KINESIOLOGICAL, ANTHROPOLOGICAL, AND METHODOLOGICAL ASPECTS OF EFFICACY EQUATION IN TEAM SPORTS GAMES

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Review paper

Abstract
Redefining the equation forming approach for specification of efficacy factors in polystructured and complex sports, and defining model features for athletes of different age provides us with important sources of information for applied diagnostics and selection of future top-level athletes, as well as rational management of the sports preparation process. The scientific and expert approach to forming models of efficacy in polystructured and complex sports activities must encompass both the external and internal determinants of athlete's performance and competition efficacy. We proposed a dynamic efficacy model that explicitly shows the influence of the external and internal variables on the concepts of the dynamic systems theory. A hypothetical model of the efficacy factors shows that sports performance and sports accomplishment under the influence of the external and internal variables are in accordance with the concept of reciprocal determinism. By introducing a larger number of relevant sport-specific variables and external factors, we would probably increase prediction value and the validity of the efficacy model for athletes and teams. Further more, it is necessary to create a sport efficacy factor model that would encompass all basic and specific anthropological features that in a greater part determine actual athlete quality. It is assumed that the cooperation of scientists and expert coaches could generate feedback that would enable further development of expert systems and a proposal of nonlinear models of efficacy factors in sport.

Key words*: models, athletes, team sports, efficacy, system theory, scientific methodology*

Introduction

The questions that have preoccupied many researchers in the field of kinesiology and psychology of sport can be reduced to: what are the relevant factors of success in a particular sport (identifying factors), how to measure and/or assess relevant factors, how big are the relevant influences of particular factors on sports efficacy coefficients a_i in a linear combination), what are the links between factors of the psychosomatic status (potential efficacy), what are the optimal training systems by which we change relevant sport-specific factors, and which basic and specific anthropologic characteristics can be significantly changed in the sports preparation process. All of the six mentioned questions require an explicit answer, since that is the precondition for an adequate theory of managing the sports preparation process and the efficacy theory (Sabioncello 1971, 1973, 1977; Dežman, 1988, 1998; Erčulj, 1998; Horga, 1993). Looking from the stand of expert systems, Erčulj (1998) states that the model of the sports efficacy factors must be formed in a way that can answer three out of the six questions: which efficacy factors is the result reliant on, what is the importance of each factor, that is, what is his relative contribution to sports efficacy, and what are the interrelations of the mentioned factors. We believe that in sports kinesiology or sports science, the standard of validity of every model is defined by answering how coherent it is with the experience of expert coaches and expert athletes. Accordingly, it is desirable that the sports-efficacy factors model contain the values that detect themselves directly. An objective, logical, precise and systematic mode of investigating kinesiological problems and occurrences, as well as their ascertaining, is what makes sports kinesiology a formally based scientific system. Also, the description of facts or inserting a model should necessarily fit real intraindividual and interindividual processes. Appropriate answers to those questions directly reflect the efficacy theory, direction and selection theory, technical staff education theory, and the sports management theory (Erčulj, 1998). Therefore, in order to have adequate diagnostics and selection, and form an appropriate training equation, expert coaches need to know the answers to the previous questions. It is quite clear that top-level athletes have relevant factors in a certain level of expression, and these efficacy factors may be altered (through the training system and different competitions) in dependence of the coefficient of intrinsic quality of particular factors (Malina and Bouchard, 1991; Bouchard et al., 1997). Team sports games belong to the group of polystructural and complex sports (Matvejev, 1977, 1981, 1999). From the expert coaches' point of view, it is probably safe to say that the best player in team sports games is the one that interacting with team players achieves maximal individual and team performance (Nikolić, 1993; Trninić, 2006). This implies that for polystructural and complex sports activities it isn't only relevant how much a particular player can do, but how efficiently he assists in assistance systems, since that determines the synergy of action in all game stages (Trninić, Trninić and Papić, 2009). Thus synergy is interpreted as a combined effort of athletes, and as a cooperation of many co directional factors in performing tasks within the game tactics model.

