THE ANALYTICAL HIERARCHY PROCESS (AHP) METHOD IN IMPROVING HIGH PERFORMANCE SPORTS TRAINING FOR POLISH WOMEN’S FOOTBALL PLAYERS

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Abstract:

**Aim.** The objective of the work is an attempt to optimize the model of the girls’ football training system in Poland, taking into account the current economic and political conditions and the possibility of using the multi-criteria method of Analytical Hierarchy Process (AHP) as an innovative technique in solving problems in sport.

**Material and methods.** The AHP method by T.L. Saaty was used to solve the decision problem. For the purpose of this study, a group of girls’ football experts (trainers) was set up, who made comparisons based on a specially prepared questionnaire. The collected data was analysed using the Expert Choice program.

**Findings.** The analysis of priority values pointed to the criteria, which should be particularly considered during the process of training girls in football. These include, in order: condition preparation (0.414), profession (0.274), recruitment and selection (0.118), to a lesser extent, material structure (0.058) and the training base (0.031). In the criterion of fitness preparation according to experts, the largest share falls on: the effectiveness of shots per goal, and equally: speed of decision making, knowledge, explosive strength and running speed, while the smallest share regards the attribute of oxygen efficiency and flexibility. In the criteria, the number of scored goals scored, the rank of the competition, the warnings and the number of matches in the season were indicated in first place. In the next criteria, which concerned recruitment and selection, the respondents pointed to: state of health, intellectual abilities, biological development, general fitness, somatic structure, emotional stability, psychological predisposition and interest in sport. An equally important criterion in the sports training system is renewal. In it, the most important are: nutrition, resistance to diseases and injuries, the ability to quickly regenerate, supplementation, physical therapy and pharmacological treatment. One important criterion, but indicated further, is the material structure. To a large extent, it consists of: psychological, technical, tactical preparation, motivation for continuous improvement. The last criterion, which has a share in the effectiveness of training, is training base. The largest share of the four sub-criteria includes: individualization of training, monitoring training and social security, and in last place, grouping.

**Conclusions.** 1. The AHP method is useful for defining priorities in developing a sports training system for young football players.
Introduction

In the common opinion of sports spectators, the determinant of football appeal, attracting the largest number of viewers to stadiums and in front of television screens, is primarily the state of player training. This can be demonstrated in the discussions held by sports fans and journalists. They are largely supported by the results of dozens of scientific studies published each month in world-renowned scientific periodicals. In Europe, there is a weekly review of publications on Footballscience.net. Most often, one can find the latest scientific research results in the field of physiological adaptation of a player’s body to special training loads as well as the effects of medical and rehabilitation impact on people practicing football at various ages. A significant part of the presented research achievements concerns the effects of training, which are the result of six basic components of its material structure, such as: 1) interval training, 2) repeated sprint, 3) speed and agility, 4) small task games, 5) game simulation, 6) special football circuits.

Such methodological studies contribute, in part, to solving the research problems, trends and strategies in the development of the sport which is football. Their cognitive function is manifested only to some extent when designing the effectiveness of the game and, above all, the attractiveness of the sports spectacle. After all, in the case of football, its magic should also be taken into account, which attracts thousands of fans to stadiums and in front of TV screens. The essence of the phenomenon of a football spectacle is perfectly captured by the maxim of the outstanding German coach, creator of the Bundesliga, Josef Sepp Herberger, who stated that: “What is beautiful in football is that you never know what the end result of the match will be” [1,2].

In addition to the element of surprise, tension and uncertainty of the game of football, in assessing its complexity, one should also take the extremely complicated essence of the so-called “original idea” into account. According to the modern assumption of the PZPN National Game Model, it is the first step in analytical action to create a coherent and thoughtful concept of team football. This is influenced by its essence: (...) all conditions and external (environmental) factors that determine the proposed game model [3]. Thus, the concept of the game idea includes: the logical concept of building a theoretical construction, taking into account the smallest details of the player profile system creating the game image, as well as the relationship between them [3].

The complexity of determinants and stimulators of the game, not only in football, has long been indicated by models of sports training, created in our country and included in scientific studies [4-8]. Due to a very simple cybernetic (block) approach to the system, certain elements of the system methodology were introduced in the sport training of Polish football players. In such a cybernetic approach to the determinants of sporting results, the central link of the system has always been training closely linked to the principle of interaction with other elements of the training system, such as recruitment and selection, forecasting, training base and mastery of the training staff [9].

Analysis of the methodological and training-related literature published in the last decade by the Polish Football Association shows that, with high awareness of the consistency of individual elements of the system structure, first of all, attention is drawn to the need to consider, in practice, the effectiveness of recruitment and selection of candidates for practicing football at various stages of achieving sports championships and the broadly defined competences of players trained at both professional and amateur levels [12-16]. The undeniable effects of such actions include the creation of theoretical assumptions and practical implications of the already mentioned PZPN National Game Model [3] and the development of the basics of sports training regarding four stages of the recruitment and selection system for competitive football [12-16]. The Polish concept for children and youth training football can be attributed to the sentence: “from kindergarten to the representation of Poland at senior age”. Its structure consists of successive stages of achieving sports championship (Tab. 1), with tasks to be implemented assigned to them. They are also adequate to the sports advancement and developmental age of children and adolescents.

