Technical Research

Designing smart model in volleyball talent identification via fuzzy logic based on main and weighted criteria resulted from the analytic hierarchy process

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ABSTRACT

Introduction: Administration of proper tools and scientific approaches in sport talent identification will lead to rapid detection of sport talents for championships. These methods may prolong the duration of athletic success as well as providing their maximum efficacy in worldwide competitions. The investigations in this field are mostly based on defining effective parameters in talent identification or determining the norms of elite players.

Objectives: The aim of this study is designing a smart model in volleyball talent identification based on main and weighted criteria resulted from analytic hierarchy process of anthropometrical, biomechanical, psychological, physiological and technical variables based on fuzzy logic.

Methods: In this investigation, important criteria were selected via analytic hierarchy process of anthropometrical, biomechanical, psychological, physiological and technical variables. The norms of the elite volleyball players in the range of 14-16 years old in these variables were used throughout this study (as the comparison index). Thereafter, a smart model was designed based on fuzzy logic using MATLAB software.

Results: The 14-16 years old volleyball player record in the previously mentioned variables were consider as input data After comparing these records with the norms of elites, the players were categorized into different groups (output): Unmatched, Semi-matched, Matched, Brilliant and Rare.

Discussion and Conclusion: The parameters including height and upper extremity length (anthropometrics), agility and power (biomechanics), self-confidence and motivation (psychology), special endurance (aerobic and anaerobic; physiology), spike and serve (techniques) were shown to be the main and weighted criteria by analytic hierarchy process. Our smart model analyzed these variables in comparison with elite norms and made a specific result of player's talents. This model of talent identification could be a reliable and useful method for selection of future volleyball stars in young population.

Keywords: Smart model, Volleyball, Talent identification, Fuzzy logic, Analytic hierarchy process.

Introduction

Holding the best ranks in the world championships and worldwide competitions has been considered as a major index in development and growth of nations which a brief review on Olympic medal standing confirms this statement. These nations not only possess the basic foundation and facilities in sport, but also in socio-economic and political positions are much more powerful in comparison with others [1, 2]. To maintain a stable and long lasting success in global competitions definitely needs supportive approach and basic structures. A scientific sport talent identification (STI) system plays critical roles in these programs [3]. Talent identification is the process of ability detection and then adjusting these abilities with main and effective criteria in related sport [4-6]. Talent identification is a method for converting of athlete potentials to a functional state which needs to be developed by professional committees [7, 8]. Optimal STI includes all important indices and provides a comprehensive model which leads to a significant result [9-11]. In recent years in the STI studies at the beginning talent identification criteria are determined following measurement the norms of these criteria in elite players and then comparing the results of participants with elites in order to show their talent in related sport. But in the past, the researchers reported the patterns based on innate and acquired factors for initial screening which finally conducted the athlete towards the proper field with higher chance of success [11]. In this study, the main criteria in anthropometry, biomechanics, psychology, physiology and techniques in volleyball were defined by analytic hierarchy process (AHP) and weighted based on their effectiveness. Afterwards, with the use of intelligent algorithm based on fuzzy logic and based on the 14-16 years old elite volleyball players norms, a smart model was designed which received the volleyball players records as input in the height and upper extremity length (anthropometrical parameters); agility and power (biomechanical parameters); self-confidence and motivation (psychological parameters); specific endurance (aerobic and anaerobic; physiological parameters); spike and serve (technical parameters), and in comparison with elite volleyball players determined their absolute ability and potential as the output. Multiple-criteria analysis and considering several factors could make the interpretation of STI very complicated [12, 13]. So, applying the models based on artificial intelligent algorithm for the capacity of processing huge volumes of data and the power of precise interpretation will result in a valid method in volleyball talent identification. Fuzzy logic algorithm in contrast to classical zero-one law considers all criteria between 0 and 1 (not only the existence or not existed) [14]. The administration of this concept in STI will lead to a more detailed comparison of athletes together or compared to a specific index (obtained of elite athletes). The accurate and valid information for the main and weighted criteria is needed for efficient and comprehensive model. In this research, the viewpoints of experts in volleyball talent identification are gathered via AHP questionnaire and analyzed by the EXPERT CHOICE software. In this study for the first time we designed a standard and smart model for volleyball talent identification in order to better detection of ability and potential of 14 to 16 years old players while traditional STIs were solely based on visual observations of one or two criteria. The aim of the current study was to design the smart model in volleyball talent identification based on main and weighted criteria resulted from analytic hierarchy process of anthropometrical, biomechanical, psychological, physiological and technical variables based on fuzzy logic.

