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A methodology for football players selection problem based on multi-measurements criteria analysis

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ABSTRACT

Football is one of the most popular sports in the world. Professional football has become a significant contributor to global economics and business. The game attracts considerable funds, which motivate participants of the sporting process (players, coaches, club owners, administration, etc.) to strive for better athletic results. However, such a motivation simultaneously promotes internal and external rivalry. The increasing number of players, the teams' desire to attract better team members, and the improved athletes' performance boost the use of assessment and rating processes. The most popular and widely used player rating systems are based on performance statistics, which reflect situational factors of the game. Most specialists believe that such systems lack objectivity. Thus, this paper presents a new methodology to assess and rank football players based on multi-criteria decision making (MCDM). A hands-on study is conducted for the assessment. A sample of 24 players is grouped into four separate groups consisting of six players for each group. The age of U17 is examined by 12 tests distributed as follows: three anthropometrics, five fitness, and four skills tests. Players are ranked on the basis of a set of measurement metric outcomes using the technique for order performance by similarity to ideal solution (TOPSIS) method to select the appropriate player using a one-shot experiment. Then, this study utilizes the mean and standard deviation to ensure that the four groups of players undergo systematic ranking, respectively. Findings are as follows: (1) systematic: TOPSIS is an effective tool used to solve player selection problems, and (2) statistics: group number one is the best group among the four groups, identical to the results of the system.

1. Introduction

Football is one of the most popular sports in the world, and its number of players annually increases at an explosive rate [1]. Soccer is a multi-player game. Accordingly, coaches are continuously seeking the most efficient technique for identifying outstanding players to form an elite team [2,3]. A team is adequately described as a small number of people with particular skills dedicated to a common goal, purpose, and approach for which they believe themselves mutually responsible.

The player selection process for professional soccer teams is crucial in the quest for winning. Such a process is so important that a wrong selection can cost a football team the championship and even millions of dollars if the player fails to live up to the team's expectations. Traditionally, professional soccer teams use various sports psychological assessments for evaluating players. Undoubtedly, these assessments are significantly beneficial and are extremely useful when attempting to form a winning soccer team. However, this process is only one part of the huge puzzle when attempting to assess a player's suitability for a team. The ability to select suitable players and arrange an effective team formation is indispensable in attaining the highest point for team sports [4].

The player selection process for a particular team intends to choose the most suitable player for a particular play position and role [5,6]. The procedure for player selection in n-player sports such as soccer is a complex multi-factor problem with multi-objectives. Player selection within a team is a difficult decision-making task with several measurements. Assessing several qualitative and quantitative factors is compulsory for coaches and their technical committee to produce the most elite players [7]. These factors may include the player's individual, anthropometric, fitness, and skills [8,6].

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Anthropometry is a technique to measure physical characteristics body size, shape of specific body parts, and proportion) of living beings, including men. Anthropometry has been widely applied in various disciplines, such as ergonomics and health sciences. Given its convenience, anthropometry has also been applied to understand athletes' physical characteristics in the field of sports science while targeting the improvement of athletic performance [8]. As the correct application of anthropometric techniques and the interpretation of information facilitate health management in athletes while improving their performance, support staff in athletic fields (including sports dieticians) must share their knowledge associated with anthropometry [9].

Physical fitness can be defined as "the ability to carry out daily tasks (work and play) with vigor and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies". Fitness requires a significantly specific and extremely clear definition. These terms are called the components of fitness, such as health-related components and motor skills components [35,36].

Skills can be defined as the ability to carry out a task frequently with pre-determined results within a given amount of time, energy, or both. Skills can be divided into two categories, namely, domain-general and domain-specific [37]. In soccer, a skill is the ability of a player to perform complex physical movements, such as controlling the movement of the ball [10].

Player selection based on the above factors can frequently become a problem for coaches on one platform in all tests. In other words, many problems may be faced by the coach during the selection process, such as the chosen players, based on all the tests we have mentioned earlier with the player and the available time for the selection process. Thus, a decision support system that can assist the coach during player selection is significantly beneficial for future games. This study presents a new methodology to assess and rank football players based on three different criteria, namely, physiology, fitness, and skill characteristics, using multi-attribute decision making. The remaining sections of this paper are organized as follows: Section 2 covers the literature review. Section 3 describes the decision-making methodology for the assessment and ranking of football players. Section 4 presents the results and discussion. Sections 5 and 6 discuss the contributions and limitations of this research, respectively. Sections 7 and 8 conclude and provide suggestions for future direction, respectively.

2. Literature review

The current literature on player selection and team formation in multi-player sports is limited and scattered. Nevertheless, some studies have attempted to create a framework for player selection.

Arnason et al. [8] offer the most related research in this study by proposing the use of a fuzzy inference system (FIS) for player selection and team formation in football fuzzy sets to transform the linguistic variables used for players' performance assessment in multiple attributes into triangular numbers. The linguistic variables are used to address the difficulty in expressing players' skill levels and performance ratings using discrete values. Fuzzy numbers are useful in promoting the representation and information processing under fuzzy environment. The linguistic variables are further used to assess the performance of each candidate player in different positions. FIS addresses the gaps in the sports science literature on the effective and efficient player selection and team formation. It uses a meaningful and robust multi-criteria model to aggregate both qualitative judgments and quantitative data. However, it considers imprecise or vague judgments that lead to ambiguity in the decision process.

Kasap and Kasap [11] investigate the general parameters to evaluate the performance of soccer players and develop a database for performance evaluation of soccer players, including a relevant decision support system (DSS) to assist people, such as the technical director. The framework is still in the proposal stage, but no players are evaluated through the system.

Johnson [12] shows that the sports domain offers an excellent opportunity to investigate decision-making domain. One reason for this is the topical scope of sports. This scope of decision making involves a number of different decision agents (coaches, players, etc.), tasks (play-calling, ball allocation, etc.), and contexts (during play, during time out, etc.), thus offering an opportunity to examine various interesting designs. Johnson added that each combination of the above factors produces a unique interaction of important elements that affect how decisions are made. Although no "standard" type of decision exists in sports, some characteristics seem general enough to abstract from this domain.

Bozbura et al. [29] propose a decision support system for player selection in the National Basketball Association (NBA). Six selected criteria, including four skills criteria with age and player salary, are created. However, their result is limited to six players only. Khatib et al. [13] evaluate the effectiveness of players using the decision-making framework by selecting the skills criteria to evaluate the players. Sathya and Jamal [14] use artificial intelligence to select a team of optimal players. They use a sample of 50 players, and their criteria are for skills only. Merigó and Gil-Lafuente [15] analyze the use of the ordered weighted averaging operator in the selection of human resources in sports management. They use the Hamming distance, the adequacy coefficient, and the index of maximum and minimum level to parameterize these decision-making techniques and selection of football players for a team. Ahmed et al. [16] consider the overall batting and bowling strength of a team and propose a constrained multi-objective optimization model for the selection of the players in the team. Raut et al. [17] proposed procedure is based on a decision-making method to assist in the selection of a suitable player from among several available players for a game based on skills criteria. Zhongyou [31] introduces a decision-making method for the evaluation of foreign players during the introduction of foreign players in CBA teams. The skills criteria are used on the evaluation, and the experiment is limited to four players only. The study claims to have achieved a good result. Ahmed et al. [30] propose decision-making approaches to team selection. They attempt to select the best team from a group of players with a certain budget. Specifically, they attempt to select 11 from 129 players within a certain budget. They analyze the result by selecting four teams with four different skills criteria, Tavana et al. [7] develop a system to assist the coach in selecting the game formation by using the skills criteria to determine the good players. However, further study on the fitness and physiological test is necessary for all the above studies.