Source: created on the basis of data included in the work: Asystent Trenera Sp. z o.o.commissioned by the Polish Football Association. Unifikacja organizacji współzawodnictwa i szkolenia dzieci i młodzieży piłkarskiej [Unification of competition and training organisation of children and youth in football] (issue modification from 2013). Warsaw, PZPN, 2019

With the intention of building a modern Polish model of football, one can see a typical feature of sports training systems, which is their unification, the diversity of content and forms of exercise load due to the gender of players is disregarded. Such a transfer of male training patterns and rules of organising a sports game to women’s football,

has significant negative impact on the attractiveness of a sports spectacle and the training process in the sport of young women. The phenomenon is the first in the world review of the literature on competitive football practice in women, created by researchers from the Faculty of Medicine and Health Sciences at the Norwegian University of Science and Technology Trondheim in Norway [18]. This justifies the causes and consequences of differences between women and men in football. The consequences of not considering the biological conditions for women playing football in the training models and in the regulations of the organisation of sports competitions have been demonstrated in this study. For decades, in the development of modern sport, including that Olympic, this was wrongly reserved only for the male sex. The International Football Federation officially granted women practicing football equality in sports competition as late as in 1971. The Football Association decree [19, 20] issued in England in 1921 formally in force, prohibited women from playing matches at football stadiums. This resulted in the need to move games to rugby stadiums [21] and gave players a self-defence boost in the form of creating the world’s first English Ladies Football Association. For a number of years, the female federation was losing the fight for equality with the men’s football federation and, oddly enough, with the International Olympic Committee at the head.

Defeating the last bastion of anti-feminism in Olympic sport did not resolve a number of organisational, legislative, medical and methodical problems of adapting the men’s football game and training to the biological and psychological conditions of the female sex [18]. Undoubtedly, such an issue concerns the traditional training system of women practicing competitive football. To date, according to the assumptions of traditional sport theory [22-25], it is assumed a priori [8, 26-30] that only systemic ordering of training components can guarantee the achievement of sports results. They do not take into account the need to relativise training content on the basis of gender.

As earlier mentioned, it should be noted that in practical training activities (ignoring even the issue of dimorphic differences), there are great difficulties in finding a way of creating links (not only in football) between the distinguished elements of the sports training system. Currently, in these practical activities, the only attempts are made to refer a typical systemic approach to the conditions of sporting results [3], which at the end of the 1970s, for the needs of competitive sport, was developed by Z. Ważny [9], based on the concept of the cybernetic model of autonomous systems by M. Mazur [31-33]. In this approach, the system is called a fragment of reality constituting a set of elements together with relations between these elements and properties. The whole separated in this way must be coupled with information [9, p. 15].

A few proposals include seeking opportunities to enrich and simplify the essence of systemic behaviour in sports training, including its combining with multi-dimensional decision-making methods. This way of merging the system model of sport training [9] with the multi-criteria method of solving decision problems of the Analytical Hierarchy Process (AHP) ([37]) was used with great success in developing the concept of sports training in the direct preparation of a candidate

<table>
<thead>
<tr>
<th>PZPN designation</th>
<th>Age in years</th>
<th>UEFA designation</th>
<th>Number of players</th>
<th>Game system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gnomes</td>
<td>U6 and U7</td>
<td>JUNIOR G2 and G1</td>
<td>4 × 4 (without goalkeeper)</td>
<td>X</td>
</tr>
<tr>
<td>Students</td>
<td>U8 and U9</td>
<td>JUNIOR F2 and F1</td>
<td>5 × 5</td>
<td>X</td>
</tr>
<tr>
<td>Columbine</td>
<td>U10 and U11</td>
<td>JUNIOR E2 and E1</td>
<td>7 × 7</td>
<td>X</td>
</tr>
<tr>
<td>Youngsters</td>
<td>U12 and U13</td>
<td>JUNIOR D2 and D1</td>
<td>9 × 9</td>
<td>1-4-3-1</td>
</tr>
<tr>
<td>Footballers</td>
<td>U14 and U15</td>
<td>JUNIOR C2 and C1</td>
<td>11 × 11</td>
<td>1-4-3-3/or 1-4-2-3-1</td>
</tr>
<tr>
<td>Younger Juniors</td>
<td>U16 and U17</td>
<td>JUNIOR B2 and B1</td>
<td>11 × 11</td>
<td>1-4-3-3/or 1-4-2-3-1</td>
</tr>
<tr>
<td>Older Juniors</td>
<td>U18 and U19</td>
<td>JUNIOR A2 and A1</td>
<td>11 × 11</td>
<td>1-4-3-3/or 1-4-2-3-1</td>
</tr>
</tbody>
</table>

Table 1. Footballer categories in the Polish Football Association (PZPN) competition system


2 It is worth noting that colonialism and racism were defeated earlier than anti-feminism in football. Women also won (of course officially) equality in social and political life.
for the medal in race walking at the Olympic Games [34, 35], and in creating a theoretical model of organising the recruitment and selection of children for competitive ice-hockey [36]. Based on the above-mentioned cognitive and applicative effects, it was decided to use the acquired experience to create a model of sports training for girls practicing football at a master level in the category established for boys: U 15 (Tab. 1). In justifying the choice of the AHP method for the implementation of the undertaken task, there are several reasons other than those mentioned above.

Firstly and currently, the consequence of the traditional approach to solving decision-making problems in sports training is the decision of one person (player or coach). In addition, even if a team of advisors (experts) sometimes makes decisions, the issue of considering all components of the system approach to sports training is ignored. Decisions are then made on the basis of single-criterion analysis, in which each potential variant is assessed in terms of one selected criterion, e.g. the amount of training expenditure, the applied training load, selection of players for the team, profitability of expenditure on renewal and sports training or earnings of players [37]. Decisions made in this way are sometimes reinforced by inferences based on theoretical foundations of single-criteria methods, e.g. theory of linear programming, parametric programming, targeted programming, marginal analysis, stochastic programming, nonlinear programming and a set of econometric methods most commonly used in physical culture sciences. These include: forecasting, simulations, formal modelling, e.g. with one or many explanatory variables [37-39]. It is worth emphasizing that this approach concerns quantitative variables and is justified only in certain, not very complex cases [38].

