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Importance of Hierarchical Structure Determining Tennis Performance for Modern Defensive Baseliner

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A B S T R A C T

Hierarchies are present everywhere (physics, medicine, nature, human needs, etc.) and tennis is no exception. Is counterpuncher's goal just to chase down every ball and force the opponents into long rallies? The aim of this first empirical study is integrate theory and practice about overall quality evaluation and accurately analyze offensive and defensive tennis priorities for counterpunchers. Weight of each criterion was obtained using AHP technique in Expert Choice software. The results indicate that this model is able to provide important training variables in order to control and manipulate training process. Also, issues prior to research indicate that sports scientists and expert coaches need to learn from each other in order to help players maximizing their performance.

Key words: *kinesiology, tennis*

Introduction

The authors found various names (defensive baseliner, counterpuncher, retriever and modern defensive baseliner) trough practical experience, observation, coaching, teaching, analyzing and previous researches in sports games[1–5]. The »»golden age« for players that played just defensive style from baseline is practically over. That type of style is often especially strong at low-level play. Accordingly, title »counterpuncher« or »modern defensive baseliner« may be more appropriate for future researchers[6]. Authors found no published study that deals with the importance coefficients of actual quality assessment for elite tennis players. Found papers mainly deal with individual match details or summation matches statistics[7–10]. This type of descriptive statistics does not contain information on the sequential context of the game (for example, what is the series of actions before Backhand down the line Winner or Forehand forced Error), or any other information on situational context of the specific action[11]. According to Trninic[12], official game statistics represents partial tennis performance; whereas expert performance evaluation contains all factors of actual quality. Therefore, it's important to determine experts opinion about importance coefficients (weights, ponders) for the all criteria defined in relation to counterpuncher playing style[13,14]. Expert sport scientist's as well as expert coaches know that everything is important, but not all criteria are equally important. In accordance with that, accurate hierarchical structure of training process, demands a clear hierarchy at the top, as well as clear matrix structure of tennis priorities further down. In modern tennis, expert practitioners' can clearly distinguish four dominant types of motor behaviour[5]. In this study, authors will analyze importance coefficients (weights) for tennis counterpuncher motor behavior using multi-criteria decision method. The idea is that a complex decision making problem is decomposed into simpler decision making problems which contribute to achieve the initial goal[15].

Materials and Methods

Model for the assessment of tennis counterpuncher's actual quality was proposed by Djurovic[16]. Figure 1 shows the proposed criteria for the assessment of actual quality of tennis players, primarily playing the following style of play: serve and volley, modern defensive baseliner, offensive baseliner, all-court player: (1) ten criteria for the assessment of actual quality of top-level tennis players on offense; (2) eight criteria for the assessment of actual quality of top-level tennis players on defense.