Miralles et al. [18] explore individual players' strategies to assess the adequacy of shooting (in a simulation laboratory task) in varying situations and degrees of physical defensive pressure, rebound, defensive balance, and shooting distance. A decision-making approach based on these criteria is necessary for the present study.

Dadelo et al. [19] suggest a systematic solution as a consistent problem-solving system. Algorithms based on multi-criteria decision making (MCDM) are regarded as simple, clear, suitable to substantiate solutions, and easily applicable in practice. Methodologies used by the authors help ensure a greater efficiency of player and team rating, more accurate prognoses of sports results, team formation, and optimization of the training process. Furthermore, these methods consider the individualism of team players and encourage their versatility, that is, conformity to the general physical preparedness norms of the team. However, the proposed model for solving complex problems in sports is a new challenge that prevents the identification and access to all factors influencing the game's efficiency. It should be implemented in practice. The described research methods may be used in other types of sports. Furthermore, established suggestions require further research.

Based on the critical reviews for the above section, many encouraging results have been achieved in the area of player selection. However, the proposed frameworks in these studies do not imply a higher level of "accuracy" in player selection and team formation. Most of these approaches enable coaches to assimilate precise data and imprecise or ambiguous judgments into a formal systematic approach. These approaches should be used with care and in conjunction with the game objectives. They assist coaches to start thinking systematically on complex MCDM problems and to improve the quality of their decisions. Coaches' judgment is an integral component of player evaluation, and therefore developing an effective methodology is necessary. This methodology can rely heavily on the cognitive capabilities of coaches in skills testing, including other fitness and physiological tests on one platform to assess and rank football players.

3. Methodology

3.1. Conceptual framework

Our study provides a detailed look at alternative football players based on a set of measures through the relatively infrequent route of players' actual measurement. Furthermore, it reports the hands-on evaluation results based on anthropometrics, fitness, and skills tests. The input to this part (test criteria of subject articles) is discussed in later subsections.

The ranking of football players receives input from conducting different physical tests in the field. Furthermore, their measurement is used as a method of gathering information. The output ranks football players based on our set of variables using the technique for order performance by similarity to ideal solution (TOPSIS) method, including additional insight into the limitations and merits of each player. Fig. 1 illustrates all the elements of our study in the overall conceptual.

3.2. Assessment of football players

Conducting different physical tests in the field and their measurement are methods of gathering information; afterwards, successive performance assessment and choices may be made [39]. These tests are grouped into three main categories, namely, anthropometric test (age, height, and weight), fitness-related test (vertical jump, yoyo, 10 m shuttle, and speed Hoff), and skills-related test (juggling and short passing, running with the ball and long passing, dribbling, and shooting) [38].

Anthropometric and fitness tests are performed objectively according to well-known procedures, which will be described in the next section. Skills tests also utilize well-known tests and procedures. However, the results require extra steps to measure the performance of each player per test. A video captures each of the skills tests during the test [21]. This procedure of using a video enables three experts to give their judgments on players' performance and then obtain the average among them for each player. Experts are given a guideline to evaluate the players' performance. The defined procedures are described in the next section. Each test is performed once or twice before allowing players to perform the tests to show the test in front of the players. In other words, performing these tests enables players to learn the accurate procedure in performing the tests [8,37].

The sample of this study was selected from one of the secondary schools in Malaysia. Twenty-four physically active students aged between 15 and 17 years old were selected to perform the required tests. Considering that all the tests in this experiment were conducted in the field, taking care of many external variables was crucial for the researchers. The test procedure required an entire month to complete. All the tests were conducted from 1400 to 1830. The given time was suitable considering that all the participants (schoolchildren) were expected to be free during these

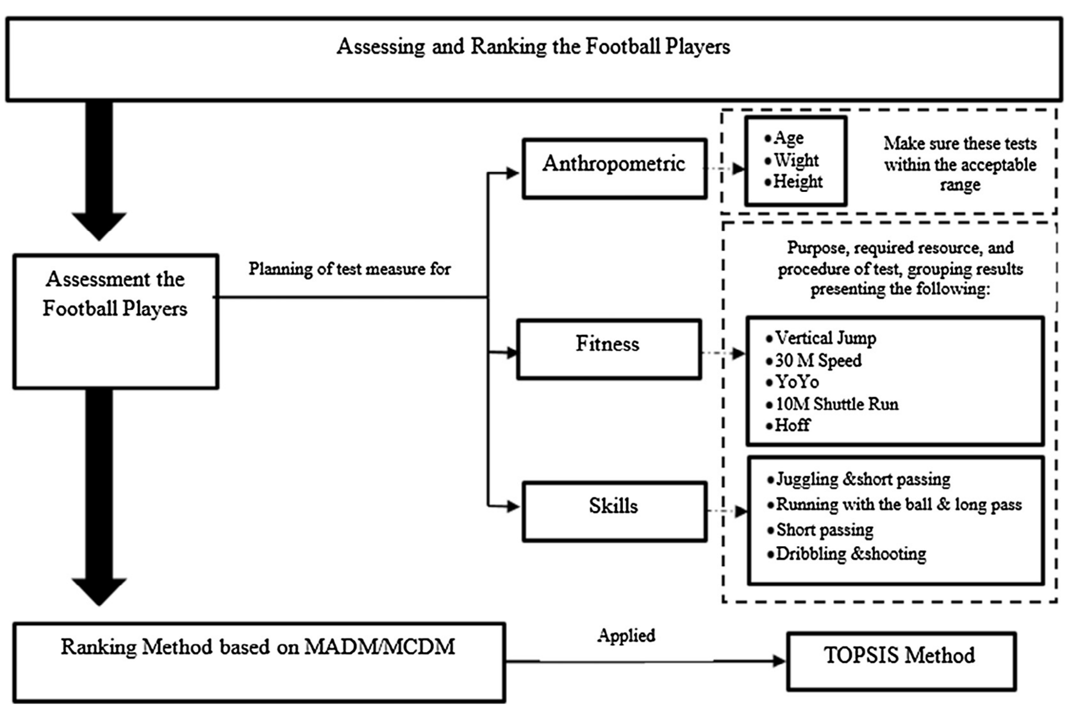

Fig. 1. Conceptual framework.

hours. After their classes ended, the moderator (school sports teacher) asked the volunteer students to stay and participate in the experiment.

3.2.1. Planning of test measure for anthropometrics

Once the students were selected as sample for the experiment, their age, weight, and height were recorded. Having the minimum height and weight for certain sports is important for physical sports players [33]. Previous literature has indicated the recommended average height and weight for professional soccer players [20]. The average height should be 180–185 cm, and the average weight should be 75–80 kg. For this study, the age bracket of the participants was 15–17 years. Regardless of the various benefits (lower expenditure, simple to conduct, minute apparatus requisite), the anthropometric test may be problematic because of its vulnerability to measurement errors and unreliability [32,21].

The unreliability of the overall anthropometric test can be divided into two: imprecision, which means the dimensional error inconsistency due to intra- and inter-observer variability, and undependability, which is a function of physiological variation, such as biological factors that may affect the reproducibility of the measure [22]. Thus, awareness of the effects of the changes for these factors is required, including the ability to measure these effects. According to the anthropometric test shown in Table 1, a total of 24 players participated in the age, body weight, and height tests. Each player was chosen according to the specified criteria matching the objective of the study. The mean value of each player represents the average score for the sample players according to the scores of the result and the (S/d) value, which represents the slight difference between scores. In our study, Table 1 shows these measurement factors as the descriptive statistics of the experimental group's test mean scores for the three components of anthropometric variables, namely, age, height, and weight [8].