Secondly, one-criterion analysis does not provide the expected results or only provides a small reduction in workload and apparent satisfaction of supporters building efficiency on simple principles [37-42]. From a scientific point of view, such a single criterion is not completely reliable, acceptable or exhaustive, i.e. it lacks the properties that a coherent family of criteria should have [41-42].

Thirdly, in a number of scientific reports, it has been demonstrated that the way out of the wrong way of acting in decision-making is to use a multi-criteria approach to solving decision-related problems. There are many different methods to be found in the literature for solving multi-criteria problems. This issue has its roots in the work of V. Pareto, who, when examining family budgets, noticed that spending decisions are not always subordinated to only one criterion [37,42]. Therefore, it was proposed to address the issues of an efficient solution to the problem (sometimes many solutions), which allowed to continue the considerations in accordance with the classical theory of usability.

The most-known multi-criteria methods in facilitating decision-making are [38], among others: ELECTRE I, II, III (Elimination and Choice Translating Reality I, II, IV), PROMETHEE I and II (Preference Ranking Organization Method for Enrichment Evaluations I, II), MAPPACC (Multicriteria Analysis of Procedures by Means of Pair-wise Action and Criterion Comparisons), PRIME (Preference Ratios Multi-attribute Evaluation), PCA (Principal Component Analysis), DEA (Data Envelopment Analysis), MCDM (Multi-Criteria Decision Analysis), AHP (Analytical Hierarchy Process), ANP (Analytic Network Process), neuron network, method of elimination, Markov chains. Each of the above-mentioned multi-criteria decision-making methods have their own advantages as well as some limitations [17, 38-42].

Among the multi-criteria methods, two are distinguished due to their originality and universality, namely: the Analytical Hierarchy Process (AHP) and the Analytical Network Process (ANP). Both were created and implemented into practice by Thomas L. Saaty [43-60]. They are considered the best: in the USA, China, Indonesia and some Western European countries [17, 38-42]. An example of particular interest in the method of the Analytical Hierarchy Process (AHP) can be China, where almost 100 Chinese universities offer courses enabling its learning and implementation in practice [61]. Many doctoral students choose problem-solving using T. L. Saaty’s methods as the subject of their dissertations. As it results from a number of reports and from hundreds of conferences devoted to the application of the AHP, already at the beginning of the 20th century, over 900 articles were published in renowned scientific journals in China [17, 47, 61]. Proof of the great utility of the discussed method in solving complicated decision problems is its use, among others, by the US Department of Defense, IBM, British Airways, Xerox, Ford and in many fields of economy, industry and business [38-42]. For a long time, successful attempts have been made to use the AHP method, especially in the organisation of high-performance sport and mainly in the selection of optimal training strategies, particularly in sports games [62-68].

The methods created by Prof. Thomas L. Saaty are not popular in Poland. They are met with great resistance and distance, especially in the sports environment [38]. According to experts’ opinions [37,69,70], the AHP and ANP methods are not perfect, but better ones have not been invented so far. The authors express the view that the valuable, multi-criteria AHP method used in Poland for the first time in combination with the traditional system approach for the need of improving the sports training of girls practicing football professionally in the U 15 age category, will contribute to the popularisation of the...
The analytical hierarchy process (AHP) method... newly created sport discipline, which is already practiced by over 40 million women around the world [69].

The authors’ research objective
The dynamic development of women’s football in our country poses new challenges for clubs, coaches and training staff. In view of the above, the purpose of the authors’ research is to develop, using an expert decision-making method, a proposal to improve the traditional Polish football training, so far based only on a simple football training model.

Materials and methods

Research questions
To meet women’s expectations regarding football, with the help of the Analytical Hierarchy Process (AHP) method, it was decided to answer the following research questions:

• What components of the main criteria in solving decision problems should be taken into account when attempting to improve the Polish traditional sports training system for girls in the U 15 age category?
• In what direction should changes in the Polish girls’ sports training system be directed at the first stage of practicing football professionally?

Research material
Pursuant to the assumptions of the Expert Choice method, in the methodological proceedings using the Analytical Hierarchy Process (AHP) method [49-52, 70], the interviewed team of experts were qualified by the main Polish U 15 coach and coaches working at clubs in which girls below the age of 15 years are trained in football.

Research methods
In the research, the method of the Analytical Hierarchy Process (AHP) by M. L. Saaty was used, combining a mathematical and psychological methodological approach to solving important decision-making problems [43-60]. In accordance with its assumptions, the following methodological steps were taken:

[1] The purpose of the main research procedure was identified.
[2] The structure of the problem was developed in the form of a hierarchical model.
[3] Criteria and sub-criteria of the main objective were defined.
[4] A model of the hierarchical structure of the problem was presented in the form of a so-called hierarchical tree (Fig. 2).
[5] Peer-to-peer criteria were verbally compared on T. Saaty’s fundamental scale.

[6] Verbal comparisons were replaced with numerical ones on the T. Saaty scale.
[7] Numeric priority of the main criteria and sub-criteria were calculated.

The issues considered in points 1-4 were implemented on the basis of discussions with experts.