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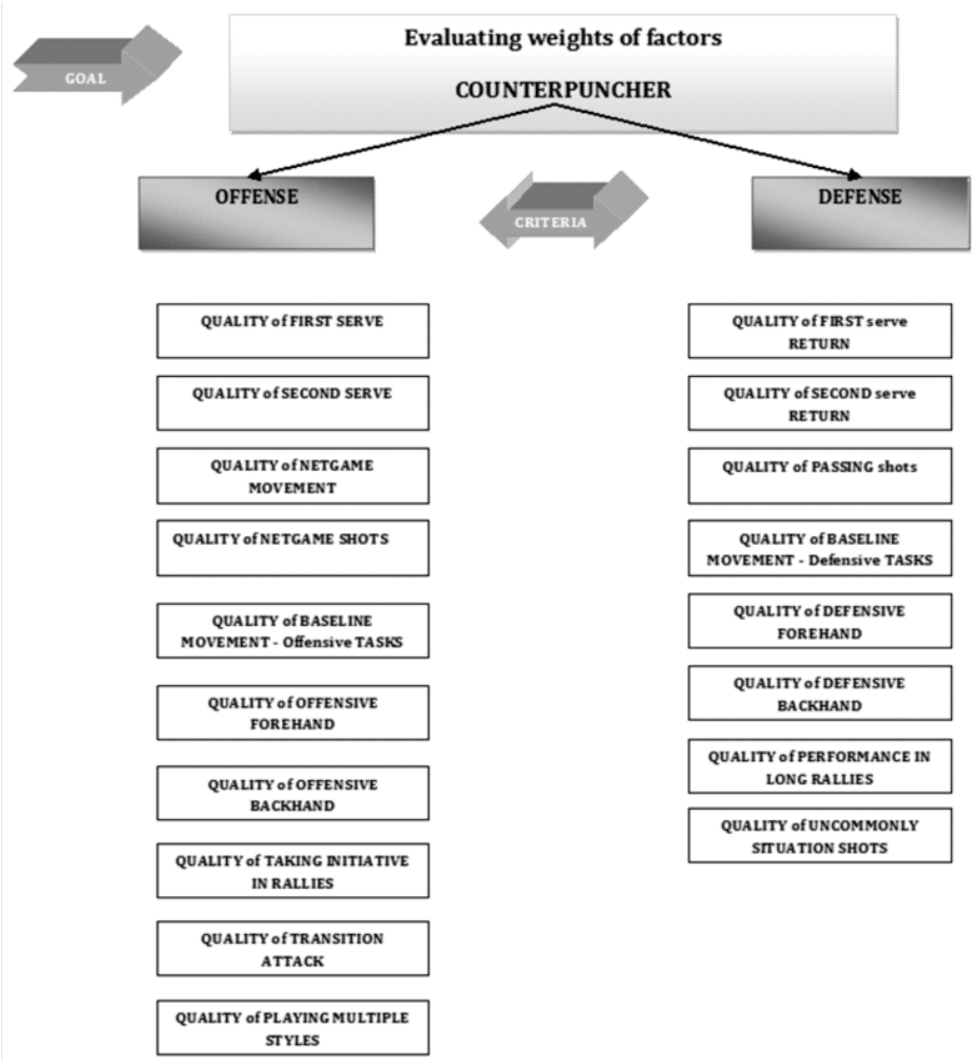


Fig. 1. AHP Model.

The criteria for the assessment of actual quality of counterpuncher – offense

Criteria 1 Quality of first serve – implies the ability of fast and accurate first service which can completely prevent or neutralize opponent return. First service quality level is surely one of the main predictors of overall technical-tactical qualities of the player. Elements such as simplicity and coherence of motion which allows the transfer of force from the legs to the wrist are of crucial importance. This criterion is also manifested trough: (1) perceive the weak points in opponent return (the empty space, previous weaknesses during opponent return), (2) achieving the initiative in point after opponent return, (3) ability to control the ball with flat service, (4) a large number of aces, (5) the proper selection of services depending on the tactics when and where to serve, (6) a large number of winners in the first two points – after gaining the initiative (7) consistency of successful first service during key moments of the match.

Criteria 2 Quality of second serve – implies the ability of optimally fast and accurate service which can completely prevent, neutralize opponent return or secure continuation of the initiative. Second service quality level is surely one of the main predictors of overall technical-tactical qualities of the player. Elements such as simplicity and coherence of motion which allows the transfer of force from the legs to the wrist are of crucial importance. This criterion is also manifested trough: (1) perceive the weak points in opponent return (the empty space, previous weaknesses during opponent return), (2) achieving the initiative in point after opponent return, (3) ability to control the ball with kick service, (4) ability to control the ball with slice service, (5) the proper selection of services depending on the tactics when and where to serve, (6) consistency of successful second service during key moments of the match

Criteria 3 Quality of netgame movement – implies the ability to have all necessary movement skills to play on

the net. This criterion is also manifested trough: (1) the timely arrival on the net, (2) the quality to cover the net area (with body height or exceptional footwork), (3) perception of the weak points of an opponent (empty space, poor movement on the baseline, poor quality of passing shots), (4) ability to maintain steady posture with a low center of gravity of the body before and after volley (5) the proper selection of movement depending on the tactics as well as the psycho / motor capabilities of players, (6) always prepared for opponents lob shot, (7) creating pressure on the opponent, (8) predicting the opponent's passing down the line shot, (9) predicting the opponent's crosscourt shot.

Criteria 4 Quality of netgame shots – implies the ability to have efficient shot performance on the net. This criterion is also manifested trough: (1) perception of the weak points of an opponent (empty space, poor movement on the baseline, poor quality of passing shots), (2) consistency of successful volleys (3) ability to control point with first volley (4) ability to control point second volley (5) extraordinary smash shot (6) extraordinary half-volley shot.