Table 1 presents the details of the means and standard deviations (SD) for the experimental group. The minimum and maximum values for the selected variables (age, height, and weight) are also presented. As shown in Table 1, the mean value of the age test is M = 16.00 ± 1.02 with a minimum age of 15.00 (years) and a maximum age of 17.00 (years). The mean value of the body weight test represents the weight of the player sample as M = 55.80 ± 5.10 with minimum of 49.00 wt and maximum of = 68.00 wt (kg). The height average value is M = 170.38 ± 4.24 with minimum of 163.00 cm and maximum of 177.00 cm.

By comparing the results between two players, for example, between player Numbers 6 and 19, the difference in the age test, which is approximately two years, can be observed. Players with a smaller age have extra advantage. The difference in the weight criteria test is approximately ±9 kg. Players with a low weight have the advantage. The height criterion test values have an approximately ±5 cm difference between these two players. The player with the highest value has the advantage. These factors are within the acceptable range.

3.2.2. Planning of test measure for fitness

A number of physical tests have been used in the past to appraise the physical fitness status of elite soccer players according to differences in age, playing position, and elite level [34]. Majority of these physical tests are based on constant exercise, and the significance of these tests varies from one sport to another. The fitness test conducted in this study consists of vertical jump, yoyo, 30 m speed, 10 m shuttle run, and Hoff tests. The following sections discuss each test, its application, and its usage in this study in terms of purpose, required resources, and test procedure [35,36]. The grouping results of the fitness component test are presented according to the following sample selection:

1. **Vertical jump test**
   - Purpose: To monitor the athlete's elastic leg strength.
   - Required Resources: Wall, tape measure, step ladder, chalk, and an assistant
   - Test procedure:
     - The athlete warms up for 10 min.
     - The athlete chalks the end of his/her fingertips.
     - The athlete stands against the wall, keeping both feet on the ground, reaches up as high as possible with one hand, and marks the wall with the tips of his/her fingers (M1).
     - The athlete from a static position jumps as high as possible and marks the wall with the chalk on his/her fingers (M2).
     - The assistant measures and records the distance between M1 and M2.
     - The athlete repeats the test three times.
     - The assistant calculates the average of the recorded distances, and uses this value to assess the athlete's performance.

2. **30 m speed test**
   - Purpose: This test aims to determine acceleration, maximum running speed, and speed endurance depending on the distance run.
   - Equipment required: Measuring tape or marked track, stop watch or timing, cone markers, a flat and clear surface of at least 50 m
   - Test Procedure: The test involves running a single maximum sprint of over 30 m with the time recorded. A thorough warm-up, including some practice starts and accelerations, should be given. Athlete starts from a stationary position with one foot in front of the other. The front foot must be on or behind the starting line. This starting position should be held for 2 s prior to starting with no rocking movements allowed. The tester should provide hints for maximizing speed (e.g., keeping low and driving hard with the arms and legs), and the athlete is encouraged to continue running hard until the finish line. Two trials are allowed, and best time is recorded to the nearest two decimal places. Timing starts from the first movement (if using a stopwatch) or when the timing system is triggered. Then, it is completed when the chest crosses the finish line and/or when the finishing timing gate is triggered.

3. **Yoyo test**
   - Purpose: To measure the subjects' cardiovascular endurance capacity. The test evaluates an individual's ability to repeatedly perform intervals over a prolonged period of time, particularly athletes of tennis, team handball, basketball, soccer, and other similar sports.

Table 1
Analysis of the mean and SD for the anthropometric test.

Anthropometric	*N*	Mean	S/d	Min	Max
Age	24	16.00	1.02	15.00	17.00
Weight	24	55.80	5.10	49.00	68.00
Height	24	170.38	4.24	163.00	177.00

- Equipment required: Flat, non-slip surface, marking cones, measuring tape, pre-recorded audio cd or mp3 (buy or use the Team Beep Test software), CD player, and recording sheets.
- Test Procedure: The tester uses cones to mark out three lines that are 20, 2.5 (endurance test), and 5 m (recovery test) apart. The athlete starts on or behind the middle line and begins running 20 m when instructed by the CD. The athlete turns and returns to the starting point when signaled by the recorded beep. An active recovery period (5 and 10 s for the endurance and recovery versions of the test, respectively,) interjects between every 20 m (out and back) shuttle, during which the subject must walk or jog around the other cone and then return to the starting point.

4. **10 m shuttle run test**
   - Purpose: To test speed and agility that are important in most sports
   - Equipment required: wooden blocks, marker cones, measuring tape, stopwatch, and a non-slip surface
     Set-up: Measure a distance of 10 m, and use the floor tape to mark the beginning and end. Set this station up first because of its large space requirement.
   - Test Procedure: This test requires the athlete to run back and forth between two parallel lines as fast as possible. The tester sets up two lines of cones 30 ft apart or use line markings, and places two blocks of wood or a similar object behind one of the lines. Starting at the line opposite the blocks and upon the signal "Ready? Go!" the athlete runs to the other line, picks up a block, and returns to place it behind the starting line. Then, the athlete returns to pick up the second block and runs back with it across the line.

5. **Hoff Test**
   - Purpose: To measure the subjects' endurance capacity
   - Equipment required: A total area of 30 m $\times$ 50 m is required to set up the test. The size of the test fits perfectly into one-half of a regular football pitch. A measurement tape to set up the distances and some cones are required.
   - Procedure of the test: The Hoff circuit is usually called the Hoff track or the Hoff test. A typical layout of the course is shown in the figure on the right. The athletes dribble the ball between the cones and lift it over the 30 cm high hurdles. They then move around the next set of cones. Between points A and B, the athletes turn and dribble backwards while controlling the ball. Depending on the exact layout of the course, the total distance covered is approximately 290 m.

The mean score of the group of tests in the experimental groups on the five components of physical fitness is analyzed. This test was performed on 24 players as shown in the fitness test table. The test involves cardiovascular endurance, muscle endurance, muscle strength, and flexibility. The performances results, which represent the ability of each player according to the specified test, are shown in the table. The mean value indicates the average value for the sample players according to value of the result. The SD value represents the slight difference that adds to the mean value.

The test mean score comparison of the components of cardiovascular endurance, muscular endurance, flexibility, and muscular endurance of the control and experimental groups indicate that the groups have a minimal difference. This result is evident as the experimental group in Table 2 shows that the mean value of the vertical Jump test is M = 265 ± 0.09 with a minimum of = 250 cm and a maximum of 280 cm. The mean value of the yoyo test is M = 5.58 ± 1.59 with a minimum of = 3.50 and a maximum of 9.00. The mean value of the 10 m shuttle run test is M = 6.45 ± 0.28 with a minimum of 6.03 and a maximum of 6.98. The mean of the 30 m player speed is M = 4.46 ± 0.54 with a minimum of 3.15 and a maximum of 5.04. The Hoff test average is M = 8.76 ± 1.58 with a minimum of 6.00 and a maximum of 12.00.