Methods for developing research results

– All criteria, sub-criteria and alternatives were compared in pairs, each with each other, using the fundamental scale of Saaty’s preferences [54].
– The intensity (weight) was determined for each sub-criterion of the main criterion.
– Global priorities were calculated by multiplying the priority for a given main criterion by the local priority for a given sub-criterion. The sum of all global priorities should be 1 (100%).

The Super Decisions program was used for calculations.

Research results

1. Model of the hierarchical structure of the problem concerning improvement of the sports training system for females below the age of 15 in football in the form of a hierarchical tree.

In Fig. 1, the constructed hierarchical structure model is presented for improving the efficiency of the girls’ U 15 age training category in football using the Analytical Hierarchy Process (AHP) method.

This includes:

Main goal: improving professional sports training in female football for the U 15 category.

Sub-criteria a-h (included in the criteria structure):

Recruitment and selection: a) Somatic structure, b) General fitness, c) advancement in biological development, d) Mental predispositions, e) Intellectual abilities, f) Interest in sport, g) Emotional stability h) Good health.

Game skill resources: a) Running speed, b) Anaerobic fitness, c) Aerobic fitness, d) Agility, e) Football competence, f) Quick decision-making, g) Effectiveness of goals defended, h) Effectiveness of goal shots.

Predicting the game model: a) Technical profile, b) Tactical profile, c) Mental profile, d) Somatic-motor profile.

Biological regeneration: a) Nutrition, b) Supplementation, c) Physical therapy, d) Drug treatment, e) Resistance to diseases and injuries, f) Ability to regenerate quickly.

Competitions: a) Number of matches per season, b) Rank of the competition, c) Number of scored goals, d)
Number of defended goals, e) Warnings, f) Number of undefended goals.

**Training base:** a) Place of training camps, b) Monitoring of training, c) Sports facilities, d) Training and social infrastructure.

At the bottom of the diagram, there are three alternatives (variants) of the proposed improvement of professional football sports training in Poland for females below the age of 15 (U 15):
- traditional Polish model,
- Russian model,
- German model.

**Determining the verbal content of the main criteria: Recruitment and selection.** Nature has given only some people special abilities. In each discipline of life, recruitment and selection are used to reveal them. According to the theory of sport, one criterion assumes the selection of individuals who have optimal somatic, motor and psychological conditions to obtain high sports results in a given sport discipline in the future [9]. Selection is a one-time activity [9, 71-72], while selection is a long-term and dynamic process, the criteria of which change and become more accentuated as sport advances increase [22, 24-25].
Resource of game skills. In the authors’ research, the meaning of the criterion of game skills should be related to the content given to the concept of Motor Performance fitness, assigned to it in kinesiology [73]. This interpretation of the meaning of the idea is also close to the Polish term special efficiency [74], which can be achieved as a result of the application of specialised training.

In this case, due to the previously indicated lack of studies on women’s sports training in football, the essence of football skills was necessarily referred to the attributes assigned to them in the National Game Model [3], which - as noted earlier - was created for the needs of men’s football. The contemporary model of stage preparation of young footballers for competitive sports was created on its basis [12, 14-16]. In connection with the above, in creating the concept of the discussed criterion and in the distinguished sub-criteria, this was based on the understanding of the concepts used to characterise men’s football [3, 12-16, 18-21]. There was also no doubt as to the need for women practicing football to have competence in versatility and completeness in all activities that exist during football matches [18-21]. The most important indicators of the criterion of fitness preparation were those that can be referred to the determinants of the master’s model, but at the same time, relativised to the footballer’s calendar age in the U 15 category [12-16].

This included: above-average level of technical skills, rich resources of open tactical habits, high level of motor preparation and level of decision-making processes, broadly understood speed of action, high level of positional specialisation, supplemented with the versatility of actions, high internal motivation and a strong psyche. It was assumed that the semantic range of the main criterion, created on the assumptions of the concept of the National PZPN Game Model [3], provides the basis for recognising it as a representative model for the football training subsystem at the level of championship for girls from the U 15 category. Theoretical assumptions and practical experience show that modern football should be characterised by balance of actions in attacking and defending, revealing strengths at all stages of the game, with particular emphasis on transition phases, creating the game with all types of fast and positional attacks, maintaining constant control during the game through a very well-organised defence phase in all its aspects, the use of very good physical preparation, non-compromise in all on-pitch activities, a wide range of fixed fragments of the game, high determination and dedication.

Predicting the game model. According to the contemporary approach to the concept of training system in competitive sport [9], forecasting is a scientific prediction based on known, stable regularities of the development of a particular phenomenon. In team sports, setting specific trends is a difficult task. In accordance with the requirements set for players in the National Game Model [3] and in the training assumptions for young players [12-16], forecasting (future model of the game) should take into account the mental, physical, tactical and motor-somatic preparation of a player, regardless of the assigned role during the game. At the current stage of development of knowledge about women’s football game methods, creating a vision for its development in Poland is an impossible task. Therefore, out of necessity, the forecasted model was based on knowledge of the current criteria for men’s football [3, 12-16].