Criteria 5 Quality of baseline movement / Offensive tasks – implies the ability to have efficient footwork performance on the baseline which can secure continuation of the initiative. This criterion is also manifested trough: (1) extraordinary split step, (2) extraordinary side step, (3) extraordinary cross step (4) extraordinary back step (5) extraordinary run step (6) extraordinary adjustment steps.

Criteria 6 Quality of offensive forehand – implies the ability which can secure efficient pressure on the opponent with extraordinary forehand shot. Main intention is achieving winner or forcing the opponent to forced error. Forehand, most powerful baseline weapon in modern tennis is surely one of the main predictors of technical-tactical qualities of the tennis player. This criterion is also manifested trough: (1) down the line forehand winner, (2) cross court forehand winner, (3) inside in forehand winner, (4) inside out forehand winner, (5) forcing opponent to make forced shot error, (6) ability to control the point making pressure on opponent with a preference to taking the ball early.

Criteria 7 Quality of offensive backhand – implies the ability which can secure efficient pressure on the opponent with extraordinary backhand shot. Main intention is achieving winner or forcing the opponent to forced error. Backhand, second most powerful baseline weapon in modern tennis is surely one of the main predictors of technical-tactical qualities of the tennis player. This criterion is also manifested trough: (1) down the line backhand winner, (2) cross court backhand winner, (3) forcing opponent to make forced shot error, (4) ability to control the point making pressure on opponent with a preference to taking the backhand early.

Criteria 8 Quality of taking initiative in rallies – implies the ability to put constant pressure on the opponent's game from the baseline. During that pressure, player is producing fast flat balls or fast spin balls from forehand or backhand side in order to secure winner or opponent forced error.

Criteria 9 Quality of transition attack – implies the ability to turn hard defensive situation to efficient offensive situation which can secure winner or initiative in the following points.

Criteria 10 Quality of playing multiple styles – implies the ability to play efficiently and consistently defensive game from the baseline, offensive game from the baseline and net game as well.

The criteria for the assessment of actual quality of counterpuncher – Defense

Criteria 1 Quality of first serve return – implies the ability to successfully neutralize the opponent's first service. This criterion is also manifested trough: (1) consistency of the efficient first serve return, (2) extraordinary anticipation of opponent's first service, (3) receiving a small number of aces, (4) extraordinary »safe« returning, (5) ability to have perfect control of the opponent flat service.

Criteria 2 Quality of second serve return – implies the ability to successfully neutralize the opponent's second service. This criterion is also manifested trough: (1) consistency of the efficient second serve return, (2) extraordinary anticipation of opponent's second service, (3) ability to have perfect control of the opponent kick service, (4) ability to have perfect control of the opponent slice service, (5) ability to completely neutralize opponent initiative trough return and turning it into you own in the point.

Criteria 3 Quality of passing shots – implies ability to completely disable or make difficult for opponent to have easy volley. This criterion is also manifested trough: (1) perception of the weak points of an opponent (empty space, poor movement on the net, poor quality of volleys), (2) short and sharp passing cross court shot, (3) deep and fast passing cross court shot, (4) deep and high top-spin lobs, (5) timely footwork to strike passing shot (6) precision in passing with head/shoulder feinting, (7) extraordinary perception when and how opponent is coming to the net.

Criteria 4 Quality of baseline movement / Defensive TASKS – implies the ability to have efficient footwork performance on the baseline which can secure maintaining of continuous balance in point while making neutralization of opponent initiative. This criterion is also manifested trough: (1) extraordinary split step, (2) extraordinary side step, (3) extraordinary cross step, (4) extraordinary back step, (5) extraordinary run step,(6) extraordinary adjustment steps, (7) lateral agility, (8) frontal agility, (9) combination of frontal-lateral agility, (10) extraordinary timeliness on strokes.

Criteria 5 Quality of defensive forehand – implies the ability to produce safe forehand shot, whose ultimate goal is opponent unforced error. This stroke is not aimed to put pressure on the opponent or taking the initiative. Accent of defensive forehand is on safety and neutralization of aggressive opponent's shots.

Criteria 6 Quality of defensive backhand – implies the ability to produce safe backhand shot, whose ultimate goal is opponent unforced error. This stroke is not aimed to put pressure on the opponent or taking the initiative. Accent of defensive backhand is on safety and neutralization of aggressive opponent's shots.

