Evaluation Model for Baseball Players of National Team-Application of Fuzzy Multiple Criteria Decision Making

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Abstract

The performance of professional baseball players infects personal wages and the value of the game. Players are under pressure from fans and sponsors. It is important to develop an evaluation model that examines player performance using scientific methods. Since the evaluation is complicated and uses multiple criteria, this study applies multi-criteria decision making to create a hierarchical model to understand the relevance of the variables. Utilizing fuzzy analytic hierarchy process (FAHP), we classify the characteristics of the performance evaluation index and study its attributes to determine their weights. Our conclusions are as follows. The most important criteria for catchers is defense, cooperation, ability to hit, psychological strength, and pitch choice. Finally, an analysis of the data from the 17th program of The Chinese Professional Baseball League with techniques for order preference by similarity to ideal solution, we have found that the results from performance analysis on the best catcher is different from the results of a journalist poll.

Keywords: Professional baseball, Performance Evaluation, Fuzzy Analytic Hierarchy Process, Technique for Order Preference by Similarity to Ideal Solution

1. Introduction

In real situations, the selection of the best domestic and international players is voted on by reporters or coaches. Many performance-based incentive awards are given out without the use of a scientific or objective approach. Chou (2002) considered that when coaches or club managers use personal experience to make a subjective judgments on player contribution and

award players that often result in failure; whereas, coupling these qualitative fundamentals with experience with scientific quantitative analysis will do more with less. Berri and Schmidt (2002) pointed out that statistical data for on-field performance of professional athletes certainly evaluates them. Therefore, the evaluation of performance for players in accordance with offensive and defensive indicators during games is a more objective evaluation. Wu (2001) showed that the annual individual award acquisition in baseball is an important consideration in determining the salary of players. However, the evaluation task on individual awards is provided by reporters or voted on by coaches, instead of using statistical information of player on-field performance. These methods lack objectivty and are not scientific.

Bodin and Eddie (2000) adopted the analytic hierarchy process (AHP) to perform selection of new players for U.S. major league teams with good results. The AHP hierarchical structure and the multi-criteria characteristics correctly and completely evaluate players well. It also provides rapid evaluation on players. Nevertheless, a real-life decision-making executive, the evaluation is often conducted in a fuzzy environment (Zadeh, 1965). Under a complex decision-making environment, including judgment on group behavior, fuzzy concepts become crucial.

After winning a silver medal for baseball at the Olympic Games in Barcelona, athletes who took part in baseball activities for Taiwan had a surge and were newly discovered in the Chinese Professional Baseball League (2007). Whether selecting the national team at that time, coaches now have a number of measure standards. It is the same for the domestic professional baseball, the performance of professional baseball players affects individual salaries and excitement levels towards the game. The commercial interests of club and fan pressure are also ineffable. Therefore, a club must have a sound method to select players, but the selection methods of today are anthropogenic ally subjective. To establish a selection model for professional baseball players, we conduct a discussion on their performance using scientific methods.

Combining hierarchy analysis with fuzzy theory, this study adopted the fuzzy analytic hierarchy process (FAHP) to provide clubs and coaches an objective and scientific method to conduct appraisals as a reference for selected players. This study then adopted technique for order preference by similarity to ideal solution (TOPSIS) to conduct empirical analysis of evaluation model on the baseball national representative team players by using the information of the 17th Chinese Professional Baseball League regular season.

2. Literature Review

2.1 Performance Evaluation

Performance evaluation is considered a process that assesses employee relevant and, contributions of a person at work, the quality or quantity of work, and the future development potential to, thereby, provide the necessary personal assistance to achieve their goals. Performance criterion are a dimension for the organization to assess the performance of an individual, a team, or a work unit. It is a direction for an individual or a team to put forth effort to achieve the organization's strategy (Jackson & Schuler, 1999).

Scully (1974) created a computational model to measure the performance of professional baseball players, but its set performance indicators do not fully measure the performance of the players. However, the attributes of each players contribution is not the same and, therefore, unable to indicate the contribution of some players. The on-field performance of players can be divided approximately into three categories: batting, pitching, and fielding performance. Wang (2005) adopted multivariate statistical analysis methods in the analytic hierarchy process to construct the selection models for catcher, pitcher, infielder, and outfielder, respectively, to provide a reference for the selection of a national baseball team.