The vertical jump test consists of five different successive strides and an initial standing point with connected feet. For soccer players, this particular examination is associated with vertical jumping. If organizations do not allow the five-jump test performance, then this relatively simple test can be conducted to evaluate the soccer player's capability. Individual data in the selected team players indicate that the performance in this test is extensively associated with anaerobic performance and is calculated by vertical jumping on a force plate. The maximum value of the vertical jump test is 285 cm and the minimum is 230 cm for player Numbers 6 and 19, respectively. The mean value of the vertical jump test is M = 265 ± 0.13. The performance comparison between two players, such as Numbers 0.6 and 19, shows a difference in the ability to perform this test because the vertical jump test is affected by all the anthropometric criteria. Occasionally, vertical jump is directly proportional to the age of the player. In speed (30 m), which monitors the development of the athlete's maximum sprint speed, the maximum value of the 30 m running speed value is approximately 5.50 s and the minimum is 4.05 s. The mean value of the 30 m running speed test is 4.61, and the SD is approximately 0.33. By comparing the performance results between two players, such as between player Numbers 6 and 19, observing the difference in the 30 m test is noticeable; the difference is approximately 0.35 s. The fastest player has the advantage. The Hoff test is associated with other factors. It reveals the sensitivity to distinguish alteration between the fitness levels and the route of the period. Therefore, the Hoff test is recommended as a soccer-specific cardio-respiratory stamina test that is simple to manage and offers valid and reliable results. However, precautions should be taken before and during the conduct of the test. The reliability and validity of the test depend on how well the researcher executes the test. The maximum value of the Hoff test is approximately 10.45 s, the minimum is 6.00 s, and M = 8.70 ± 1.27. By comparing the performance results between two players, such as between player Numbers 6 and 19, observing the difference in the Hoff test is noticeable; the difference is approximately two 2.40 s. The fastest player in the lines 10 m apart has the advantage. The 10 m shuttle test is a test of speed, body control, and ability to change direction (agility). The maximum value of the 10 m shuttle test value is approximately 6.96 s, the minimum is 6.00 s, and M = 6.64 ± 0.44. By comparing the performance results between two players, such as between player Numbers 6 and 19, observing the difference in the 10 m shuttle test is noticeable; the difference is approximately 0.96 s. The fastest player has the advantage. The yoyo test assesses a subject's capability to frequently perform a concentrated exercise. It is based on two 20 m shuttle runs at increasing speeds interspersed with a 10 s phase of lively improvement until the individual can no longer uphold the pace necessary to finish a precise level of the test. Using the yoyo test as a testing tool may offer a time-proficient technique of combating objective sluggishness among inactive people. High-strength interval exercises have been revealed in previous studies to extract constructive physiological variations. The maximum value of the yoyo test is approximately 9 levels, the minimum is 4.3 levels, and M = 5.27 ± 1.42 levels. By comparing the performance results between two players, such as between player Numbers 6 and 19, observing the difference in the yoyo test is noticeable; the differ-

Table 2
Analysis of the mean and SD for the fitness tests.

	V. jump	Yoyo	Huttle	Speed	Hoff
Mean	2.66	5.58	6.45	4.46	8.76
N	24	24	24	24	24
SD	0.09	1.59	0.28	0.54	1.58
Minimum	2.50	3.50	6.03	3.15	6.00
Maximum	2.80	9.00	6.98	5.04	12.00

ence is approximately 0.96 s. The fastest player has the advantage. The anthropometric criteria have a direct effect on player performance under these tests, thus enabling us to determine the difference in the result values.

3.2.3. Planning of test measure for skills

Players' evaluation of skills test is a difficult process, especially when the test is not based on the criteria of a particular game. A good soccer match has a fluid-like quality, full speed, the right skills, the right targets, and the right tactics [37]. However, this quality can be tarnished by inexperienced coaches who have the tendency to turn soccer games into a display of discrete actions and a match based on goal-scoring instead of on game quality. Although having an in-depth knowledge of the discrete components of soccer techniques is important, which is in fact a quality of an experienced coach, this aspect is not desired when evaluating players on fitness matters [8].

The fitness test conducted in this study consists of juggling and short passing, running with the ball and long passing, and dribbling and shooting. The following sections discuss each test conducted in detail in terms of purpose, required resources, and test procedure [8,37]. The grouping results of the skills component test are presented according to the sample selection based on expert opinion.

1. **Running with the ball and long passing**
   - Purpose: To measure the speed of a player while running with the ball and accuracy in long passing
   - Equipment required: 5 balls, 30–40 markers, 5 cones (3 ft), and 2 stopwatches
   - Procedure of the test: Five footballs are placed along a base line, which is 25 m away from the center point of three circular targets. The targets comprise three concentric circles with a diameter of 3, 5, and 7 m, respectively. From the starting line, a player has to run with the ball to the end line. Upon reaching the end line (10 m), the player has to prepare to make a long pass (20 m) to the targeted circle from inside the preparation area. The correlation of scores from two judges is as follows:
     - Method of scoring for running with the ball: The time for each attempt is obtained. The stopwatch starts the moment the player takes a first touch on the ball and stops when both the player and the ball cross the end line after completing the 10 m distance. The quickest time among the three attempts is recorded.
     - Method of scoring for long passing: Points are awarded based on the area where the football makes the first contact with the ground. The total score is the accumulated points from the three attempts based on the following:
       - 3 points when the ball makes its first contact on or within the 3 m circle
       - 2 points when the ball makes its first contact on or within the 5 m circle
       - 1 point when the ball makes its first contact on or within the 7 m circle
       - 0 point when the ball lands outside the 7 m circle.

2. **Dribbling and shooting**
   - Purpose: To measure the coordination, quickness, and agility of a player while dribbling a football and his accuracy in shooting
   - Equipment required: 2 balls, 6 markers, 5 cones (3 ft), and 2 stopwatches
   - Procedure of the test: Five tall cones (3 ft) are placed 2 m apart on a line. One football is placed along the starting line 2 m away and perpendicular from the first cone. From the starting line, a player has to dribble (i.e., slalom) between the four cones. When crossing the finish line, the player must continue to prepare to shoot the ball before the penalty box line. The player is required to shoot four times with two attempts with his right foot and two with his left foot. The player does not have to make a goal but must be seen to shoot the ball with maximum effort.
     Number of attempts: 4
     The correlation of scores from two judges is as follows:
     - Method of scoring for dribbling: The time for each attempt is obtained. The stopwatch starts the moment the player takes the first touch on the ball and stops when the ball and the player cross the end line. The quickest time among the four attempts is recorded.
     - Method of scoring for shooting: Points are given according to the following point system. The total score is the accumulated points from the four attempts.
       - 3 points for every shot that goes into the two end zones
       - 2 points for every shot that deflects off the crossbar or post into the end zone
       - 1 point for every shot that goes directly into the middle zone or deflects off the crossbar into the middle zone
       - 0 point for any shot that misses the target.

3. **Juggling and short passing**
   - Purpose: To measure the ability of a player in juggling the ball using all parts of the body apart from hands and arms and his accuracy in short passing
   - Equipment required: a stopwatch and a ball
   - Set-up: one player with one football within the center circle of the pit
   - Procedure of the test: A player has to juggle the ball from behind the starting line and must use various parts of the body except the arms and hands to move from the starting line to the end line, which is 10 m in distance. If the ball drops to the ground, the player is allowed to pick it up and continue juggling while moving. After crossing the end line with the ball, the player must be ready to make a short pass through the target, which is located 15 m away from the passing line. The target comprises two red cones placed 2 m apart and another pair of blue cones aligned 1.5 m outside the red cones. The placement of the cones creates a target for the center, left, and right zones.

Number of attempts: 3
The correlation of scores from two judges is as follows:

- ○ Method of scoring for juggling: The total score is the accumulated points from the three attempts. Points are awarded as follows:
  - ■ 5 points = if the player juggles the ball from the starting to the end line without the ball dropping
  - ■ 4 points = if the ball drops once
  - ■ 3 points = if the ball drops twice
  - ■ 2 points = if the ball drops thrice
  - ■ 1 point = if the ball drops four times
  - ■ 0 point = if the ball drops five times or more.
- ○ Method of scoring for short passing: Points are awarded for every successful pass made on the ground and through the zones. The total score is the accumulated points from the three attempts.
  - ■ 3 points for a pass made directly through the center zone or a pass that deflects off the cones into the center zone
  - ■ 2 points for a pass made directly through the end zones or a pass that deflects off the cones into the end zones
  - ■ 1 point for a pass that deflects off the cones
  - ■ 0 point for attempts that do not go in between or do not touch any of the cones.