Criteria 7 Quality of performance in long rallies – implies the ability to neutralize the opponent's aggressive play and to impose a tennis dominated by long rallies. The most important predictor of this criterion is the quality of physiological level.

Criteria 8 Quality of uncommonly situation shots – implies the ability to produce efficient shots in some specific situations like: moving back and play between the legs, moving back and play sideward's, moving back and play over the shoulder (Figure 1).

Tennis experts

Persons regarded as tennis experts (seven) in this research were coaches that had won: 1. one of the top four places at the global competition (Fed Cup, Davis Cup, Grand Slam, Hopman Cup); 2. one of the first four places in the tournament ITF Pro Circuit; 3. one of the top two spots in the National Championship as a head coach.

Data acquisition and processing methods

Coefficients of importance within the defined set of criteria for the actual quality of counterpunchers on defense and offense were determined by means of the AHP (Analytic Hierarchy Process) method for the multi-criteria decision making[17–19]. Application of the AHP method was executed through the following four steps:

1. Every tennis expert numerically evaluated importance of each criterion by comparing it with the other ones in pairs and registration the relative importance for counterpunchers. For example, if the criterion »A« is twice as important as the criterion »B«, then in the matrix of pair wise comparisons value 2 was assigned at the position AB, while ½ was assigned at the position BA. Thus each tennis expert produced a square reciprocal matrix of grades for all counterpunchers;
2. From each matrix the criterion importance coefficient was completed by employing the geometric mean method (GMM). In that way one vector of the coefficient of importance for each criterion was obtained from every expert and the matrix of coefficients of importance was formed for all counterpunchers;
3. Vectors of the arithmetic means and standard deviations of the importance coefficients for this particular style of play were then computed from the obtained matrices (1 vector for defense, 1 vector for offense).
4. Vectors of the arithmetic means of the coefficients of importance were then rescaled in the manner that their sum equals one.

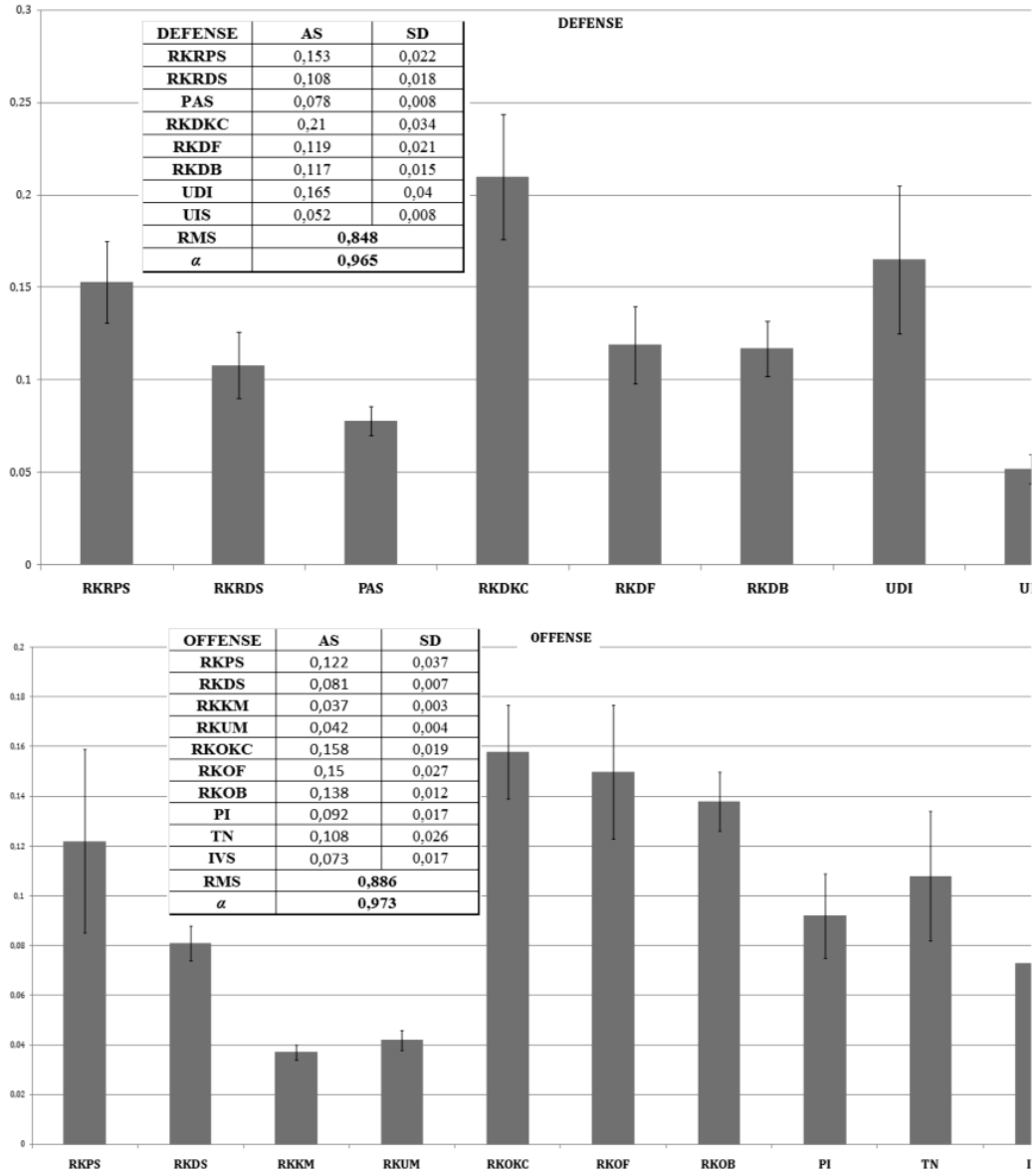
The reliability of the established importance coefficients (weights) of the performance criteria for counterpuncher style was determined by computing: correlation means of experts' (RMS – rank means scores) agreement (interobservers' agreement) and Cronbach's reliability coefficient (α).