2.2 Fuzzy Multi-Criteria Decision Making

The earliest quantitative method on human judgment and decision making is based on probability statistics as the core. Subsequently for computing psychology, different studies were conducted on areas of utility theory and decision making theory (Teng, 1990). After Zadeh (1965) published fuzzy set theory, the development of fuzzy theory had begun. For a real-life decision making executive, it is usually conducted in a fuzzy environment. When the decision making environment has grown complex and includes judging group behavior, fuzzy concepts becomes important.

Bellman and Zadeh (1970) proposed decision making in a fuzzy environment and gradually developed many fuzzy decision methods. Fuzzy theory has considerable theoretical foundation on studies for issues of uncertainty or subjective awareness. The theory has been widely used on domains of control engineering, expert systems, artificial intelligence, management science, operations research, and multi-criteria decision making (Chen, 2003). FAHP has been widely used in planning and group decision making. Associating the process with fuzzy theory solves problems of conventional AHP, such as restriction on the application of ratio scales, relevant issues of decision attribute, the average number, inaccuracies, group decision making problems, and other issues. The FAHP method has the fuzzy concept, so that it will not result in great disparities due to the preference of the author on a particular factor. Therefore, it is a more objective approach.

3. Research Method

In this study, we measured to acquire criteria weights through the use of the designated questionnaire of Fuzzy AHP hierarchical structure and relevant experts conducted pairwise comparisons on the importance of performance evaluation criteria for professional baseball players. It was to establish a systematic evaluation model of professional baseball players for the selection of a national baseball team. Then, based on the selection criteria for professional baseball players performance evaluation, we established a hierarchical structure with the FAHP architecture features. Thus, the determination of the weights for each evaluation criteria.

3.1 Establishment of Player Evaluation Structure

This study first collected and systematically listed the performance evaluation of professional baseball players, journals, theses, and other literature. Then, we followed this up with further analysis and classification based on the study questions. Through interviews with experts on

the assessment criteria, data was duplicated, retained, deleted, modified, or made under another arrangement. The retained data is used as the foundation for the preparation of a follow-up questionnaire and as a basis for indicator standards for future use of FAHP.

Based on the literature and the views of experts, this study preliminarily constructed an AHP structure for selection dimensions of the best baseball players. The first level is the goal level, the ultimate goal of the player selection; the second layer is the objective level; and the third layer is a standard level.

3.2 Weights of Selection Criteria on Players

Since AHP has no direct use of fuzzy concept or methods to solve this uncertainty, it merely compares relatively the proportion to measure the important perceptions of experts among pairwise factors that results in differences between the evaluation and the reality (Belton and Gear, 1985). Due to the inability of AHP to overcome the shortcomings of decision making fuzziness, Laarhoven and Pedrycz (1983) adopted the AHP of Saaty (1980) under evolution to develop the FAHP from the substitution of a triangular fuzzy number directly into the pairwise comparison matrix to solve the problem. In this study, the performance of professional baseball players includes on-field offensive and defensive data and the psychological qualities of the player against the game. Moreover, every evaluator does not necessarily provide the same relative importance ratio of pairwise comparison for each criterion. Therefore, to reduce semantic perceptions of the evaluators and to obtain optimal criteria weights, this study adopted the FAHP method to strike for the evaluation criteria weights of player performance.

3.3 Fuzzy Analytic Hierarchy Process (FAHP)

In this study, the triangular fuzzy numbers are computed by modifying the calculation process of Buckley (1985) and using the proposed defuzzification of Zhao and Govind (1991). The steps are as follows:

Step (1): Establish hierarchical structure

Using AHP to break down the complex problems into levels, we established a hierarchy structure with the performance evaluation of professional baseball. The first level is the ultimate goal, i.e., searching for the best professional baseball players. The second level is an objective level of effect-based evaluation on professional baseball players. The third level is a criterion level or an attribute level of effect-based evaluation on professional baseball players. The final level is optional.

Step (2): Design professional questionnaire

For the questionnaire design, we adopted a pairwise comparison to identify the relative importance of decision factors on each level. The evaluation scale is divided into five ratings, which are "Absolutely essential", "Very important", "Quite important", "Somewhat important", and "Equally important".