4. **Short passing**

- Purpose: To measure the accuracy and quickness of short passing
- Equipment required: 5 balls, 6 cones (3 ft), and 6 markers
- Procedure of the test: Five footballs are placed along a baseline 20 m away and parallel to the target. The target comprises two red cones placed 2 m apart. Another pair of blue cones is aligned 1.5 m outside the red cones. This placement creates center, left, and right zones. Two boards are placed 7.5 m apart. A 1.5 m square is marked 3 m from the two boards to denote the passing zone area. A player starts the test with a ball from within the 1.5 m square. The test commences once the player makes a short pass toward the board with pace. The player receives the returning ball and turns to pass the ball to the opposite board. The player continues with short passes of the ball to the opposite boards with pace. A pass is only successful when the ball is received back in the passing zone area. The player performs this test for 30 s. Two attempts are allowed. The correlation of scores from two judges is as follows:
  - ○ Method of scoring for short passing: The highest number of passes executed from the two attempts within 30 s is recorded.

The skills test depends on the subjective judgment based on the coach experience of three experts after watching the video. The three experts give their opinion by giving a score between 1 and 5. Table 3 presents the evaluation of the three experts on the performance of 24 players in the skill tests. The descriptive statistics of the test mean scores of the experimental group serve as the components of the skills data analysis of the test score and the SD of the experimental group.

From the above table, we can summarize the following conclusions:

- Based on the evaluation results of the first expert on the skills test after watching the video, the statistical analysis indicates that the juggling and short passing test (accuracy) has a mean of M = 3.58 ± 0.83. The mean of the running with the ball and long passing test is M = 3.58 ± 0.77. The mean of the short passing test (quickness) is M = 3.38 ± 0.82. The mean of the dribbling and shooting test is M = 3.62 ± 0.87. All the mean values of the tests have a minimum of 2.00 and a maximum of 5.00.
- Based on the evaluation results of the second expert on the skills test after watching the video, the statistical analysis indicates that the juggling and short passing test (accuracy) has a mean of M = 3.96 ± 0.69 with a minimum of 3.00 and a maximum of 5.00. The mean of the running with the ball and long passing test is M = 3.62 ± 0.77. The mean values of the short passing test (quickness) and the dribbling and shooting test are M = 3.66 ± 0.81 and M = 3.75 ± 0.84, respectively. The mean values of the three latter tests have a minimum of 2.00 and a maximum of 5.00.
- Based on the evaluation results of the third expert on the skills test after watching the video, the statistical analysis indicates that the juggling and short passing test (accuracy) has a mean of M = 3.87 ± 0.94. The mean of the running with the ball and long passing test is M = 3.62 ± 0.76. The mean values of the short passing test (quickness) and the dribbling and shooting test are M = 3.54 ± 0.88 and M = 3.80 ± 1.02, respectively. All the mean values of the tests have a minimum of 2.00 and a maximum of 5.00.

3.3. Ranking method based on multiple attribute decision making (MADM)/MCDM

MADM problems are encountered under various situations in which a number of decision makers have several alternatives and actions or candidates to select from based on a set of attributes [23]. MADM methods are classified into three types according to the type of information provided by the decision makers; these types are no information, information on attribute, and information on alternative [27]. Hence, the researcher focuses on the type in which decision makers provide information on the attribute. The six popular methods of MADM using different concepts are Multiplicative Exponential Weighting (MEW, Weighted Product Method (WPM, Weighted Sum Model (WSM, Simple Additive Weighting (SAW, Hierarchical Adaptive Weighting (HAW and TOPSIS The variety of Multi-criteria decision making algorithms creates another challenge for the researchers to select the most proper technique. Multi criteria decision making or MCDM problems are encountered under various situations where a number of the decision maker has several alternatives and actions or candidates need to be chosen based on a set of attributes. Therefore, it is important to select between the algorithms.

To find the best among these techniques, several articles have developed comparative studies between these techniques and others. When comparing SAW and TOPSIS, TOPSIS is more robust than SAW theoretically. The former considers the alternative with regard to the most desirable result by taking into account the distance of each result from the most desirable and the least desirable results. This consideration further increases the accuracy of the final result. Thus, TOPSIS is recognized as a stronger weighing model than MEW and SAW. Shih et al. [24] also claim that TOPSIS is a major MADM technique compared with the AHP because of the aforementioned advantages of the former. TOPSIS is considered a major decision-making technique.

Other researchers have insisted that SAW is the preferred weighted model. For instance, Chou et al. [25] discuss the evaluation of eight MADM methods. Based on their investigation, SAW performs better than MEW, TOPSIS, and AHP. Furthermore, the

Table 3
Analysis of the mean and stand deviation for skills test based on the subjective judgment of the measurement factors by three experts.

Component	Juggling and short passing (Accuracy)	Running with the ball and long passing	Short passing (Quickness)	Dribbling and shooting
First expert opinion				
Mean	3.58	3.58	3.38	3.62
N	24	24	24	24
SD	0.83	0.77	0.82	0.87
Minimum	2.00	2.00	2.00	2.00
Maximum	5.00	5.00	5.00	5.00
Second expert opinion				
Mean	3.96	3.62	3.66	3.75
N	24	24	24	24
SD	0.69	0.77	0.81	0.84
Minimum	3.00	2.00	2.00	2.00
Maximum	5.00	5.00	5.00	5.00
Third expert opinion				
Mean	3.87	3.62	3.54	3.80
N	24	24	24	24
SD	0.94	0.77	0.88	1.02
Minimum	2.00	2.00	2.00	2.00
Maximum	5.00	5.00	5.00	5.00

superiority of SAW was discussed in an empirical study of SAW, weighted product, and TOPSIS. In conclusion, Chou et al. [25] find that a simple evaluation technique is usually superior to other complex techniques. A major disadvantage of SAW is the fact that the establishment of the weights is subjective. According to Opricovic and Tzeng [26], among the highest ranked alternative methods, TOPSIS is the best in terms of ranking index, which does not imply that TOPSIS is always the closest to the ideal solution. However, the author does not consider the trade-offs involved in normalization in obtaining the aggregating function. Hence, TOPSIS is considered the best among major MADM techniques as it has an advantage over other MADM and group decision-making techniques [25].

In any MADM ranking, fundamental terms should be defined, such as the decision matrix (DM) or the evaluation matrix (EM), the alternatives, and the criteria. The EM consisting of m alternatives and n criteria should be created. The intersection of each alternative and criterion is given as x_{ij}. Thus, we have a matrix $(x_{ij})_{m*n}$

$$D = \begin{matrix} & \begin{matrix} C_1 & C_2 & \dots & C_n \end{matrix} \\ \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix} & \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \end{matrix}$$

where $A_1, A_2, \ldots, A_m$ are possible alternatives from which decision makers have to choose (i.e., player); $C_1, C_2, \ldots, C_n$ are the criteria against which each alternative's performance is measured (i.e., fitness process, skills process, and anthropometric process); x_{ij} is the rating of alternative A_i with respect to criterion C_j; and W_j is the weight of criterion C_j. Certain processes should be completed to rank the alternatives, such as normalization, maximization indicator, addition of weights, and other processes depending on the method. Additional details are provided in the next section.

3.3.1. TOPSIS

TOPSIS is a MADM method. We are not aware of any previous work that utilizes a similar methodology as ours to model a sports draft. TOPSIS selects the best attributes of the DM among all the alternatives to create an ideal solution. Then, the alternative closest to the ideal solution and simultaneously farthest from the non-ideal solution is selected [27]. To make this selection, TOPSIS creates an index that combines the closeness and remoteness of an alternative to the ideal solution and to the non-ideal solution, respectively [28]. Bozbura et al. [29] apply TOPSIS to solve the problems of selecting one of the six basketball players in the NBA. TOPSIS generally follows six steps.

