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Usage of Group AHP Approach in Karate Agility Test Selection

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ABSTRACT

Karate is one of the most popular martial art styles in the world as well as a popular sport in Iran. Successful performance in karate requires a high level of agility that enables the karateka (karate player) to avoid the opponent's attacks, and to assume optimal position for efficient performance of karate techniques. In order to measure agility in karatekas, karate coaches make use of general and available agility tests. However, there are many agility tests but coaches need to know which one is the best test for karatekas. Analytic Hierarchy Process (AHP). Data were collected from six karate experts' opinions in order to weight and rank agility tests specifically to select the best agility test. AHP approach allows the weight of each criterion from each expert to be computed in geometrical mean. As a result, based on experts' opinion and using Group AHP approach, the best validated agility test for Karate is Illinois test. This paper describes the usage of the group AHP approach in selecting the most appropriate agility test for karate. It discusses some of the advantages and disadvantages of using this approach. It also suggests how the approach can be used in sports research.

Keywords: Agility Test, karate, analytic hierarchy process

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INTRODUCTION

Karate is one of the most popular martial art styles in the world (Urban, 1993) as

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well in Iran (Iran Karate Federation, IKF, 1995). Currently, more than 180 countries are members of the World Karate Federation (WKF) (WKF, 1999). In karate, agility (for example, the mobility of the karateka in various directions) contributes greatly to successful performance of the karateka. Good agility enables the karateka to avoid the opponent's attacks and to assume optimal position for efficient performance of karate techniques (Blaevi *et al.,*2005).

Agility is the physical ability that enables an individual to rapidly change the body position and direction in a precise manner (Johson, 1988). It is not a single ability but a complex of several abilities (Blume, 1978; Dey, Kar, & Debray *et al.,* 2010; Meinel & Schnabel, 1976). These abilities are primarily dependent upon the coordinative processes of the central nervous system that are important, specifically in karate.

In order to measure agility, there exist some general standard tests (Lacy & Hastad, 2007). These test results can be used both to motivate self-improvement and help individuals to plan their fitness goals. Test is a tool or instrument of measurement; measurement is a major step in evaluation, and evaluation is an encompassing process, making qualitative decisions based on the quantitative data derived from tests and measurement. Therefore, tests of agility provide objective measure of agility ability among karatekas.

Agility is an important component of fitness for success in a wide variety of sports. It assumes a vital role in predicting the success of individuals in sport and physical activity (Lacy & Hastad, 2007). According to Sheppard and Young (2006), reported agility is a multi-factorial physical ability affected by explosive strength, speed, balance, muscular coordination, and flexibility. Besides, agility tests are best used for diagnostic purpose to determine which karateka is the most agile, and which one requires more additional practice to perform better. A good agility test depends on strength, speed, coordination, and dynamic balance (Chelladurai, 1976; Miller, 2006).

Many researchers have reported that agility is the most discriminating factor of performance among players (Reilly *et al.,* 2000) and it has a key role in improving performance (Pauole *et al.,* 2000). It is the most critical factor for sport competitors in fighting off the competition from their rivals in karate. For instance, a karateka requires changing direction speed and position in response to the movements of adversary and must be of a dominant agility to an opponent (Blaevi *et al*., 2006). As mentioned above, agility is the most critical factor for sport competitors in karate. Tests of agility are best used for the purpose of diagnostic and classification of players. However, there is no karate-specific validated agility test to achieve the above goals.

Based on some previous studies (see Ellis *et al*., 2000; Harman *et al*., 2000; Hasegawa *et al*., 2002; Kirkendall, 2000; Lacy & Hastad, 2007; Miller, 2006; Pollitt, 2003; Vescovi & McGuigan, 2008), the researcher selected eight general and validated agility tests. These are referred to as alternatives according to AHP approach. These alternatives include Illinois test (Cureton, 1951), Zig Zag test (Barrow, 1953), SEMO Agility test (Kirby, 1971) Shuttle Run test and 505 Agility test (*AAHPER,1976*), Side Step test (Johnson & Nelson, 1986), T test (Semenick, 1990) and Hexagon test (Roetert *et al.,* 1995) due to their specific characteristics that are in line with the main concern of the study. In addition, eight components of agility, which are named criteria based on AHP approach, are as follows: speed, strength, power, coordination, balance, reaction time, flexibility and body mechanism (Chelladurai, 1976; Sheppard & Young, 2006). Since AHP is one of the most validated Multi Criteria Decision Making (MCDM) methods, its uses solving and includes advantages which are the first quantitative and qualitative criteria that help us in the decision making. It also embraces a large quantity of criteria that can be considered and it constructs a flexible hierarchy that can be constructed according to the problem. Therefore, the purpose of this study was to select the best and most appropriate agility test for karateka using the AHP method.