Step (3): Introduce fuzzy numbers to create a fuzzy inverted matrix

Substituting the fuzzy number, representing the fuzzy semantic set by using FAHP in this study into pairwise comparison matrices:

$$\tilde{M} = \left[\tilde{R}_{ij} \right]_{N \times N}$$

$$\tilde{M}_{ij} = \tilde{R}_{ij} \ \ if \ i < j \tag{4.1}$$

$\tilde{M}$: Fuzzy inversion matrix

$$\tilde{R}_{ij} : \text{Fuzzy numbers} \ \ \tilde{R}_{ij} = 1 / \tilde{R}_{ij}, \ \ \forall \, i, j = 1, 2, \ldots, n \tag{4.2}$$

Step (4): Fuzzy weight calculation

$$\tilde{Z}_i = (\tilde{R}_{i1} \otimes \tilde{R}_{i2} \otimes \ldots \otimes \tilde{R}_{in})^{1/n}, \ \ \forall \, i = 1, 2, \ldots, n \tag{4.3}$$

$$\tilde{w}_i = \tilde{Z}_i \otimes (\tilde{Z}_1 \oplus \tilde{Z}_2 \ldots \oplus \tilde{Z}_n)^{-1} \tag{4.4}$$

Step (5): Defuzzification

In this study, we adopted the center of gravity defuzzification method. Its main considerations: the method is simple and easy to operate as well as does not take into account the evaluation committee preferences (Yu, 2004). The calculation is as follows:

$$\tilde{A}_{ij} = \left(L_{ij}, M_{ij}, U_{ij} \right) \tag{4.5}$$

$$DF_{ij} = \frac{\left\lfloor \left(U_{ij} - L_{ij} \right) + \left(M_{ij} - L_{ij} \right) \right\rfloor}{3} + L_{ij}, \ \ \forall \, i, j = 1, 2, \ldots, n \tag{4.6}$$

Step (6): Group Integration

The fuzzy weight of each expert is defuzzified, converted into explicit values, and the summation of values is averaged and integrated as w_i

$$w_i = \frac{w_m}{m} + \frac{w_c}{c} + \frac{w_p}{p} + \frac{w_r}{r}, \ \ \forall \, i = 1, 2, \ldots, n \tag{4.7}$$

Baseball management(m) = 1, 2, ..., m; coach(c) = 1, 2, ..., c; player(p) = 1, 2, ..., p; reporter (r) = 1, 2 , ..., r.

3.4 Questionnaire

Par-takers in professional baseball served to fill in the FAHP questionnaire. A total of 160 questionnaires were handed out (13 managers, 42 coaches, 85 players, 20 reporters); 51 copies were recovered (6 managers, 13 coaches, 17 players, 15 reporters); 32 of those recovered passed the consistency test (4 managers, eight coaches, 10 players, 10 reporters); and the effective recovery was 20%.

3.5 Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) Calculation Steps

Techniques for order preference by similarity to ideal solution (TOPSIS) as developed by Hwang and Yoon (1981) is based on the concept to select a feasible plan that is near to ideal solution, but far away from the negative ideal solution. Upon the closeness to the relatively ideal solution from the use of (TOPSIS), the separation between ideal and negative-ideal solution is also considered. Therefore, it is easy to use and does not generate controversy over priorities and other advantages. (TOPSIS) has a monotonically increasing (or decreasing) effect, thus, the higher the requirement on effectiveness criteria the better, but the lower requirement on cost assessment the better. The equation and steps for (TOPSIS) are as follows (Hwang & Yoon, 1981):

Step (1): Construct a normalized decision matrix

The scale of different criteria is transformed into a comparable scale. The normalized decision matrix, R, is obtained by calculating the value of each normalized, r_{ij}, so that all criteria have the same vector unit, as shown in equation (4.8).