Biological regeneration. According to the encyclopaedic approach to the term biological regeneration [75], it can be assumed that it is a conscious effect on the body through natural and artificial means and environmental conditions in order to accelerate physiological recreation processes. In modern competitive sport, biological regeneration is aimed at restoring psychophysical fitness of a player after a competition and sports training through the use of special complex pedagogical, psychological, medical and biological means [76-77]. Such synchronised action is primarily aimed at raising the threshold of the physiological capabilities of an athlete’s body. All wellness treatments can be divided into four basic groups [76, 78, 79]:

- Medical and biological methods. These include, respectively, biochemical agents which directly or indirectly affect the intensity of energy metabolism in the body, e.g., vitamins, mineral salts, lipids, amino acids, carbohydrates and hormones. This complex of such measures also comprise: rational nutrition, with particular emphasis on the use of various types of diets enriched with vitamin supplements, minerals or other substances showing a nutritional or physiological effect.
- Pedagogical methods. These concern how a training programme is carried out, its intensity, variability of physical effort and implementation of training classes in various environmental conditions.
- Psychological methods. Their task is to reduce psycho-nervous tension and mental fatigue caused by sports competition and training. In this area of regenerative impact, it is most often recommended to use: relaxation massage, psycho-regulatory and autogenic training as well as various types of relaxation exercises.
- Physiotherapeutic methods. Such methods are the most common and most often used by athletes. These include various types of restitution, hardening and physical therapy treatments (all types of massage, Finnish sauna, therapies, mineral baths, water baths and showers, balneotherapy).
Competitions. In the case of men’s and women’s football, sports competitions should be referred to the concept of matches, that is to say, sports matches played between two teams [10]. Their cycle plays an important role in the sport training system [9, 22-25]. This is both a means of controlling the player’s level of preparation and a very effective training stimulus, especially for young players representing the highest level of sports championship [12-16]. In relation to the improvement of the sports training system taken into account, participation in football matches can also fulfill the role of assessing their suitability for national teams. Due to the above criteria, the following classification of matches was proposed: 1) control (providing an image of preparation for one or several game components), 2) introductory (qualification for a team at a certain level of competition), 3) selection (selection for national representation), 4) main (participation on the national team).

Training base. In the modern competitive sport training system [9], the importance of the criterion should be related to securing material training conditions. In the case of women’s and men’s football training, the existence of a complex of well-equipped sports facilities is considered to be a necessary and indispensable element [3, 9-10, 24-25]. These include, first of all, football pitches, with a surface that allows playing in various weather conditions. In addition, the standard includes equipping sports facilities with the necessary devices, measuring tools, instruments, equipment, training apparatus, wellness and methodical rooms. As part of the material conditions of training, there is also the possibility of using sports facilities in specific geoclimatic conditions. The base also includes the possibility to implement coach training, player training education, as well as the functioning of a system of financial bonuses for trainers and players adequate to the amount of work and talent.

2. The importance of the main criteria (subsystems) in improving the sports training system for females below the age of 15 in football in light of research using the Analytical Hierarchy Process (AHP)

Priorities from the comparison of criteria with reference to the main objective

In Fig. 2., the priority weights are given to determine the share of the distinguished criteria in the improvement of the football sports training system for females below the age of 15. Their values allow the following order to be determined: 1. game skill resources (0.414), 2. competition (0.274), 3. recruitment and selection (0.118), 4. biological regeneration (0.105) 5. predicting the game model (0.058) 6. training base (0.031). The sum of priorities totalling 1 (100%) at each level of the conducted analyses speaks for the correctness of calculations. The results of the authors’ research indirectly confirm the possibility that experts attach great importance to the traditional Polish model of the training system, in which training and competitions were the central link. In addition to the criteria mentioned above, there are others included in the structure of the traditional training system [9], however, in the opinion of experts, they are not of great importance in improving the sports training system of girls practicing football in the U-15 age category. They include the following criteria: recruitment and selection (0.118), and biological regeneration (0.105).
noted as the lowest were: predicting the game model (0.058) and training base (0.031).

Based on the analysis of the presented research results, it can also be assumed that, to a large extent, the age of football players presented, using a multi-criteria method in decision making, for whom priority according to the National Model of the PZPN Game [3] and the assumptions of training children and young people, should be first of all acquiring a large amount of football skills and achieving special fitness in playing football [12-16]. Training trends revealed by respondents (trainer experts) involved in the training of football players qualified into U 15 training groups at clubs may confirm the implementation in training practice of the concept of the training process, developed for boys, unified by the Polish Football Association [12-16].

It is difficult to say to what extent the use of such men’s training patterns may affect the future development of women practicing football at a championship level in the senior category.

3. Degree of intensity (weight) of sub-criteria priorities distinguished in relation to the main criteria
In Fig. 3-4ab and 5ab, numerical values (weights) of sub-criteria in relation to the main criteria are provided. a) main criterion: resource of game skills

As highlighted in the contribution analysis of the main criteria in determining the purpose of the work, the highest rate of impact on the improvement of the football sports training system of females aged 15, was obtained by the criterion: resource of game skills. Taking the eight sub-criteria assigned to it into account (Fig. 3), the following order of their share in relation to the main criterion, assigned by experts, should be given: 1) effectiveness of goal shots (0.331), 2) Speed of decision making (0.150), 3) Anaerobic capacity (0.135), 4) Running speed (0.124), 5) Football competences (0.125), 6) Effectiveness of defended goals (0.064) 7) Aerobic capacity (0.047) 8) Flexibility (0.022).

Analysis of the presented data shows that the opinions of respondents (experts) have largely revealed the traditional view on the direction of development in the training of football skills. This primarily prefers the aspect of speed preparation, based on anaerobic capacity and a high level of psychological/mental preparation. As emphasized in the verbal characteristics of the main criteria, nowadays, a professional footballer is required at every stage of the development of a sports career to: achieve broadly understood speed of action, make accurate decisions, footballing, supplemented with: versatility of activities, above-average level of technical skills, high internal motivation, strong psyche, rich resource of open tactical habits [3].