Technical and Experimental Methods

In our study, the viewpoints of 15 expert coaches in AHP questionnaires were gathered for criteria determination in volleyball talent identification (table 1), then data analysis with EXPERT CHOICE software revealed the important and main criteria as well as their weight. The AHP technique is a valuable and valid way for complex decision analysis. This method is based on pairwise comparisons of elements with each other considering their impact, and has an application in group decision making (developed by Thomas L. Saaty, in the 1970s). The AHP technique reflects the human judgment and converts the complex relations to a comprehensible format and defines a weight or priority for the elements. In other words, the AHP is the theory of measurements by pairwise comparisons and is dependent to expert judgment to obtain priority scales.

Table 1. Field and criteria for the volleyball talent identification

Field	Code	Criteria	Code
Anthropometrics	A	Height	a_1
		Lower extremity length	a_2
		Upper extremity length	a_3
		Palm-size	a_4
		Shoulder width	a_5
Biomechanics	B	Agility	b_1
		Endurance	b_2
		Strength	b_3
		Flexibility	b_4
		Power	b_5
Psychology	C	Self-confidence	c_1
		Motivation	c_2
		Focus	c_3
		Goal-directed behavior	c_4
		Imagination	c_5
Physiology	D	Aerobic endurance	d_1
		Anaerobic endurance	d_2
		Specific endurance (aerobic and anaerobic)	d_3
		Lactic acid tolerance	d_4
Technique	E	Spike	e_1
		Serve	e_2
		Forearm pass	e_3
		Overhead pass	e_4

The scoring scale of variables for AHP questionnaire is presented in table 2.

Table 2. Pairwise scoring scales in AHP questionnaire.

The importance of criteria	Numerical value
Most important	9
Very strong importance	7
Strong importance	5
Slightly more important	3
Similar importance	1

The example of AHP questionnaire is shown in table 3. For instance height has a value of three in comparison with lower extremity length which shows that height is slightly more important than lower extremity length (as shown in table 2). In contrast, lower extremity length compare to height has a value of one third (0.333).

Table 3. AHP questionnaire for determination of criteria importance.

	Height	L. extremity length	U. extremity length	Palm-size	Shoulder width
Height	1	3	1	3	5
L. extremity length	0.333	1	0.333	1	3
U. extremity length	1	3	1	3	5
Palm-size	0.333	1	0.333	1	3
Shoulder width	0.2	0.333	0.2	0.333	1
	Agility	**Endurance**	**Strength**	**Flexibility**	**Power**
Agility	1	5	3	3	0.333
Endurance	0.2	1	0.333	0.333	0.2
Strength	0.333	3	1	1	0.333
Flexibility	0.333	3	1	1	0.333
Power	3	5	3	3	1
	Self-confidence	**Motivation**	**Focus**	**Goal-directed behav.**	**Imagination**
Self-confidence	1	1	3	5	5
Motivation	1	1	5	7	7
Focus	0.333	0.2	1	3	5
Goal-directed behav.	0.2	0.142	0.333	1	3
Imagination	0.2	0.142	0.2	0.333	1
	Aerobic endur.	**Anaerobic endur.**	**Specific endurance**		**LA tolerance**
Aerobic endurance	1	0.142	0.2		1
Anaerobic endur.	7	1	3		7
Specific endurance	5	0.333	1		3
Lactic acid tolerance	1	0.142	0.333		1
	Spike	**Serve**	**Forearm pass**		**Overhead pass**
Spike	1	3	5		7
Serve	0.333	1	3		5
Forearm pass	0.2	0.333	1		3
Overhead pass	0.142	0.2	0.333		1

The results were analyzed by EXPERT CHOICE software and their main and weighted criteria were determined (Figure 1).