Assuming the initial form of original decision matrix as D,

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_i \\ \vdots \\ A_m \end{array} \begin{array}{cccccc} X_1 & X_2 & \cdots & X_j & \cdots & X_n \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1j} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2j} & \cdots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ x_{i1} & x_{i2} & \cdots & x_{ij} & \cdots & x_{in} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mj} & \cdots & x_{mn} \end{bmatrix} \end{array}$$

Where column is the optional schemes for consideration $\{A_i \mid i = 1, 2, 3, ..., m\}$; row is the indicators for decision making $\{X_j \mid j = 1, 2, 3, ..., n\}$. As each indicator, X_j, has different criteria scale, it can be transformed into comparable scale via normalization. The normalization equation of x_{ij} is as follows:

$$r_{ij} = x_{ij} \left/ \sqrt{\sum_{i=1}^{m} x_{ij}^2} \right. \tag{4.8}$$

Step (2): Construct weighted normalized decision matrix, V

Each column of the R matrix is multiplied by its corresponding priority weights, w_j.

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

A^+ is used to represent the better choice to construct the optimal value of each objective, which is the ideal solution; A^- is used to represent the poorer choice to construct the worst value of each objective, which is the negative-ideal solution.

Step (4): Calculate separation measure:

The separation measure between each scheme is calculated by using the n-dimensional Euclidean space. The separation between each scheme and ideal solution is noted as S_i^+; whereas the separation measure of negative-ideal solutions is noted as S_i^-.

Step (5): Calculate the relative closeness to the ideal solution:

The relative closeness of scheme A_i to the ideal solution A^+ is noted as C_i^*.

Step (6): List the preference order

The preference order is listed based on the gradual decline of C_i^*. If the C_i^* value is closer to 1, it indicates that the scheme is better; the opposite represents a poorer scheme.

4. Results and Discussions

(i) Establishment of player evaluation model

According to the selection structure for the best player developed in this study from the use of the FAHP method to perform weight analysis, the consistency index (CI), the consistency ratio (CR), and the consistency ratio for the whole hierarchy (CRH) are verified to comply with a standard (≤ 0.1), to show that the hierarchical factor for recovered questionnaires has consistency. For expert evaluations that comply with the consistency verification, the semantic variables are substituted into the corresponding triangular fuzzy numbers by use of equations from (4.1) to (4.4) as mentioned in this study to individually calculate the factor of each level and the fuzzy weight of the index. Then, equations (4.5) and (4.6) are used to obtain the defuzzification values. Finally, equation (4.7) is used to integrate the weights of each expert, so that we can analyze the player with the evaluation criteria weights from the different backgrounds of evaluators.

(ii) Weights of objective level and standard

Table 1 shows the defuzzification values of the weights on the objective level and the standard level while evaluating catcher. For catchers, the highest weight is the pitching sequence ability, reaching 0.1875; followed by the fielding percentage with the weight value of 0.1804; catching skill with the weight value of 0.1178 is ranked third. The total weights of these three criteria are 0.4857, which is nearly half the value of the whole weights. We can see the importance of on-field commanding led by catcher during the baseball game.

Table 2 shows he defuzzification values of the weights on the objective level and the standard level while evaluating pitcher. For pitchers, the highest weight is the number of wins, reaching 0.2573; followed by the earned run average at 0.1349; resistance to stress is ranked third at 0.1346; and winning percentage is ranked fourth at 0.1331. This shows that pitchers have to place importance on victory over everything else.

Table 3 shows the defuzzification values of the weights on the objective level and the standard level while evaluating fielder. For fielders, the highest weight is fielding percentage, reaching 0.1375 and is followed by tactical execution at 0.1049. We can see that baseball is a team sport that emphasizes team cooperation more than some other team sports.

Table 1. Evaluation hierarchical structure on catcher and its weights

Goal Level	Objective Level	Overall Weights	Standard Level	Overall Weights
Catcher Evaluation	Batting Performance (0.1756)		Batting average(0.0587)	
			Home runs(0.0297)	
			Slugging average(0.0272)	
			Hits(0.0203)	
			On-base percentage(0.0397)	
	Team Contribution (0.2977)		Pitching sequence ability（0.1875）	
			Tactical execution（0.0744）	
			Run batted in（0.0208）	
			Number of successful steal（0.0060）	
			Scoring（0.0090）	
	Fielding ability (0.2982)		Fielding Percentage(0.1804)	
			Caught Stealing (0.1178)	
	Plate Discipline (0.1032)		Base on balls record (0.0723)	
			Strikeout Percentage(0.0309)	
	Psychological qualities (0.1253)		Energy and Determination(0.0612)	
			Resistance to Stress(0.0641)	