This enables a reinforced effect of interaction which is larger then the pondered linear combination of single player effects. Synergy of interaction in team sports shows potential rescission of potential advantages of opposing players and teams by mode of collective outplay in all game phases. This means that the tactical systems of a particular team are ran by: cooperative interaction, mutual assistance, and common dependence of players within the tactics model. Schilling (1975) states that the overall athlete personality is marked by his potential and readiness for accomplishment**.** Hereby he believes that the category of potential sports accomplishment (what an athlete is capable of) and his accomplishment readiness (what the athlete is willing to do), and how much he assists, especially in complex sports activities, are in constant interaction. From the methodological aspect, the ways for defining potential accomplishment and accomplishment readiness differ from researcher to researcher (Horga, 1993). So, in polystructural and complex sports, it isn't exclusively relevant how much a player can do individually, but how much he assists and encourages mutual assistance, because achieving common goals of certain team athletes is determined by their level of cooperative behaviour and assistance reciprocity. To reduce an efficacy equation in team sports to a linear combination of anthropological athlete characteristics (manifested features or latent dimensions) would be an inadequate and reductionist approach, which is not in accordance with the real complexity and interaction of internal and external factors that determine sports efficacy. This primarily applies to martial arts sports and team sports games that have significantly more complex demands on a single athlete then the mono-structural cyclic and acyclic sports activities. It is quite obvious that the mono-structural sports activities (cyclic and acyclic) are simpler motoric activities, whose efficacy equation is made from a small number of relevant basic and sport-specific dimensions. This is because complex sports activities (team sports games), and the polystructural ones (martial arts) are determined by a larger number of internal and external factors in multiple interaction.

Aspects of efficacy equation

From the kinesiological aspect, the efficacy equation in team sports games is impossible to explain and understand without the structural and functional analyses of sports activities. Structural analyses of sports activities encompassed analysis of structural complexity of a particular sport. Accordingly we must determine and explain: the number and complexity of actions, and the number and complexity of different types of motion (Horga, 2006). At the same time, it is important to identify typical and atypical motion and situation structures, and the analysis of technical-tactical activities or tasks for particular types of players in all phases of the course of the game. Also, it is necessary to determine players' roles, as well as players' roles and internal and external training weight for certain game positions.

Further more, we need to explicitly define sub phases within the game phases, and the structural units of a particular polystructural and complex sport. Since the efficacy of resolving problem situations in team sport games is dependent on functional relations within the team (the quality of cooperation among the players in terms of the chosen game tactics model), and on actual player quality in different positions in the game, as well as on the features of the opposing players and teams, it is necessary to use the interactional approach to explaining individual and team situational efficacy. Such a functional analysis of polystructural and complex sports primarily investigates processes of interaction of players of one and both teams, and those individually classified motoric activities are primarily determined by actions of cooperation and confrontation. The functional structure of team sports game is possible to analyse from the aspect of relation of technical-tactical action, within the phases of the game course and the established tactics model. Accordingly, it is necessary to investigate the relation cooperation-confrontation of both teams. So the efficiency of action of a particular team is dependent on the suitable game tactics model that must be coherent with the total potential and momentary actual quality of players of a particular team. In addition, the team must know how to self regulate even without direct coach's influence (Trninić, Papić and Dimec, 2008). It is important to point out that the quality of sports individual and team performance in team sports games isn't only directly connected to the level of development of the total athlete and team potential, and their momentary actual quality, but also with the level of adequacy of the game tactics model of both teams, the level of players' inter-coordination, coaches game management, competition conditions, refereeing criterion and other external factors. From the anthropological aspect, the factorial structure of sport is possible to reduce to the question of which basic and sport-specific capabilities, treats, knowledge, skills and habits an athlete must embody as a precondition for achieving efficient sports performance and sports accomplishment. Such an approach encompasses a partial efficacy equation. Inspecting previous research (Horga, 1993; Trninić, 1996) we encountered several problems. The first problem is seen in the reduction of efficacy factors in sport on athlete's anthropological characteristics. This probably fulfils the simplicity principle, but not the encompassment principle that is based on the multi-factorial nature of team sports games in which athlete's reactions are largely influenced by the constant changes of the situations in the game on one hand, and the level of development of basic and sport-specific features on the other. For this reason, it is necessary to explain the multi-causality of the model of sport efficacy equation. Real unavailability of the current sport efficacy equation comes from the linear model, which is not enough to completely grasp the knowledge of interaction of the internal and external efficacy factors. This is especially expressed in polystructural and complex contact sports, where the opponent's intentions are