Source: own elaboration

Fig. 3. Share of sub-criteria in relation to the criteria resources of game skills
Attention is paid to the relatively small role in improving the training system for females aged 15, the level of motor skills (agility) and aerobic fitness. Perhaps in this case, the features of the traditional way of training Polish players were revealed, which were dominated primarily by such aspects as: total football, very good physical preparation, optimally selected tactics for human potential, advantages in fast attack, motion speed, character and motivation, good technical preparation, the human collective, world-class footballer’s individuality [3: 15]. For various reasons, the necessity to focus attention on the efficacy and fitness of players has been ignored [3].

According to the assumptions of the National Game Model [3], other guidelines can also be found regarding the directions of players’ fitness preparation, which were not taken into account by experts at the time of concept creation. With reference to the idea of the modern concept of the football game, such aspects occupy an important place. Great significance is attached to physical preparation, mental strength and striving for an uncompromising attitude in all pitch activities [4,16].

b) main criterion: competitions (matches)

Based on the opinions of experts in the criterion hierarchy, called competitions (matches), the following order of sub-criteria may be determined, which are important in improving the modern football sports training system of females up to the age of 15: 1) Number of scored goals, 2) Number of lost goals, 3) Number of defended goals, 4) Competition rank, 5) Warnings, 6) Number of matches per season.

Based on the analysis of the presented data, it can be assumed that in the training procedure, attention should be primarily paid to the issue of improving football skills and competences of playing matches on a specific position on the pitch (sub-criterion 1-3). The issue of effort load related to the number of matches played and raising their culture of the game is of minor importance.

It may be that the expressed expert position resulted from the belief that the issues of game organisation are regulated in a satisfactory manner in applicable laws and ordinances. Therefore, it is difficult to take them into account when considering the main problem, which was considered to improve the sports training system of girls aged 15, playing football at a championship level. However, the culture of women’s games in accordance with applicable regulations is so good that it is difficult to be improved.

c) main criteria: recruitment and selection as well as biological regeneration

The presented data regarding ordering of the significance of the main criteria in improving the female training system in the U 15 category shows that two of them: recruitment and selection (0.1178) and biological regeneration (0.1048) obtained a lower rank than previously characterised, but their weight, the task of experts, was significant. Due to the fact that both criteria obtained a similar priority weight, it was decided to discuss the role of the priorities constituting their structure together.

– recruitment and selection

From the graphic illustration and ordering of weights according to increase of the distinguished sub-criteria (Fig. 4) in the selection improvement and selection criterion, it can be deduced that, in the opinion of experts, in improving the recruitment and selection of females for football teams in the U 15 category, the following should be primarily taken into account: 1) good health, 2) intellectual skills, 3) biological development, 4) general efficiency.

Source: own elaboration

Fig. 4. The share of sub-criteria with reference to the criterion: competition (matches)
Less importance was assigned to the features: somatic structure, emotional stability, psychological predisposition and interest in sport.

The presented hierarchy of criteria should be considered as important and significant in achieving the main goal, which was considered the intention to improve the theoretical model of the training system in competitive sport in Poland for several reasons. In the authors’ research, experts used the AHP method to select the most important sub-criteria for improving recruitment and selection in specialist training of women’s football. So far, in theoretical studies [11, 22-25] and methodological guides [4, 12-16], only a general catalogue of recruitment criteria are mentioned, paying attention to the features relevant to the master’s model [71-72], and highly heritable biological features [73-74]. Most often, their reference to a specific sport is not given. Under no circumstances shall the diversity of selection and their criteria be based on gender. It can be assumed that this study broadens the scope of knowledge about the fea-

![Graph](source: own elaboration)

**Fig. 4. a) Share of sub-criteria in relation to the main criterion: recruitment and selection**

![Graph](source: own elaboration)

**Fig. 4 b) Share of sub-criteria in relation to the criterion: biological regeneration**
tures important for women in the future to compete in football at a championship level.

- biological regeneration

In Fig. 4b, the ordering of the sub-criteria share is demonstrated according to the increase in relation to the criterion of biological regeneration, the participation of which in the determination of the main objective was also rated low by respondents. The highest place in it was given to nutrition (0.464). Considering the previously presented interpretation of the definition regarding verbal content of the main criteria, the importance of the nutrition sub-criterion should be related only to a certain range of effects of biological and medical means (athlete’s diet) on the athlete’s regeneration process following training and competition. Other components of the above measures such as supplementation have not found much recognition in the opinion of experts. More attention was paid to the individual susceptibility of young footballers to training load and illness (resistance to diseases and injuries, priority weight: 0.180) and their ability to quickly recover after exercise (priority weight: 0.175).

d) main criteria: game model prediction and base

As it results from the participation of criteria in improving the sports training system of females below the age of 15 in football (Fig. 2), the lowest priorities in relation to the main goal were obtained for: predicting the game model (0.058) and base (0.031). In view of the above, it can be assumed that the listed training system criteria were not recognised by expert opinions. They were assigned little importance in improving the modern system of training females aged 15 playing football. It is worth noting, however, to what extent individual sub-criteria may have affected their low value.

- game model prediction

Based on the data presented in Figure 5a, it can be assumed that the following hierarchy of sub-criteria weights (football players’ profiles) appeared in the forecasting structure of the women’s game model: 1) mental profile (weight 0.504), 2) technical profile (weight 0.248), 3) tactical profile (weight 0.134), 4) somatomotor profile (weight 0.112). As demonstrated by the data above, the greatest significance in the development plans for wom-
en’s football should be given to the mental profile of the female player, regardless of the position she has on the pitch at any phase of the game.