Step 1: Construct a normalized decision matrix.

This process attempts to transform the various dimensional attributes to non-dimensional attributes and enables a comparison across the attributes. The matrix $(x_{ij})_{m*n}$ is then normalized from $(x_{ij})_{m*n}$ to the matrix $R = (r_{ij})_{m*n}$ using the following normalization method:

$$r_{ij} = \boldsymbol{x_{ij}} / \sqrt{\sum_{i=1}^{m} \boldsymbol{x_{ij}^2}} \quad (1)$$

This process results in a new matrix R, where R is given as

$$R = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{bmatrix}$$

Step 2: Construct a weighted normalized decision matrix.

In this process, a set of weights $w = w_1, w_2, w_3, \ldots, w_j, \ldots, w_n$, from the decision maker is accommodated to the normalized DM. The resulting matrix can be calculated by multiplying each column from the normalized DM (R) with its associated weight w_j. The set of the weights is equal to 1.

$$\sum_{j=1}^{m} \boldsymbol{w_j} = \mathbf{1} \quad (2)$$

This process results in a new matrix V, where V is given as follows:

$$V = \begin{bmatrix} v_{11} & v_{12} & \dots & v_{1n} \\ v_{21} & v_{22} & \dots & v_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ v_{m1} & v_{m2} & \dots & v_{mn} \end{bmatrix} = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \dots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \dots & w_n r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ w_1 r_{m1} & w_2 r_{m2} & \dots & w_n r_{mn} \end{bmatrix}$$

Step 3: Determine the ideal and non-ideal solutions.

In this process, two artificial alternatives, namely, A^* (i.e., ideal alternative) and A^- (i.e., non-ideal alternative), are defined as

$$A^* = \left\{ \left(\left(\max_i v_{ij} | j \in J \right), \left(\min_i v_{ij} | j \in J^- \right) | i = 1, 2, \ldots, m \right) \right\} = \left\{ v_1^*, v_2^*, \ldots, v_j^*, \ldots v_n^* \right\} \quad (3)$$

$$A^- = \left\{ \left(\left(\min_i v_{ij} | j \in J \right), \left(\max_i v_{ij} | j \in J^- \right) | i = 1, 2, \ldots, m \right) \right\} = \left\{ v_1^-, v_2^-, \ldots, v_j^-, \ldots v_n^- \right\} \quad (4)$$

where J is a sub-set of {i = 1, 2, ..., m}, which presents the benefit attribute (i.e. which offers an increasing utility with its higher values), whereas J− is the complement set of J and the opposite could be added for cost type attribute as well, as denoted by J_c.

Step 4: Calculate the separation measurement based on the Euclidean distance.

In this process, the separation measurement is completed by calculating the distance between each alternative in V and the ideal vector A^* using the Euclidean distance, which is given by

$$S_{i^*} = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^* \right)^2}, \quad i = (1, 2, \ldots m) \quad (5)$$

Similarly, the separation measurement for each alternative in V from the non-ideal A^- is given by

$$S_{i^-} = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^- \right)^2}, \quad i = (1, 2, \ldots m) \quad (6)$$

At the end of step 4, two values, namely, S_{i^*} and S_{i^-}, for each alternative have been counted. These two values represent the distance between each alternative and both the ideal and the non-ideal alternative.

Step 5: Calculate the closeness to the ideal solution.

In this process, the closeness of A_i to the ideal solution A^* is defined as follows:

$$C_{i^*} = S_{i^-} / (S_{i^-} + S_{i^*}), \quad 0 < C_{i^*} < 1, \quad i = (1, 2, \ldots m) \quad (7)$$

Clearly, $C_{i^*} = 1$ if and only if $(A_i = A^*)$. Similarly, $C_{i^*} = 0$ if and only if $(A_i = A^-)$.

Step 6: Rank the alternative according to the closeness to the ideal solution.

The set of alternative A_i can now be ranked in descending order of C_{i^*}. A high value implies an enhanced performance.

4. Discussion results and evaluation

The best players are chosen among the player sample based on their skills and abilities. The overall success of any team depends on the performance and abilities of each player. Accordingly, the discussion results and evaluation are based on two main steps, namely, **player decision matrix** and **ranking players**.

Step 1: Player decision matrix

The performance of a player in the different tests is gathered in this step. The three main groups of tests are collected in one platform. The evaluation results for all tests are listed as the player decision matrix in Table 4.

Table 4 presents the final performance results of the 24 players when they performed the 12 tests. Each test has different evaluation criteria: anthropometrics (age, weight, and height), fitness (vertical jump, yoyo, 10 m shuttle run, and Hoff test) and skills (juggling and short passing (accuracy), running with the ball and long passing, short passing (quickness), and dribbling and shooting). This constructed matrix $(12 * 24)$ represents the MADM matrix.

Step 2: Ranking players

Twenty-four players are evaluated by different fitness, anthropometric, and skill tests (see Table 4). However, the task of selecting the best player is yet to be achieved. Each player is represented by a set of numbers that represent the performance of the player per test. TOPSIS is used to measure the overall performance of the players and rank them.

TOPSIS identifies the best and the worst performances of the players for each test. Each performance is then compared with the ideal performance and worst performance. S− represents the closeness of the player to the worst performance, and S+ represents the closeness of the player to the best one. The player who is close to the best performance and far from the worst performance is the best player. Table 5 presents the closeness of each player to the best and the worst performances.

S− and S+ represent the separation measurements determined by computing the distance between each alternative. The outcome is completed by applying the Euclidean distance in the V and ideal vector A. Player 16 has the highest value for S+ and the lowest value for S−. Thus, he obtained the highest scoring value. Player 3 has the lowest and highest values for S− and S+, respectively. Therefore, this player received the lowest scoring value among the 24 players.

To validate our result, the 24 players are divided into four groups according to the selection result using TOPSIS. Each group consists of six players who are selected based on the scoring values from the selection process results shown in Table 5. The validation process is achieved using two methods based on a statistical platform, which should prove that the first group should reach the highest scoring value by measuring the mean and SD. The mean and SD are measured to show which group is the best. According to the systematic ranking results, the first group is proven statistically to be the best group among the four groups.

The results of the statistical analysis in Table 6 are summarized as follows:

- **In the first group,** the mean value of the age test is M = 15.33 ± 0.81 with a minimum value of 15 (years) and a maximum of 17. The mean value of the body weight test, which represents the weight of the player sample, is M = 55.16 ± 4.75 kg; the minimum and maximum values are 50 and 61 kg, respectively. The average height is M = 172.33 ± 3.44 cm with a minimum value of 167 cm and a maximum of 175 cm. The mean value of the vertical jump test is M = 265 ± 0.08 with a minimum value of 260 cm and a maximum of 280 cm. The mean value of the yoyo test is M = 7.85 ± 1.58 with minimum and maximum values of 6.00 and 9.00, respectively. The mean value of the 10 m shuttle run test is M = 6.32 ± 0.10 s with a minimum value of 6.25 and a maximum 6.77. The mean value of the 30 m speed test is M = 4.27 ± 0.62 with a minimum value of 3.15 and a maximum of 5.00. The average value of the Hoff test is M = 7.60 ± 1.28 with a minimum value of 6.00 and a maximum of 9.30. For the skills test, the mean of the juggling and short passing (accuracy) is M = 4.55 ± 0.50 with a minimum value of 4.00 and a maximum of 5.00. The mean of the running with the ball and long passing test is M = 4.50 ± 0.55 with a minimum value of 2.67 and a maximum of 4.67. The mean value of the short pass-

Table 4
Player decision matrix.