Table 2. Evaluation hierarchical structure on pitcher and its weights

Goal Level	Objective Level	Overall Weights	Standard Level	Overall Weights
Pitcher Evaluation	Pitching Performance (0.2017)		Batting average against (0.0439)	
			Number of innings per home run hit (0.0229)	
			Earned run average (0.1349)	
	Team Contribution (0.3904)		Winning Percentage (0.1331)	
			Wins(0.2573)	
	Ball Controlling (0.2057)		Wild Pitch Percentage (0.0469)	
			Strikeouts per nine innings (0.0592)	
			Base on ball record (0.0996)	
	Psychological qualities (0.2022)		Leadership(0.0676)	
			Resistance to stress(0.1346)	

Table 3. Evaluation hierarchical structure on fielder and its weights

Goal Level	Objective Level	Overall Weights	Standard Level	Overall Weights
Fielder Evaluation	Batting Performance (0.2475)		Batting average(0.0865)	
			Home runs(0.0404)	
			Slugging average(0.0332)	
			Hits (0.0235)	
			On-base percentage (0.0639)	
	Team Contribution (0.2031)		Tactical execution（0.1049）	
			Run batted in（0.0469）	
			Number of successful steal（0.0206）	
			Scoring（0.0307）	
	Fielding Ability (0.1926)		Fielding percentage (0.1375)	
			Caught stealing (0.0551)	
	Plate Discipline (0.1494)		Base on ball record (0.0932)	
			Strikeout percentage (0.0562)	
	Psychological qualities (0.2074)		Energy and determination(0.1037)	
			Resistance to stress(0.1037)	

(iii) Application on the Selection of Players

The Chinese Professional Baseball League is the top-tier baseball tournament for Taiwan. The baseball players owned by the League Union over the years are the main source for the national team. In this study, we performed empirical analysis on the 17th Chinese Professional Baseball League regular season records for the best players by using (TOPSIS). For the pitching sequence ability, tactical execution ability, energy and determination, resistance to stress of catcher at standard level; for leadership, resistance to stress of pitcher at standard level; for the energy and determination, resistance to stress and attributes scorings of fielder at standard level; and additional questionnaires were handed out for scoring. Except for filling in fuzzy weights of baseball players, the professional questionnaire in this study does not directly provide evaluation values on the quality of the baseball players. Therefore, it is still required for the same experts to perform an appraisal on the numerical data of performance against the qualitative criteria.

Using the fourth step of (TOPSIS), the separation measure of ideal solution (S_i^+) and the separation measure of negative-ideal solution (S_i^-) for each player are calculated. Smaller S_i^+ value indicates it is closer to ideal solution; larger S_i^- value means further away the negative-ideal solution. The fifth step is to calculate the relative closeness to the ideal solution for each player. If the calculated value tends to be 1, it indicated that the player is closer to the ideal solution. The final step is to list the preference order for each player after the calculation by using the equation. According to the decision-making principle of (TOPSIS), a higher score for the relative closeness to the ideal solution is the best plan.

5. Conclusions and Recommendations

In conclusion, this study constructed an evaluation model to elect a national baseball team with three levels, which are the goal level (first level), the objective level (second layer), and the standard level (third level). Conducting empirical data analysis on the 17th Chinese Professional Baseball League regular season records using (TOPSIS) (Table 4).