ANALYTIC HIERARCHY PROCESS (AHP)

The AHP is a theory of relative measurement with absolute scales of both tangible and intangible criteria based on the judgment of knowledgeable and expert people (Ahmad & Qiu, 2009). It is introduced by Saaty (1980) and is one of the widely used Multi Criteria Decision Making approach. It resolves decision-making problems by structuring each problem into a hierarchy with different levels of criteria. In other words, AHP structures a decision problem into a hierarchy and evaluates multi-criteria tangible and intangible factors systematically. AHP also has been applied in numerous fields including many software selection decisions (Forman & Gass, 2001; Vargas, 1990; Zahedi, 1986).

This method is also discussed in a number of books (Bourke, Stagnitti, & Mitchell, 1993; Golden, Wasil, Harker, & Alexander, 1989; Saaty, 1980). The AHP method involves four steps to solve a decision problem (Lin & Yang, 1996; Tam & Tummala, 2001; Zahedi, 1986). The steps are: 1) Structuring the decision problem; 2) Creating pairwise comparison Matrix; 3) Determining normalized weights, and 4) synthesize the priorities.

The AHP is a structured technique for organizing and analyzing complex decisions. Based on Mathematics and Psychology, it was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then. It has particular application in group decision making and is used the world in a wide variety of decision situations in fields such as government, business, industry, healthcare, sports and education (Saaty & Peniwati, 2008). The research methodology involved two separate phases. The phases are described as follows:

Phase 1: The first phase of this paper was formed in order to explore suitable agility tests and components of agility, respectively. The instrument of data collection applied for this phase is questionnaire. By using the comparison matrix that has been prepared by the experts, the weights of components of agility were calculated. Having gathered data from experts, the consistency was determined. If the consistency is more than 0.1, the data must be refined until this number decreases to less than 0.1. This phase is important because it provides the knowledge platform for the next phase.

Phase 2: The applied methodology for this phase is based on the output of phase one and the approach used is AHP. In this phase, computing weights of components of agility and also validated agility tests with respect to each components of agility was constructed. At the end of this phase, all the components of agility and validated agility tests which had been considered were sorted.

A three-level hierarchy model was used to choose the best agility test for Iranian karatekas. Fig.1 shows the three-level hierarchy model. The first level presents the goal of the problem, which is to find the best validated agility test among potential candidates. As shown in the second level, the criteria of the model are divided into eight ones, namely, speed, coordination, strength, reaction time, power, flexibility, balance and body mechanic. The third level consists of eight potential validated agility tests for Iranian Karatekas, which include Hexagon test, 505 Agility test, Illinois test, SEMO Agility test, Shuttle Run test, Side Step test, T test and Zig Zag test. The tests were given at the final level of the proposed hierarchical mode. In a hierarchy, the criteria are assumed to be independent among them. This is called independence case between the criteria (Saaty, 1987). Please refer to Fig.2.

METHODOLOGY

Research Design

This research employs a descriptive design. The most important aim of this design is to find the best agility test among available agility tests. Descriptive research design is a valid method for researching specific subjects and as an antecedent to more quantitative studies. Although there are some valid concerns about the statistical validity, as long as the limitations are understood by the researcher, this type of study is a valuable scientific tool (Ary, Jacobs, Razavieh, & Sorensen, 2009). In the current research, independent variable is the best agility test in karateka, while dependent variables are eight validated and general agility tests and their components.