Player	Age	Weight	Height	Vertical jump	Yoyo	10 m shuttle	Speed	Hoff	Juggling and short passing (Accuracy)	Running with the ball and long passing	Short Passing (Quickness)	Dribbling & shooting
P 1	15	50	169	2.7	6.5	6.4	4.5	7.3	5	4	3.33	4
P 2	17	53	173	2.8	3.6	6.86	5	11	3	3	3	3
P 3	17	56	175	2.7	3.5	6.98	5	12	3	2.67	3.33	3.33
P 4	17	60	168	2.6	3.6	6.68	5.04	9	3	3	3	3
P 5	15	60	175	2.6	7.5	6.2	4.5	9	4	4	4	5
P 6	15	50	175	2.7	5.3	6.37	4.6	10	4	3.67	3.67	3.67
P 7	17	60	173	2.8	6.1	6.03	5	9.5	4.33	4	4	3.33
P 8	17	61	175	2.8	4.5	6.3	4.5	7.5	3	4	3	3
P 9	17	58	165	2.65	5.1	6.47	4.1	8.7	4	3.33	3	4
P 10	15	52	165	2.6	5	6.3	5	8.5	4	3	3	4
P 11	15	50	165	2.5	5.1	6.4	5	9	3.67	3	3	3
P 12	15	63	163	2.5	4.3	6.8	5.04	11	3	3.33	3.33	3
P 13	15	50	168	2.6	4.5	6.34	4.5	8	3	3.33	3	3
P 14	15	58	170	2.6	6.3	6.2	4.3	8	4	3.33	4.33	4
P 15	15	61	174	2.6	6.8	6.5	5	7	4	5	4	5
P 16	15	50	167	2.6	9	6.28	4.06	6	5	5	5	5
P 17	15	54	174	2.8	8.3	6.3	4.4	7	4.33	4	4.33	4
P 18	17	51	177	2.75	5.3	6.24	4.5	9.14	3	3	3	3
P 19	17	68	170	2.8	4.3	6.96	4.5	7.5	3	3	4	3
P 20	17	49	165	2.6	5.3	6.24	4.4	9	3	3	3	3
P 21	17	59	166	2.6	4.5	6.68	3.9	7.3	3	3	3	3
P 22	17	56	175	2.6	9	6.25	3.15	9.3	5	5	5	5
P 23	17	53	173	2.65	5.6	6.18	3.18	7.6	3	4	3.33	4
P 24	15	57	169	2.6	5	6.96	3.95	12	3	3.33	3.67	4

Table 5
Closeness of players to the best and worst performances.

Player number	S−	S+
1	0.61	0.88
2	1.09	0.40
3	1.17	0.32
4	1.03	0.46
5	0.56	0.93
6	0.71	0.77
7	0.69	0.80
8	0.77	0.72
9	0.73	0.76
10	0.73	0.76
11	0.75	0.74
12	1.06	0.43
13	0.81	0.68
14	0.64	0.85
15	0.57	0.92
16	0.26	1.23
17	0.48	1.00
18	0.81	0.68
19	1.02	0.47
20	0.86	0.63
21	0.93	0.56
22	0.31	1.17
23	0.68	0.81
24	0.84	0.65

ing (quickness) test is M = 4.27 ± 0.65 with a minimum value of 3.33 and a maximum of 5.00. The mean of the dribbling and shooting test is M = 4.66 ± 0.51 with a minimum value of 4.00 and a maximum of 500. The first group is the best among the four groups because the mean and SD have the highest values.

- **In the second group,** the mean value of the age test is M = 16 ± 1.09 with a minimum value of 15 (years) and a maximum of 17. The mean value of the body weight test is M = 55.16 ± 4.02 kg with a minimum value of 50 kg and a maximum of 60 kg. The average height value is M = 170 ± 4.31 cm with a minimum value of 165 cm and a maximum of 175 cm. The mean value of the vertical jump test is M = 266 ± 0.07 with a minimum value of 260 cm and a maximum of 280 cm. The mean value of the yoyo test is M = 5.56 ± 0.53 with a minimum value of 5.00 and a maximum of 6.30. The mean value of the 10 m shuttle run test is M = 6.25 ± 0.15 with a minimum value of 6.03 and a maximum of 6.47. The mean of the 30 m speed test is M = 4.36 ± 0.68 with a minimum value of 3.18 and a maximum of 5.00. The average value of the Hoff test is M = 8.71 ± 0.90 with a minimum value of 7.60 and a maximum of 10.00. For the skills test, the mean of the juggling and short passing (accuracy) test is M = 3.88 ± 0.45 with a minimum value of 3.00 and a maximum of 4.00. The mean of the running with the ball and long passing test is M = 3.55 ± 0.40 with a minimum value of 3.00 and a maximum is 4.00. The mean of the short passing (quickness) test is M = 3.55 ± 0.54 with a minimum value of 3.00 and a maximum of 4.33. The mean of the dribbling and shooting test is M = 3.83 ± 0.28 with a minimum value of 3.33 and a maximum of 4.00. The second group has lower scoring values than the first group but higher scoring values than the third and fourth groups.

- **In the third group,** the mean value of the age test is M = 16 ± 1.09 with a minimum value of 15 (years) and a maximum of 17. The mean value of the body weight test is M = 53 ± 4.85 kg with a minimum value of 49 kg and a maximum of 61 kg. The average height value is M = 170 ± 5.07 cm with a minimum value of 165 cm and a maximum of 177 cm. The mean value of the vertical jump test is M = 264 ± 0.11 with a minimum value of 250 cm and a maximum of 280 cm. The mean value of the yoyo test is M = 4.95 ± 0.37 with minimum and maximum values of 4.50 and 5.30, respectively. The mean value of the 10 m shuttle run test is M = 6.41 ± 0.27 with a minimum value of 6.24 and a maximum of 6.96. The mean of the 30 m speed test is M = 4.47 ± 0.33 with a minimum value of 3.95 and a maximum of 5.00. The average value of the Hoff test is M = 9.10 ± 1.56 with a minimum value of 7.50 and a maximum of 12.00. For the skills test, the mean of the juggling and short passing (accuracy) test is M = 3.27 ± 0.39 with a minimum value of 3.00 and a maximum of 3.67. The mean of the running with the ball and long passing test is M = 3.27 ± 0.39 with a minimum value of 3.00 and a maximum of 4.00. The mean of

Table 6
Results of the players based on the separation into four groups.