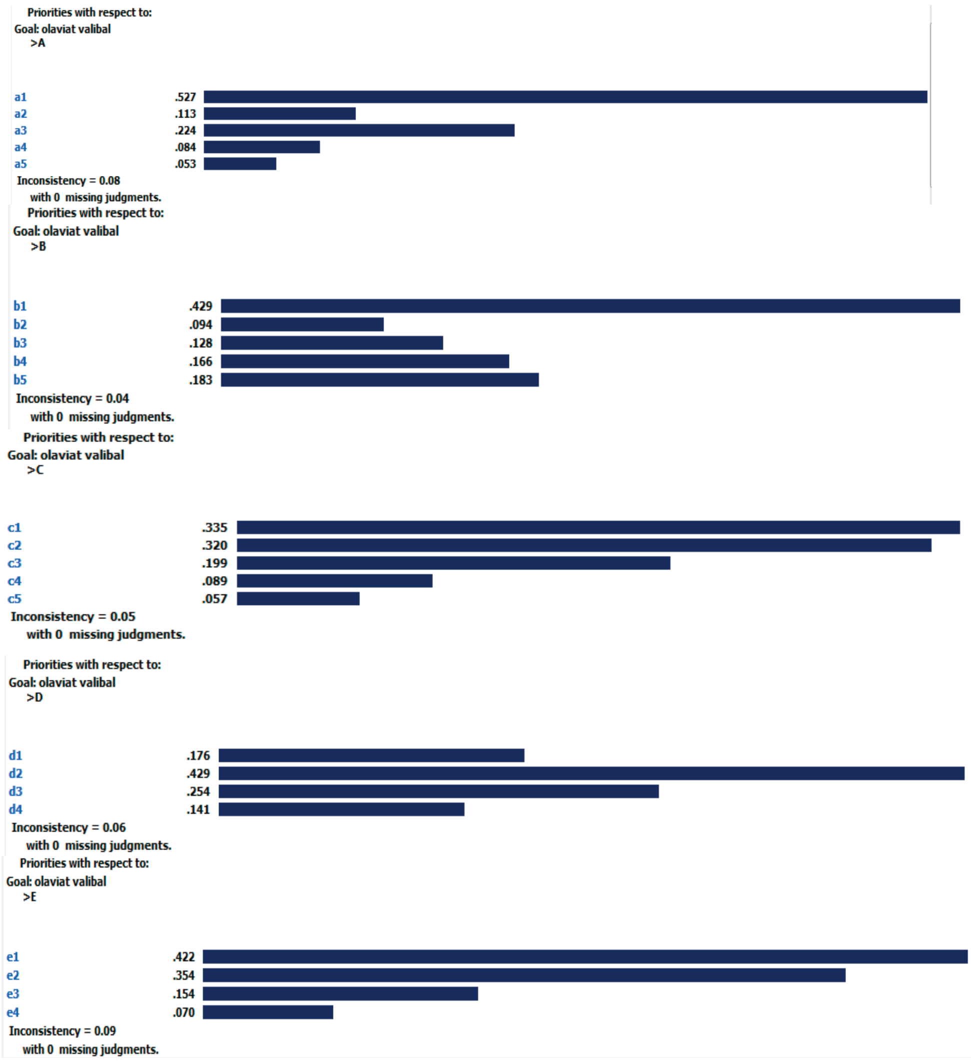

Figure 1. The determination of main and weighted criteria by AHP method.