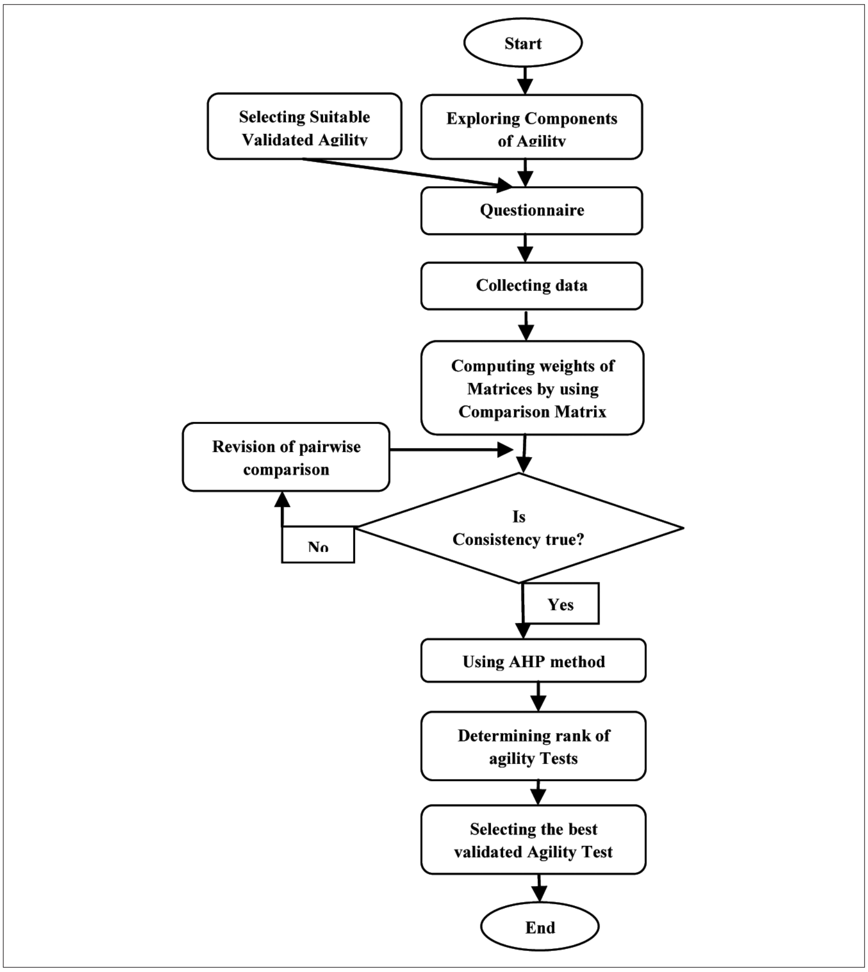

Fig.1 Research Framework

Population and Sampling

All the Iranian international and national karate coaches at various levels (i.e. youth and cadet, adults, and karate league) formed the population of this study. The population of the study should be in the level of at least bachelor or higher degrees in physical education and sports science. The other reason for choosing the above people as the population of this study is that they are experts and have in-depth knowledge and experiences which assure reliability and validity of the tests. Based on their weightings of the test components, the researchers selected the best test. This is very important because adequate knowledge can improve reliability and validity of the study (Saaty, 1996; Saaty & Ozdemir, 2003).

Based on statistics from Iran Karate Federation (1995), there are only 21 expert karateka coaches in the country. The population has been all former karate national and international champions. Saaty (2003) indicated that the number of experts