Results and Discussion

Figure 2 present arithmetic means (AS) and standard deviations (SD) of grades, obtained from the 7 experts, for the relative importance of 18 criteria. Average Cronbach's measure of reliability (α) is 0.969, while the average correlation of judges amounts from 0.848 to 0.886, and indicates a high degree of interobservers' agreement.

Counterpuncher / offensive hierarchy – RKOKC level of baseline movement / offensive tasks has very high importance (AS 0.158), RKOF the level of offensive forehand and RKOB the level of offensive backhand have high importance (AS 0.150; AS 0.138), RKPS the level of first serve has medium to high importance (AS 0.122), TN level of transition attack and PI level of taking initiative in rallies have low to medium importance (AS 0.108; AS 0.092), RKDS level of second serve and IVS playing multiple styles have low to medium importance (AS 0.081; AS 0.073), RKUM level of net shots and RKKM level of net game movement have very low importance (AS 0.042; AS 0.037).

Counterpuncher / defensive hierarchy – RKDKC level of movement / defensive tasks has very high importance (AS 0.210), UDI level of performance in long rallies has high importance (AS 0.165), RKRPS level of first serve return has medium to high importance (AS 0.153), RKDF level of defensive forehand; RKRDS the level of second serve return and RKDB level of defensive backhand have medium importance (AS 0.119; AS 0.117; AS 0.108), PAS level of passing shots has low to medium importance (AS 0.078) and UIS level of uncommonly situation shots has low importance (AS 0.052). Based on the results we can conclude that efficient footwork performance on the baseline which can secure maintaining of continuous balance in point, while making neutralization of opponent initiative is main priority for counterpuncher style. These data directly demonstrate the relevance of duration, manipulation of intensity and frequency of tennis training sessions[20]. If we presume that the hierarchical structure for other style of play (serve and volley, offensive baseline, all-round play) is completely different, then it is logical that these types are also differing in other parameters such as anthropometry, match activity, heart rate, blood lactate, maximal oxygen uptake, etc.[21]. While top offensive baseliners can overpower any opponent, usually with forehand, top counterpunchers are equally good on both sides (2nd defensive priority). In addition, we suggest that future research investigate forehand and backhand shot placement between all four dominant types of motor behaviour[22]. Ability to successfully control and neutralize the opponent's flat service, speaks directly to counterpuncher strategy (3rd defensive priority). Some players hit ball