**– training base**

In turn, in Fig. 5b, weights were taken into account for the second low-noted criterion due to the possibility of improving the football game of females aged 15, which can be included on the basis of expert opinions - the base (or material conditions securing the training process). The very low position of the criterion in the structure of priorities, conditioning the improvement of the training system for females aged 15, playing football at a professional level, was probably caused by the fact that currently, in accordance with international standards, clubs must have sports centres with well-equipped social and training facilities. Therefore, the question in the interview about their significance in sports training may have been rhetorical, and in this case, the response could not have been relevant to the policy of training organisation, especially for young female footballers. To a large extent, this hypothesis was justified by the relatively low and balanced value of weights given to the sub-criteria: 1) sports facilities (0.444), 2) social and training infrastructure (0.258), 3) place of training camps (weight: 0.189), 4) training monitoring (weight 0.107).

4. **Participation of distinguished sub-criteria in achieving the objective of the authors’ research**

To look at the sub-criteria as a whole, affecting the achievement of the goal defined as: improving the
system of sports training in football for females below the age of 15, global priorities of individual sub-criteria were calculated. The calculations were performed by multiplying the priority for a given main criterion by the local priority for a given sub-criterion. The sum of the global priorities obtained in this manner should equal 1 (100%). The results of the authors’ research are presented in Fig. 6.

From the analysis of the size of global priorities of individual sub-criteria, which were illustrated and numerically presented in Fig. 6, it follows that the greatest impact on the achievement of the main goal regards: 1) the effectiveness of goals defended (0.137), 2) the number of goals scored (0.127). From the analysis of the size of global priorities of individual sub-criteria, which were illustrated and numerically presented in Fig. 6, it follows that other sub-criteria also gained relatively high global priority values: quick decision making (0.062), anaerobic fitness (0.056), warnings (0.055), football competences (0.052), running speed (0.051) and the nutrition sub-criterion (0.049).

In the authors’ research, it was also decided to determine which of the considered sub-criteria could significantly affect the process of improving the women’s sports training system in the youngest category of competitive football.

5. Determining the set of criteria affecting achievement of the main goal

According to the “Paret principle”, also known as the “20/80 principle”, commonly attributed to Vilfred F. D. Paret and widely used in economics and management, it may be assumed that many phenomena occurring in life result from the ratio of 20% to 80%. For example, about 80% of the company’s revenues are generated by 20% of its clients, or 20% of the time devoted to work generates 80% of the effects. In other words, it can also be said that 80% of the consequences are the result of 20% of the cause.

Referring to this phenomenon, it was assumed that 20% of the sub-criteria with the highest position in the ranking will be responsible for 80% of the overall success in improving competitive sports training of females in the U 15 football category. Due to the fact that the total number of sub-criteria was 36, then in accordance with the above, as a rule, only 7 of them can be responsible for the final effect of the implementation of tasks undertaken. The top 20% consists of 7 sub-criteria, which were determined according to the order in the ranking of their priorities (Fig. 6), thus: 1) the effectiveness of the goals defended \( (P = 0.137) \); 2) the number of scored goals \( (P = 0.127) \); 3) quick decision making by players on the field; including accuracy of passes \( (P = 0.062) \); 4) anaerobic fitness \( (P = 0.056) \); 5) warnings \( (P = 0.055) \); 6) football competences \( (P = 0.052) \) and 7) running speed \( (P = 0.051) \).

Based on such findings, it can be assumed that 54% of participation in the improvement of the training system for women playing professional football can include 7 sub-criteria with the highest priorities, and the remaining 46% will be attributed to 29, taken into account from the total number of 36.

Conclusion: The above-identified critical determinants of success in achieving the main goal set in the authors’ research should primarily be taken into account when developing new training concepts for females aged 15 practicing football professionally.

6. Selection of the best alternative training concept for females aged 15

The last stage of the research was the selection of the best alternative of the authors’ improvement model for female football sports training in the U 15 category (Fig. 1) against three variants (alternatives): the traditional Polish model, the Russian model, the German model (Fig. 1). By comparing all of the alternatives with one another, in pairs, in relation to each of the sub-criteria, it was found that the best model for improving professional sports training in women’s football could be the German model. There is nothing unusual about this result. The German model of women’s football sports training is leading in the world. Its effects are unique. In Germany, approximately 7 mln women play football at about 25,000 clubs [https://diehalbzeit.wordpress.com/2018/08/24/system-szkolenia-w-niemczech]. Only the American women’s training system can compete with the German model.

Summary

In this study, the possibility of using the method of the Analytical Hierarchy Process in increasing the effectiveness of training girls in Poland competitively playing football at the age of 15 is presented. The use of a multi-dimensional method to develop the main objective of research, combined with the traditional systemic concept of approaching the characteristics of similar problems in competitive sport [4-11] is an innovative approach to solving the problem, not only in Poland.

Until now, there have been no reports demonstrating differences in the training model at different stages of achieving female and male football players’ sports...
championship. Most often, in foreign studies, only selected issues related to preparation of football players are undertaken or those technical or tactical [18-21]. The aspect of the training system understood as a set of elements together with the relationships between them and their properties was not undertaken even in the work in which the issues of differences in the football game of women and men were widely analysed [19]. Although the authors’ interpretation and analysis of the research problem was not aimed at demonstrating gender-related differences in the conditions for improving football, the use of the AHP multidimensional decision-making method has demonstrated the typical elements of professional football for females in the U15 age category.