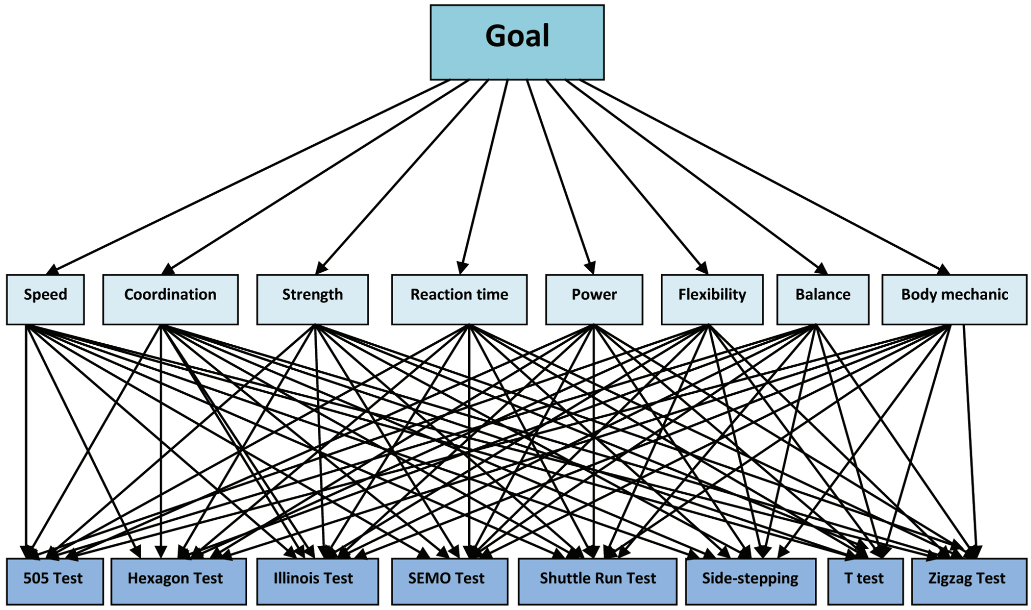

Fig.2 Hierarchy model of research

as interviewees should not be too many, and in general, five to fifteen interviewees is most suitable (Saaty, 1996). However, in the current research to increase the reliability of the research six expert karateka coaches were chosen as the research sample.

The AHP Approach Procedures

The AHP approach used in this study involved several procedures. First, selecting suitable, validating agility tests and exploring components of agility. Second, preparing questionnaire and sending it to expert karateka coaches. Third, gathering data and analysing these data. Fourth, computing consistency ratio. Fifth, using decision making software for weighting the criteria and ranking of alternatives. Finally, selecting the best agility test based on the ranking.

By using the AHP, the computing weights of components of agility and also validated agility tests with respect to each component of agility, should be calculated. In addition, all the components of agility and validated agility tests which had been considered would be sorted and the best one could also be distinguished.

Comparison Matrix

Comparison matrix is a part of the model structure of the analytical hierarchy process, which is a widely used Multi criteria decision-making methodology. It is useful where priorities are not clear, where there are chosen due to conflicting demands on resources or are competing in importance. It is a tool that provides a framework for comparing each criterion against all others, and helps to show the difference in importance between the criteria. In other words, it is used to compare each factor with each other factor, one-by-one. For each comparison, which of the two criteria will be decided as the most important, and then a score will then be assigned to show how much more important it is. It can compare positive and negative criteria simultaneously. The main difficulty is to get the inconsistency of the pairwise comparison matrix obtained from the decision makers in real-world applications (Choo & Wedley, 2004). It should be accepted if the amount of inconsistency is less than 0.1. Otherwise, the experts' opinion must be revised. The steps of preparing comparison matrix can be generally described as follows:

Step 1: To define the problem and specify the research objective.

Step 2: To construct a squared pair-wise comparison matrix (n × n) for criteria, with respect to objective by using Saaty's 1-9 scale of the pair-wise comparisons shown in Table 1. The pair-wise comparisons are done in terms of which element dominates the other.

TABLE 1
Saaty's 1-9 scale of pair-wise comparisons

Intensity of importance	Definition
1	Equal Importance
2	Weak Moderate
3	Importance
4	Moderate Plus
5	Strong Importance
6	Strong Plus
7	Very Strong
8	Very, very Strong
9	Extreme Importance

Step 3: There are $\frac{n \times (n-1)}{2}$ judgments required to develop the set of matrix in step 2. Reciprocals are automatically assigned in each pair-wise comparison.

Step 4: Synthesizing the pair wise comparison matrix is performed by dividing each element of the matrix by its column total.

Step 5: The priority vector can be obtained by finding the row averages.

Step 6: Weighted sum matrix is found by multiplying the pairwise comparison matrix and priority vector.

Step 7: Dividing all the elements of the weighted sum matrix by their respective priority vector element.

Step 8: Compute the average of this value to obtain $\lambda_{\max}$.