Classification of criteria based on their weights: Height (a_1, weight: 0.527) and upper extremity (a_3, weight: 0.224) in anthropometric field. Agility (b_1, weight: 0.429) and power (b_5, weight: 0.183) in biomechanical field. Self-confidence (c_1, weight: 0.355) and motivation (c_2, weight: 0.320) in psychology field. Specific endurance (d_3, weight: 0.254) in physiology field. Spike (e_1, weight: 0.422) and serve (e_2, weight: 0.354) in technical field. These main and weighted criteria were inputs in smart model of talent identification. Afterwards, the norms of elites (14 to 16 years old) in the 5 fields which were measured by Brown (2003) were considered as comparison indices (Table 4). The fuzzy logic of MATLAB software was used as smart algorithm. The height and upper extremity length (anthropometry), agility and power (biomechanics), self-confidence and motivation (psychology), specific endurance (physiology), spike and serve (technical) were considered as main and weighted criteria. In the norms of elites measured by Brown the tape meter was used as measuring tool for height and upper extremity length (from acromion to distal phalange of third finger). The shuttle run (4×9) test was used for agility measurement. The standing long jump test was used for the power of lower extremity. The South Australian Sport Institute (SASI) questionnaire was used for quantification of the psychological criteria (self-confidence and motivation). The six-minute shuttle run test across the length of volleyball court was used for specific endurance. Running vertical jump test was used for measurement of spike technique. The serve test (one-minute serving in 6 zones of volleyball court) was used for serve technique.

Table 4. Main talent identification criteria norms of elite players (15 ± 1 years old).

Row	Volleyball talent identification criteria	Elite volleyball players (Mean ± SD)
1	Height (cm)	192.5 ± 3
2	Upper extremity length (cm)	75 ± 3
3	Agility (s)	8.8 ± 0.4
4	Power (cm)	220 ± 5
5	Self-confidence (score)	43 ± 3
6	Motivation (score)	42 ± 4
7	Specific endurance (number)	30 ± 3
8	Spike (cm)	310 ± 8
9	Serve (number)	18 ± 4

Fuzzy inputs

The nine main and weighted criteria converted to fuzzy inputs based on elite volleyball player norms. The description is as follow: the mean of elite volleyball player norms in the main and weighted criteria (Very good); one standard deviation upper (Excellent); one standard deviation lower (Good); two standard deviation lower (Poor); three standard deviation lower (Weak). Figure 2 illustrates the fuzzy input of height and other criteria converted to fuzzy input as well.

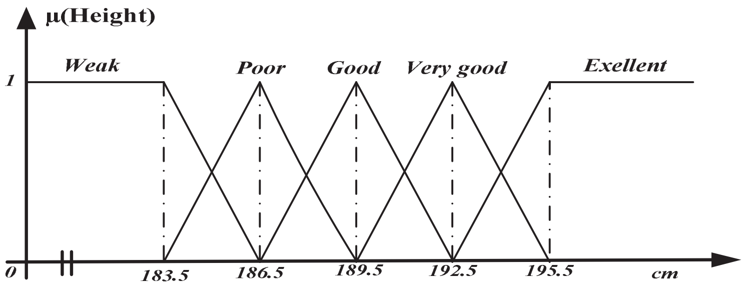

Figure 2. The fuzzy input of height.

Fuzzy outputs

The outputs of smart model are in the range of 0 to 100 which are classified as follow: Unmatched (<10); Semi-matched (=30); Matched (=50); Brilliant (=70, elite volleyball player norms) and Rare (>90) (Figure 3). The other points between the above-mentioned ranges (10 to 90) are reported as ratio/fuzzy functions.

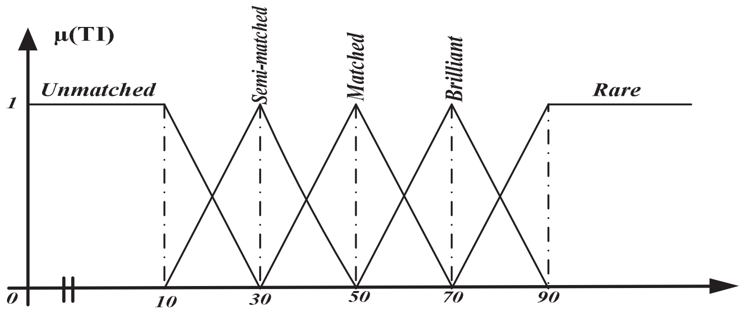

Figure 3. The fuzzy output of smart talent identification pattern.