Component	Age	Weight	Height	Vertical jump	Yoyo	10 m shuttle	Speed	Hoff	Juggling and short passing (Accuracy)	Running with the ball and long passing	Short passing (Quickness)	Dribbling and shooting
Results of the first group												
Mean	15.33	55.16	172.3	2.65	7.85	6.32	4.27	7.60	4.55	4.50	4.27	4.66
N	6	6	6	6	6	6	6	6	6	6	6	6
SD	0.81	4.75	3.44	0.08	1.08	0.10	0.62	1.28	0.50	0.55	0.65	0.51
Minimum	15.00	50.00	167	2.60	6.50	6.20	3.15	6.00	4.00	4.00	3.33	4.00
Maximum	17.00	61.00	175	2.80	9.00	6.50	5.00	9.30	5.00	5.00	5.00	5.00
Results of the second group												
Mean	16.00	55.16	170	2.66	5.56	6.25	4.36	8.71	3.88	3.55	3.55	3.83
N	6	6	6	6	6	6	6	6	6	6	6	6
SD	1.09	4.02	4.31	0.07	0.53	0.15	0.68	0.90	0.45	0.40	0.54	0.28
Minimum	15.00	50.00	165.00	2.60	5.00	6.03	3.18	7.60	3.00	3.00	3.00	3.33
Maximum	17.00	60.00	175.00	2.80	6.30	6.47	5.00	10.00	4.33	4.00	4.33	4.00
Results of the third group												
Mean	16.00	53.00	170	2.64	4.95	6.41	4.47	9.10	3.11	3.27	3.11	3.16
N	6	6	6	6	6	6	6	6	6	6	6	6
SD	1.09	4.85	5.07	0.11	0.37	0.27	0.33	1.56	0.27	0.39	0.27	0.41
Minimum	15.00	49.00	165.00	2.50	4.50	6.24	3.95	7.50	3.00	3.00	3.00	3.00
Maximum	17.00	61.00	177.00	2.80	5.30	6.96	5.00	12.00	3.67	4.00	3.67	4.00
Results of the fourth group												
Mean	16.66	60	169	2.66	3.96	6.82	4.74	9.63	3.00	3.00	3.27	3.05
N	6	6	6	6	6	6	6	6	6	6	6	6
SD	0.81	5.27	4.44	0.12	0.44	0.13	0.46	1.98	0.00	0.21	0.39	0.13
Minimum	15	53	163	2.50	3.50	6.68	3.90	7.30	3.00	2.67	3.00	3.00
Maximum	17	68	175	2.80	4.50	6.98	5.04	12.00	3.00	3.33	4.00	3.33

the short passing (quickness) test is M = 3.11 ± 0.27 with a minimum value of 3.00 and a maximum of 3.67. The mean of the dribbling and shooting test is M = 3.16 ± 0.41 with a minimum value of 3.00 and a maximum of 4.00. The third group has lower scoring values than the first and second groups but higher scoring values than the fourth group.

- **In the fourth group,** the mean value of the age test is M = 16.66 ± 0.81 with a minimum value of 15 (years) and a maximum of 17. The mean value of the body weight test is M = 60 ± 5.27 kg with a minimum value of 53 kg and a maximum of 68 kg. The average height value is M = 169 ± 4.44 cm with a minimum value of 163 cm and a maximum of 175 cm. The mean value of the vertical jump test is M = 266 ± 0.12 with a minimum value of 250 cm and a maximum of 280 cm. The mean value of the yoyo test is M = 3.96 ± 0.44 with minimum and maximum values of 3.50 and 4.50, respectively. The mean value of the 10 m shuttle run test is M = 6.82 ± 0.13 s with a minimum value of 6.68 and a maximum of 6.98. The mean of the 30 m speed test is M = 4.74 ± 0.46 with a minimum value of 3.90 and a maximum of 5.04. The average value of the Hoff test is M = 9.63 ± 1.98 with a minimum value of 7.30 and a maximum of 12.00. For the skills test, the mean of the juggling and short passing (accuracy) test is M = 3.00 ± 0.00 with a minimum value of 3.00 and a maximum of 3.00. The mean of the running with the ball and long passing test is M = 3.00 ± 0.21 with a minimum value of 2.67 and a maximum of 3.33. For the short passing (quickness) test, the mean is M = 3.27 ± 0.39 with a minimum value of 3.00 and a maximum of 4.00. The mean of the dribbling and shooting test is M = 3.05 ± 0.13 with minimum and maximum values of 3.00 and 3.33, respectively. The fourth group has the lowest scoring values among the four groups.

The means and SDs of the groups' scores per test were compared (Table 7). The comparison indicates that the first group scored the best in the age, height, Yoyo, Hoff, juggling and short passing (accuracy), running with the ball and long passing, short passing (quickness), and dribbling and shooting tests. The first group scored second best in the weight, vertical jump, and 10 m shuttle run tests. The scores of the second and third groups were nearly identical in the age, height, yoyo, speed, Hoff, juggling and short passing (accuracy), running with the ball and long passing, and dribbling and shooting tests. Both groups scored second best in these tests.

The differences were in the vertical jump test in which the second group scored the best and the third group scored the worst. In the 10 m shuttle run, the second group scored the best and the third group scored the second worst. Finally, in the short passing test, the second group scored the second best and the third group scored the worst. The fourth group scored the worst among the other groups in the age, weight, height, yoyo, 10 m shuttle run, speed, Hoff, juggling and short passing, running with the ball and long passing, and dribbling and shooting tests. The fourth group scored the second best in vertical jump and short passing. In conclusion, the first group is the best among the four groups.

5. Research contribution

This research aims to suggest and develop an instrument that can be used to measure and select soccer players effectively. From a practical perspective, the results of this study can provide guidance to help sports managers and coaches to look at their facility from the viewpoint of the players. By focusing on the specific elements of the player selection criteria, sports managers and coaches can determine how efficient and effective players can be to be selected at the school level. Although several researchers have attempted to explore various aspects of the player selection criteria, to the best of our knowledge no one has applied the aforementioned tests at the school level in the Malaysian context. In conclusion, this exploratory study took the initial steps toward improving the understanding of the player selection criteria of sports managers in selecting sports players.

Table 7
Comparison between the means and SDs of the group scores per test.

Test	First Group	Second Group	Third Group	Fourth Group
Age	15.33	16	16	16.66
Weight	55.16	55.16	53	60
Height	172.33	170	170	169
Vertical jump	265 cm	266	264	266
Yoyo test	7.85	5.56	4.95	3.96
10 m shuttle run	6.32	6.25	6.41	6.82
Speed	4.27	4.36	4.47	4.74
Hoff test	7.60 m	8.71	9.10	9.63
Juggling and short passing	4.55	3.88	3.11	3.00
Running with the ball and Long passing	4.50	3.55	3.27	3.00
Short passing	4.27	3.55	3.11	3.27
Dribbling and shooting	4.66	3.83	3.16	3.05

6. Limitations of the research

This study has several limitations. First, it only used a limited number of respondents because the study was conducted in only one school in Selangor, Malaysia. Consequently, the results cannot be representative of students in other schools. Second, previous literature has revealed the moderating variables that may mitigate the relationship between the dependent and independent variables. This study did not test the effect of any variable that may moderate the relationship between the dependent and independent variables.

7. Conclusion

A new methodology to assess and rank football players based on multi-criteria analysis was presented in this study. To assess the players, three main groups of tests were utilized, namely, fitness, skills, and anthropometrics. This study improved the understanding on the measures as criteria for player selection. The anthropometric and fitness tests were performed objectively according to well-known procedures described in the methodology. The skills tests also used recognized procedures. The sample of this study was selected from a secondary school in Malaysia. Twenty-four players were selected to perform the required tests, and the players were divided to four groups to validate the results. TOPSIS, which is a MCDM technique, was adopted to measure the overall performance of the players and rank them. The means and SD were measured to determine which group was the best. The results indicate that systematically TOPSIS is an effective tool in solving player selection problems. The first group is the best group followed by the second, third, and fourth groups. Statistically, a comparison was conducted between the scores of groups and the ranking of players. The players were ranked the same.

8. Suggestions for future direction

This study examines the soccer player selection in only one school in Malaysia. Furthermore, previous literature has revealed a number of other variables crucial in the selection process of soccer players. This research has uncovered many questions in need of further investigation. In particular, other factors that may affect football player selection criteria and procedure should be determined. Further replication of the present work should be conducted to establish whether similar results can be found if a large sample size is used along with a representative population that covers other players from different geographical locations throughout Malaysia. This replication will enable the generalization of the findings to the entire population of Malaysian players. Furthermore, the findings of such replication can strengthen the validation of the instruments used in the present research. Future research in the selection of soccer players can be extended in a number of directions. First, future research can investigate other contingency factors that may affect the selection process. Second, other factors that may affect player selection criteria can be examined. Third, other variables important in this process can be included. Fourth, future studies may be replicated by adding any moderating variables to examine the same objective.

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