Step 9: Find the Consistency Index (CI), as follows:

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

(1) Where n is the matrix size.

Step 10: Calculate the Consistency Ratio (CR) from dividing CI on RI (Randomize Index)

$$CR = \frac{CI}{RI} \quad (2)$$

(2) Judgment consistency can be checked by taking the CR of CI with the appropriate value in Table 2.

TABLE 2
Average random consistency (RI)

Size of matrix	Random consistency
1	0
2	0
3	0.58
4	0.9
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10 and more	1.49

The CR is acceptable, if it does not exceed 0.10. If it is more, the judgment matrix is inconsistent. In order to obtain a consistent matrix, judgments should be reviewed and improved.

In this study, these steps were carried out through the use of expert choice software. By using this software, the agility tests could be ranked with respect to all the criteria that were applied in this paper.

Procedure of Group AHP

The AHP procedure in theory has different steps as specified below:

Step 1: Structuring the decision problem. Structure the hierarchy from the top (goal) through the intermediate levels (criteria, sub-sequent levels depend on) to the lowest level which usually contains the list of alternatives.

Step 2: Creating the pair-wise comparison Matrix.

After constructing the AHP model, the priorities should be done. By priorities here we mean weights, comparing objectives, and relative scale measurements. Weights are assigned to each criterion and sub-criterion. These weights are assigned through a process of pair-wise comparison. In the pair-wise comparison, each objective is compared at a peer level in terms of importance. In this time, a set of pair-wise comparison matrices (size n $\times$ n) for each of the lower levels with one matrix for each element in the level immediately above by using the relative scale measurement shown in Table 1 is constructed. The pairwise comparisons are done in terms of which element dominates the other. In group AHP, the weights of each criterion for each expert should be computed in the geometrical mean and the result of this step will be done in the next step.

Step 3: Determining normalized weights.

Therefore, by using each pair-wise comparison matrices, the weight of each row was computed by the matrix of "W".

$$C_{ij} = \frac{a_{ij}}{\sum_{k=1}^{n} a_{kj}} \quad i=1,2, \ldots n; j=1,2,\ldots m \quad (3)$$

$$W_i = \frac{\sum_{j=1}^{m} C_{ij}}{n} \quad i=1, 2,\ldots n \text{ (denominator must be size of matrix)} \quad (4)$$

TABLE 3
Comparing the components with respect to goal

	Speed	Strength	Power	Balance	Co-ordination	Reaction time	Flexibility	Body mechanic
Speed	**1**	2.44	0.58	3.14	0.73	0.51	3.6	1.26
Strength	0.41	**1**	0.22	0.54	0.73	0.33	2.31	0.67
Power	1.72	4.56	**1**	4.92	3.58	2.74	4.78	2.49
Balance	0.32	1.86	0.2	**1**	0.33	0.39	1.94	0.62
Co-ordination	1.37	1.37	0.28	3.05	**1**	0.59	2.85	1.63
Reaction time	1.96	3.06	0.37	2.58	1.7	**1**	3.99	1.98
Flexibility	0.28	0.43	0.21	0.51	0.35	0.25	**1**	0.61
Body mechanic	0.79	1.49	0.4	1.61	0.61	0.51	1.63	**1**

Step 4: Synthesize the priorities.

The final step is to synthesize the solution for the decision problem in order to obtain the set of priorities for alternatives. After computing the weight of the alternatives in respect to sub-criteria and then the sub-criteria in respect to criteria and also the criteria in respect to goal from step 3 (in the level immediately above), they are aggregated to produce composite weights which will be used to evaluate decision alternatives.

RESULTS

The data of this kind of tables were gathered from the same experts' viewpoints. Each expert filled it up and then computed the geometrical mean which had been done by authors. Consistency Ratio (CR) of the matrices calculated is less than 0.1. They are gathered in Table 4. Therefore, it shows sufficient consistency. By using the matrix in this study, the inconsistency Index was calculated at 0.012555, that is less than 0.1, indicating a sufficient consistency and it is accepted. As a result, based on the karateka experts' opinions and using the AHP method, the best validated agility test is the Illinois test, and this is followed by Hexagon test, Zig Zag, 505 Agility test, SEMO Agility test, Shuttle Run test, T test and Side Step test respectively. The results are given in Table 7.