Fuzzy rules

These rules are presented as conditional statement in the form of IF-THEN. By these rules the relation of inputs to outputs are as follow: weak to unmatched; poor to semi-matched; good to matched; very good to brilliant and excellent to rare. The weight of every input is reflected in the related fuzzy rule. After programming of fuzzy input, output and rules in MATLAB software the ability, talent and potential of volleyball players 14 to 16 years old will be evaluated. Our smart model of talent identification can also interpret the ratio/fuzzy conditions which are impossible in zero-one law.

Results

After running the smart model each record was compared with the norms of elite volleyball players and with regard to the weakness or strength of records the output was shown as a number in the range of 0 to 100. The effects of main and weighted criteria were assessed as the combination of ability and potential and according to the table 5 the output was shown as the percentage of unmatched, semi-matched, matched, brilliant and rare.

Table 5. Outputs of smart model talent identification for 10 different records in volleyball players.

Row	Height (cm)	Upper extremity length (cm)	Agility (s)	Power (cm)	Self-confidence (score)	Motivation (score)	Specific endurance (number)	Spike (cm)	Serve (number)	Output 0 - 100	Volleyball talent identification
1	180	70	8.5	210	38	40	30	295	12	43.5	32% semi-matched, 68% matched
2	190	73	9.1	218	45	44	28	310	16	65.3	23% matched, 77% brilliant
3	176	66	8	198	42	39	29	285	15	39.7	51% semi-matched, 49% matched
4	169	60	9	195	41	40	26	278	11	30	semi-matched
5	**192.5**	**75**	**8.8**	**220**	**43**	**42**	**30**	**310**	**18**	**70**	**brilliant**
6	204	79	9.5	225	44	45	26	325	18	76	71% brilliant, 29% rare
7	188	69	8.2	200	38	39	31	301	11	50	matched
8	198	77	8.9	213	46	43	25	312	14	72	91% brilliant, 9% rare
9	183	67	9.5	204	37	39	24	298	17	31.2	94% semi-matched, 6% matched
10	154	51	7.8	181	35	35	30	260	11	30	semi-matched

Discussion

The results demonstrated that with the access to the elite player norms in main and weighted criteria and using the fuzzy logic algorithm the talent identification could be done. This research with combination of the scientific talent identification results and applying the artificial intelligence (fuzzy logic) represented a smart model of talent identification in volleyball. The result of our study was in line with Brown et al. study (2003) and the results of volleyball federation talent identification committee of Islamic Republic of Iran (2016) in determination of elite volleyball player norms, meaning that if the norms of elites (14 to 16 years old) are entered as inputs the output will be the status of brilliant and if the lower records are entered (dependent on the degree of weakness) the status unmatched, semi-matched or matched or combination of them (unmatched/semi-matched, semi-matched/matched or matched/brilliant) will be reported and the records upper than elites show brilliant/rare or rare status. The smart model of talent identification considers the abilities and potentials of volleyball players in main and weighted criteria. The model summates the numerical value of every record after comparing with the elite norms to show the final output, so the output is a reflection of all records. In traditional talent identification all aspects were not considered [15-17]. There are only few studies which represent valid methods, models or software; Papic and Rogulj (2009) showed the sport talent identification (STI) parameters in fuzzy mode and believed that the absolute zero-one law (exist or not exist) is not efficient in STI but did not define a specific model [18]. Noori and Sadeghi (2013) designed a software based on fuzzy logic in main criteria of basketball talent identification [19]. It is necessary to design similar models or software in other sports in order to identify the athlete talents and enhance the duration of championships as well as achieving the best ranks in the international competitions.

Conclusion

Appropriate and accurate selection of main volleyball talent identification criteria and their weights leads to designing a useful smart model which could be helpful and advantageous for federations, committees and the coaches. The scientific smart model of talent identification causes a standard policy in volleyball talent identification.

Conflict of Interest

This smart model was designed by the author.

Acknowledgement

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