Thanks to the experts’ opinions, the criteria for the elements of the training system have been specified by giving them content as well as their structural elements, referred to as sub-criteria. In such expert proceedings, the connection with the current PZPN Polish National Game Model [3] and the concepts of unification of sport training of children and youth (from kindergarten to the national representation) can be seen [12-16]. Undoubtedly, the inclination towards the principles of men’s football training were caused by the lack of theoretical development of the basics of the women’s football specialisation. This has far-reaching consequences in the way women are prepared to practice sport [19], who as late as in 1971 obtained the citizenship rights to exist in football stadiums [18]. For these reasons, the interpretation of experts in the conditions of women’s games could have been influenced by the experience of experts gained from working at clubs training only men. However, it can be assumed that due to the applied Analytical Hierarchy Process (AHP) method, from several dozen different factors (sub-criteria) of the training model, specific elements were extracted conditioning women’s effective football in the youngest category of professional football training (U15) and also in the future at the level of the national team game.

It is worth noting that the experts attributed the highest rank in the created model of determinants to: the effectiveness of defended goals (0.137). This may lead to confirmation of the conclusion that the authors’ found confirmation in 100% of the correct rule of coaching, based on the assumption that the team should be built from behind, i.e. from the goalkeeper and the defence [3, 10]. It is true that the whole team wins or loses, but the defence line and goalkeeper are responsible for lost goals. The number of scored goals (0.127) obtained the second highest global priority. It is known the attack line is responsible for the execution of such a task, which aims to create match situations conducive to scoring goals. Rapid decision-making also proved to be an important sub-criterion (0.062). This is an extremely important feature of a player, because overtaking an opponent’s action by a split second can largely determine the advantage of one team over the other. Speed in decision making can be improved. It is therefore an important task to be implemented in the training of football players, especially from youth teams. In light of the results of the authors’ research, anaerobic capacity (0.056) can be included in the set of significant sub-criteria affecting the improvement of women’s sports championships and running speed (0.51) closely related to it. This would be difficult to ignore such basic motor skills of a football player, considering their role in the modern way of playing men’s football matches.

As it results from the presented list of global priorities and the analysis of weighting priority criteria and sub-criteria (Fig. 1 and 6), professional development of women’s football games (even in the youngest age category) places great demands on the need to involve the psychological and physiological potential of a player during the game. Such complexity is a consequence of the movement pattern performed during training and during matches. The requirement of frequent changes in both speed of movement on the pitch in a different direction (e.g. walking, jogging, high intensity running and sprinting), further complicates the intermittent nature of physical effort. Interrupting exercise causes involvement of the energy production process from aerobic as well as anaerobic mechanisms for obtaining energy. Training programmes for young footballers should therefore include activities and exercise recommendations that improve various muscle metabolism systems in physical work. Women playing football must also have strong and flexible muscles. These attributes are important for the successful performance of technical activities (e.g. passing the ball, goal shots, etc.), because they ultimately affect the result of the match. Effective ways to develop both strength and range of movement, especially of the lower limbs, must be systematically planned in sports training. The need to include a number of fitness elements in training programmes means that their impact on the training state of young football players is multidimensional.

The realisation of a large number of training sessions and the use of a number of intense exercises in them is a difficult task to perform in training (not only of women). Most often in the league season, for various reasons, their volume is limited only to improving technical and tactical skills. Then, the time allocated for physical training is minimised or completely eliminated. After all, in the case of youth groups, the inclusion of fitness preparation (even in the season of games at different levels) should not be up for discussion.
Considering the aspect of sports training, in light of the research results and discussion being carried out, there is a postulate that the direction of improving the training system of female football in the U 15 category was multilateral and considered the wide spectrum of impact on the body of girls practicing sport professionally, by:
- systematic participation in the football education process,
- education through sport in accordance with didactics and ethics,
- comprehensive development of physical fitness,
- improvement of special and targeted technique,
- teaching and improving individual, group and team activities occurring during the game of attack and defence within the aspect of their purposefulness,
- determining the position in the game (playing several positions)
- developing motor skills, with stronger emphasis on the development of speed-strength abilities and special football endurance,
- improving teamwork skills,
- improving motivation to play football,
- intellectualisation of football activities (news about the game and its participants, the importance of physical effort and the problem of nutrition),
- moving on to next stages of the specialist selection process.

Individualisation of football classes should be of lesser importance in improving the training system for females in the younger age category.

Conclusions

1. The Analytical Hierarchy Process (AHP) method by T.L. Saaty turned out to be useful for building a holistic model of improving the sports training system of females playing football in the U 15 age category (up to the age of 15).
2. The method of combining the sports training system model with a multi-criteria method of solving decision-making problems has allowed for the inclusion of traditional methods of developing training issues in the theory and practice of competitive sport.
3. Comparisons of the importance of criteria in the developed model by experts allowed estimation of numerical priorities for all criteria, sub-criteria and alternatives needed to analyse the conditions of women’s football, improvement in a specific category of calendar age (U 15).
4. The diversity of the aspects under consideration excludes the lack of objectivity in verbal statements of experts on the position of criteria and sub-criteria in the model of improving the women’s football game.
5. Comparison of the designed theoretical model of improving the women’s football game with the existing assumptions and concepts of sports training of football players, allowing to make an optimal choice of the variant of the training process for the female sex.
6. The results of the authors’ research indicate the critical aspects of the modern model of women’s sports training, which is modelled on the Polish contemporary PZPN National Game Model, developed for men.

References:

The analytical hierarchy process (AHP) method...


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