TABLE 4
List of consistency ratio

Comparing agility tests	
With respect to:	Consistency Ratio
Speed	0.0125
Strength	0.0141
Power	0.0152
Balance	0.0137
Coordination	0.0164
Reaction time	0.0155
Flexibility	0.0129
Body mechanic	0.0109

Karateka coaches make use of the general agility tests to measure agility. Hence, selecting and validating karate specific agility test to assess the karateka is

TABLE 5
Comparing the validated agility tests with respect to speed

	Speed	Strength	Power	Balance	Co-ordination	Reaction time	Flexibility	Body mechanic
Speed	**1**	3.37	1.44	2.82	2.74	4	1.94	1.92
Strength	0.3	**1**	0.38	0.71	0.49	1.35	0.44	0.37
Power	0.69	2.61	**1**	1.47	0.91	1.7	0.99	0.72
Balance	0.35	1.4	0.68	**1**	0.65	1.74	0.87	0.48
Coordination	0.37	2.03	1.1	1.54	**1**	2.88	1.47	1.4
Reaction time	0.25	0.74	0.59	0.57	0.35	**1**	0.41	0.31
Flexibility	0.51	2.29	1.01	1.15	0.68	2.47	**1**	0.66
Body mechanic	0.52	2.71	1.38	2.09	0.71	3.17	1.51	**1**

essential. To this end, data were collected from 6 karateka experts' opinions in order to weight and rank agility tests, and especially to select the best agility test for the Iranian karateka players. After specifying the relative components as criteria and also considering the validated agility tests as alternatives respectively, data collection was done (see Table 3).

The weights of the criteria based on the group decision making were computed and are shown in Table 4. The table was completed based on six karate experts' point of view in Iran. Each expert filled it up by using Table 1 separately and then by computing the geometrical mean and after rounding off, Table 3 was completed. For example in column 7 and row 6, the number 3.99 ($\cong 4$) shows that *Reaction time* is moderate and is important than *Flexibility*, while number 4.92 ($\cong 5$) in the 4th column and row 3 indicate that *Power* is stronger and important than *Balance*. The inconsistency Index was calculated at 0.0125, that is less than 0.1, so it shows sufficient consistency. Table 4 illustrates the Consistency Ratio (CR) of matrices with respect to the components of agility. In addition to Table 3, there are eight Tables, as each expert should fill them up, and they are called "comparing validated agility tests with respect to each component". To illustrate this clearly, please refer to Table 5.

TABLE 6
Weight of the components

Components	Weights
Speed	0.14
Strength	0.06
Power	0.3
Balance	0.07
Co-ordination	0.13
Reaction time	0.18
Flexibility	0.04
Body mechanic	0.09

TABLE 7
Rank of the validated agility tests

Validated agility tests	Ranked
Illinois test	0.175
Hexagon test	0.165
Zigzag test	0.142
505 test	0.119
SEMO test	0.118
Shuttle run test	0.104
T test	0.102
Side step test	0.076

CONCLUSION AND RECOMMENDATIONS

In this study, the selection of the best agility test for karateka was done using the AHP approach. This method was applied in this study using the data from a real case in Iran. In order to increase the efficiency and ease-of-use of the proposed model, a simple software such as MS Excel can be used. The limitation of this article is that AHP ignores the uncertainty of executives' judgement during the decision-making process. Besides, some criteria could have a qualitative structure or an uncertain structure which cannot be measured precisely. In such cases, fuzzy numbers can be used to obtain the evaluation matrix, and the proposed model can be enlarged by using fuzzy numbers. For future research, the authors suggest that other multi-criteria approaches such as TOPSIS and ELECTRE with or without fuzzy methods be used, and to be compared as justification for the agility test selection in karate. The method may also be applied to other areas of sports. As a result of this paper, the best validated agility test for Iranian karatekas is the Illinois test and this is followed by Hexagon test, Zig Zag test, 505 Agility test, SEMO Agility test, Shuttle Run test, T test and Side Step test, respectively.

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