733	0.0901	0.0834	0.0801

Table 5. Weighted normalized decision matrix.

Pitcher's name	IP	ERA	WHIP	K/9
Pan, Wei-Lun	0.0256	0.0229	0.0199	0.0136
Jim Magrane	0.0257	0.0162	0.0194	0.0191
Orlando Roman	0.0217	0.0167	0.0218	0.0196
Kenneth Alan Ray	0.0206	0.0189	0.0253	0.0173
Christopher Lee Mason	0.0222	0.0202	0.0213	0.0278
Itsuki Shoda	0.0258	0.0218	0.0211	0.0174
Lin, Ying-Chieh	0.0197	0.0193	0.0213	0.0248
Yang, Chien-Fu	0.0191	0.0167	0.0203	0.0167
Wang, Jing-Ming	0.0166	0.0275	0.0254	0.0324
Aaron James Rakers	0.0162	0.0298	0.0227	0.0171
Carlos Castillo	0.0221	0.0156	0.0180	0.0150
Jerome Williams	0.0186	0.0223	0.0215	0.0192

lower than average. Itsuki Shoda pitched 193.0 innings, the most of all starting pitchers in the 2010 season, but his ERA, WHIP and K/9 performance was insufficient to rank him higher than eighth place. Ranked nine was

Table 6. Positive and negative ideal solutions.

	IP	ERA	WHIP	K/9
Positive ideal solution	0.0258	0.0156	0.0180	0.0324
Negative ideal solution	0.0162	0.0298	0.0227	0.0136

Table 7. Positive and negative ideal solutions and distance for each alternative, closeness coefficient and Rank.

Pitcher's name	d^*	d^-	CC_i	Rank
Pan, Wei-Lun	0.0203	0.0120	0.3718	10
Jim Magrane	0.0134	0.0178	0.5706	3
Orlando Roman	0.0140	0.0154	0.5244	5
Kenneth Alan Ray	0.0179	0.0126	0.4135	9
Christopher Lee Mason	0.0081	0.0182	0.6913	1
Itsuki Shoda	0.0165	0.0132	0.4433	8
Lin, Ying-Chieh	0.0109	0.0158	0.5911	2
Yang, Chien-Fu	0.0173	0.0140	0.4475	7
Wang, Jing-Ming	0.0168	0.0191	0.5330	4
Aaron James Rakers	0.0235	0.0035	0.1299	12
Carlos Castillo	0.0178	0.0161	0.4757	6
Jerome Williams	0.0168	0.0097	0.3665	11

Kenneth Alan Ray. His ERA was 2.629, better than average, but other criteria such as IP, WHIP, K/9 were worse than average. Pan, Wei-Lun although a well-known pitcher in Taiwan, usually enlisted by the Chinese Taipei baseball team, in this study, ranked tenth place for overall starting pitchers in the CPBL. This ranking was greatly affected by his worse performance in terms of ERA and K/9. Jerome Williams and Aaron James Rakers were ranked eleventh and twelfth. Their IP, ERA, WHIP and K/9 performance was worse than average.

Conclusion

Generally, most baseball fans or commentators judge who is the best starting pitcher based on their number of wins or ERA. Based on the above criteria, in the 2010 season, the best starting pitcher of the CPBL was Carlos Castillo. In order to evaluate the performance of starting pitchers in CPBL more objectively, however, this study employs the Entropy and TOPSIS methodology for analysis to find best starting pitcher in the Taiwanese professional baseball league. Using this methodology, the best starting pitcher was Christopher Lee Mason, not Carlos Castillo. From a methodological point of view, the results of this study adopting the Entropy approach reveal that IP, ERA, WHIP and K/9 have mostly the same weight on determining the best starting pitcher in the CPBL. The findings demonstrate that Entropy is a useful tool to help support a decision to calculating the weights of criteria. It generates objective weights and breaks down a complex decision-marking system into a simple way to avoid misleading judgments resulting from subjective opinions. These findings demonstrate that TOPSIS is an adequate tool to select the best alternative. In conclusion, developing a model that fits all decision-makers and every decision situation may not be realistic. Each starting pitcher has different pitchingskills for their team. The study does not attempt to recommend which pitcher is the best, but rather provides coaches or managers with information that can give insight into a pitcher's abilities.

Starting pitchers are a valuable asset to professional baseball teams. It is hard to train a good starter, and not every candidate is necessarily suitable for the job. If coaches or managers make incorrect decisions to release a potentially good starter based on incomplete information this would be a loss to the team. We suggest two avenues for future research, first, the selection of more criteria for determining the best starting pitchers, such as batting average against (AVG) or rate of ground outs divided by air outs (GO/AO). Second, the Entropy and TOPSIS methodology could also be employed to analyze relief pitchers, catchers, infielders and outfielders, ultimately to help coaches or managers make decisions correctly based on the analysis results.

Conflict of Interests

The authors have not declared any conflict of interests.

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