DEFENSE	AS	SD
RKRPS	0,153	0,022
RKRDS	0,108	0,018
PAS	0,078	0,008
RKDKC	0,21	0,034
RKDF	0,119	0,021
RKDB	0,117	0,015
UDI	0,165	0,04
UIS	0,052	0,008
RMS	0,848	
α	0,965	

OFFENSE	AS	SD
RKPS	0,122	0,037
RKDS	0,081	0,007
RKKM	0,037	0,003
RKUM	0,042	0,004
RKOKC	0,158	0,019
RKOF	0,15	0,027
RKOB	0,138	0,012
PI	0,092	0,017
TN	0,108	0,026
IVS	0,073	0,017
RMS	0,886	
α	0,973	

Fig. 2. Arithmetic means (as), standard deviations (sd) the relative importance coefficients of the grades given by experts for the relative importance of 18 performance evaluation criteria for counterpuncher, as well as the correlation means of experts (rms) & cronbach's alpha (α).

early or on the rise, but usually, top counterpunchers move back (especially on clay) waiting a ball to slow down before starting a point. By developing this criterion, we are directly disabling opponents the most important criteria's (level of first serve and taking initiative in rallies). In addition, we suggest that future research investigate strategy on return between all four dominant types of motor behaviour[7,23,24]. The results also indicate frequent loss of initiative (level of 1st and 2nd serve), but ability when baseline rally starts, to turn defensive situation to efficient offensive situation (5th offensive priority). Netgame weights (coefficients) indicate worst comfort zone for counterpuncher[24]. These informations are most useful to expert coaches at elite level, who may initiate appropriate actions with quality communication skills. Suggestion for coaches: designing the training process in a way to merge the most important criteria's/offense with the most important criteria's/defense, while simultaneously working on specific psychosocial criteria. Mentioned training system which connects physiology, psychology, biomechanics and tennis criteria's allows new neural programs development and training progress measurement. Therefore, future research may investigate non-linear, hybrid systems, detection of neurotransmitter and hormonal factors, and factors of diversity of motor programs that determine individual quality differences in elite players[25]. Observing all of these differences in a physiological context, future studies should examine muscular endurance according to playing

style[26], heart rate recovery after anaerobic running[27] and morphological- physiological profile of different types of players[28]. Also, number of criteria is strongly related to the consistency ratio (CR≤0.10). We suggest for future researchers, instead of reducing the number of criteria, add another table where experts (before evaluation) can rank each criterion. Instead of a large number of subjects (typical tennis surveys), a small sample has been used in this study, and many different AHP studies. Basically, AHP is usually used to survey coaches who have expert knowledge about a particular topic.

Conclusion

This case study was the first in the sport tennis literature to empirically test what factors decision makers at an elite level consider when determining counterpuncher priorities. The data obtained was analyzed using Expert Choice software. Hierarchies are present everywhere (physics, medicine, nature, human needs, etc.) and tennis is no exception. Given the above, coaches should not be devoted to all criteria development equally, because different styles of play have different priorities. Also, sports scientists and expert coaches need to learn from each other in order to help athletes maximizing their performance.

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VAŽNOST HIJERARHIJSKE STRUKTURE UTVRĐIVANJA TENIS IZVEDBE ZA MODERNE DEFANZIVNE BASELINERE

SAŽETAK

Hijerarhija je prisutna svugdje (fizika, medicina, priroda, ljudske potrebe, itd.) i tenis nije iznimka. Da li je cilj modernog defanzivnog igrača sa osnovne linije neutralizirati svaku loptu protivnika te ga prisiliti na duge izmjene? Cilj ovog prvog empirijskog istraživanja je integrirati teoriju i praksu o cjelokupnoj ocjeni igračke kvalitete te precizno analizirati napadačke i obrambene prioritete za moderne defanzivne baselinere. Ponderi (težine) svakog kriterija su dobivene primjenom AHP tehnike putem Expert Choice Softvera. Rezultati indiciraju kako se putem ovog modela mogu pružiti važne trenažne varijable u cilju preciznije kontrole i manipulacije trenažnog procesa. Isto tako, problemi prije istraživanja sugeriraju nam da sportski znanstvenici i ekspertni treneri trebaju učiti jedni od drugih, u cilju pomaganja igračima kako bi maksimizirali svoju izvedbu.