Table 4. Best representative players

Catcher	Chen Feng-min	Kao Cheng-hua	Kao Chih-kang	Ye Jun-zhang	Wu Chao-hui	Wang Shin-min	Shi Jin-shou	Chen Je-chang		
Team	La new	Uni-President	Uni-President	Sinon	Macoto	Chinatrust	Chinatrust	Brother		
C_i^*	0.8127	0.2803	0.4900	0.5649	0.5178	0.3263	0.1721	0.3808		
Chen Feng-min > Ye Jun-zhang > Wu Chao-hui > Kao Chih-kang > Chen Je-chang > Wang Shin-min > Kao Cheng-hua > Shi Jin-shou										
Pitcher	Tsai Ying-Feng	Pan Wei-lun	Yang Chien-fu	Chang Xian-zhi	Treng Chou-Hau	Tu Chang-wei	Liu Chun-nan	Lin En-yu	Lin Yueh-ping	Wu Szu-yu
Team	La new	Uni-President	Sinon	Macoto	Chinatrust	Chinatrust	Brother	Macoto	Uni-President	La new
C_i^*	0.5501	0.7398	0.5559	0.5830	0.6242	0.2221	0.0444	0.8519	0.2513	0.8750
Wu Szu-yu > Lin En-yu > Pan Wei-lun > Treng Chou-Hau > Chang Xian-zhi > Yang Chien-fu > Tsai Ying-Feng > Lin Yueh-ping > Tu Chang-wei > Liu Chun-nan										

First Baseman	Pan Chung-wei	Kao Kuo-ching	Hsu Guo-long	Hsieh Chia-hsien	Wang Chuen-chia	Chen Chia-wei				
Team	La new	Uni-President	Sinon	Macoto	Macoto	Uni-President				
C_i^*	0.4054	0.2455	0.3278	0.8233	0.5361	0.1093				
Hsieh Chia-hsien > Wang Chuen-chia > Pan Chung-wei > Hsu Guo-long > Kao Kuo-ching > Chen Chia-wei										
Second Baseman	Yang Sen	Huang Chung-yi	Wang Yi-min	Feng Sheng-hsien	LuJun-hsiung					
Team	Uni-President	Sinon	Chinatrust	Brother	La new					
C_i^*	0.6519	0.7585	0.2544	0.3071	0.2758					
Huang Chung-yi > Yang Sen > Feng Sheng-hsien > Lu Jun-hsiung > Wang Yi-min										
Third Baseman	Shih Chih-wei	Chang Tai-shan	Wang Jin-yong							
Team	La new	Sinon	Brother							
C_i^*	0.3891	0.8387	0.1122							
Chang Tai-shan > Shih Chih-wei > Wang Jin-yong										
Shortstop	Lin Chih-Sheng	Cheng Chang-ming	Chen Je-cheng							
Team	La new	Chinatrust	Brother							
C_i^*	0.8652	0.1518	0.2041							
Lin Chih-Sheng > Chen Je-cheng > Cheng Chang-ming										
Left Fielder	Chen Chin-feng	Kuo Dai-chi	Chen Chih-Yuan							
Team	La new	Uni-President	Brother							
C_i^*	0.9300	0.1288	0.3387							
Chen Chin-feng > Chen Chih-Yuan > Kuo Dai-chi										
Center Fielder	Huang Lung-yi	Tseng Hua-wei	Chi Chun-lin							
Team	La new	Sinon	Chinatrust							
C_i^*	0.3473	0.2895	0.7896							
Chi Chun-lin > Huang Lung-yi > Tseng Hua-wei										
Right Fielder	Liu Fu-hao	Wi Shin-ming	Chang Chien-ming	Chen Kua-jen	Tsai Jin-wei					
Team	Uni-President	Sinon Bull	Sinon	Brother Elephants	La new					
C_i^*	0.5402	0.4206	0.3295	0.5692	0.2793					
Chen Kua-jen > Liu Fu-hao > Wi Shin-ming > Chang Chien-ming > Tsai Jin-wei										

Our findings indicated that the best representatives for the baseball national team from the performance evaluation model are Chen Feng-Min from La New as catcher, Wu Szu-Yu from La New as pitcher, Hsieh Chia-Hsien from Macoto as first baseman, Huang Chung-Yi from Sinon as second baseman, Chang Tai-Shan from Sinon as third baseman, Lin Chih-Sheng from La New as shortstop, Chen Chin-Feng from La New as left fielder, Chi Chun-Lin from Chinatrust as center fielder, and Chen Kua-Jen from Brother as right fielder.

We established a complete evaluation system from the evaluation model for the baseball national team players by using a multi-criteria decision making approach. Its advantage is to avoid bias caused by the subjective impression of voting during the selection of players. In this study, FAHP and (TOPSIS) were applied on the selection model of national baseball team players. We are proposing to apply these methods in the follow-up studies on athlete selection in other sports or for other sports-related research.

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