defeated by direct physical aggressiveness (Trninić et al., 2009). Such sports activities require a complex selection of reactions since the players of both teams act in situations of opposition (Gréhaigne at al., 1995; Lebed, 2007; McGarry and Franks, 2007). Expectedly the athletes that reach the national level of efficacy have higher scores in desirable relevant features and a lover degree expressed in undesirable human characteristics (Trninić et al., 2009), which probably enables a higher level of functioning in resolving typical and atypical situations, and a greater dosage of consistency in situational efficiency in different competition systems. From the aspect of polystructural and complex sports, each role in the game requires special anthropological features, as well as specific structure of actual player quality. This means that the structure of the anthropologic factors of efficacy, as well as total actual quality for different types of players in a particular team sports game is specific (Dežman, 1988; Trninić, 1995). Further more, in team sports games, player's role clarity and role acceptance are the precondition for an effective individual and team performance, and competition efficacy. From the aspect of scientific research, precisely defined roles within the group, and precision as a precondition for team's competitive efficacy enforce development and cohesion (Partridge and Stevens, 2002; Cox, 2005). So in the polystructural and complex sports, it is necessary to engage the theory or the concept of interdependence of **internal and external** factors (Gabrijelić, 1977; Pavlović, 1977; Dežman, 1988, 1999). The theory of interdependence emphasises that the outcomes of a particular sports game are partly or completely determined by actions of a single player and the whole team. On the other hand, mutual dependence in team sports games is evident from the fact that personal and team outcomes are partly or completely defined by the opponent's game tactics model. Such interactions and relations are connected to stability and mutual cooperation and defiance to the opponent. The coherence of preferences of the athletes within the whole team is probably one of the important factors that determine the quality of cooperation within the phases and the game tactics model (Trninić, 1995; Ćorluka, 2008).

At the same time an individual can influence co players' behaviour, amongst other things, and regarding the criteria of tactical decision-making in the game. Further more, the maximisation of the outcome of co players is determined through the system of mutual assistance in which the whole team participates. On the other hand, in complex team activities, direct team management can be internal (when player's position on the playfield determines the role) in coherence with the game tactics model. At the same time, the head coach and his technical staff are in charge of indirect or external team management. Therefore, team sports games are defined by the relations of interdependence between a particular athlete and/or the whole team, and the head coach, as well as the behaviour of the opposing team (coach and his technical staff, players on the field and their replacements). Polystructural and complex sports are considered to be self-regulating dynamic systems (according to the relations between participants of the competition and their behaviour) (McGarry and Franks, 2007; Lebed, 2006, 2007).

Problem of selecting the model

In sports kinesiology there is a great number of paradigms of sports efficacy factors (Filipčić, 1996; Dežman, 1998). From the team sports games aspect, an example of an adequate paradigmatic frame was formed by Dežman (1998). In figure 1, we presented the relations of basic elements, that is, the sports efficacy factors (team's and player's). Also, in the scheme of external factors he includes those that directly or indirectly influence potential efficacy. Among the direct factors we listed competition quality, game management, competition conditions (game conditions, refereeing criterion, spectators' behaviour). Further more, as indirect sports efficacy factors, we listed: expert staff, management, organisation and technical staff, parents and materially- technical terms. Dežman (1998), in the scheme of internal factors of potential player efficacy, indicates an existence of basic, realisation, and mobilisation dimensions. Additionally, internal team efficacy factors include team structure, adequacy of the game tactics model (in defence and offence), and the level of preparation for the game of the opposing team. In the final assembly of the social factors that affect potential efficacy of a team, we list: the relation of society toward team games, basic conditions, level of education and organisation of the expert, organisational, and technical staff, and the level of development of the profession and science (Figure 1). In agreement with the mentioned, sports efficacy probably varies if internal and external efficacy factors vary, as well as social factors. So it is immanent to find a function that shows how athlete's performance and competition efficacy change under the influence of relevant internal, external and social factors' variability. Sports efficacy in moment t can be described with recursive formulas:

$SE(t)=F(SE(t-1), IF(t),EF(t))$

$IF(t)=G(TS(t),AGTM(t),LPG(t))$

$EF(t)=H(SAG(t),BC(t),LEO(t), LDP(t))$

Where acronyms and symbols stand for: IF-Internal factors; EF-External factors; SE-Sports efficacy; TS-Team structure; AGTM-Adequacy of game tactics model (offence and defence); LPG-Level of preparation for opposing team's game; SAG-Society's attitude towards team games; BC-Basic conditions; LEO-Level of education and organisation of the expert, organisational and technical staff; LDP-Level of development of the profession and science; F, G, H – Functions that describe relations between given variables.

Therefore, in order for the functions to be established, it is necessary to identify internal, external and social factors, and determine the form of the function that connects internal, external and social factors that influence athlete's performance and competition efficacy.

For this kind of approach, it is necessary to hypothetically and deductively observe the nature of the mutual relations of efficacy factors in sports. At the same time, it is important to know that testing a potential mathematical model is the basis of research work in sports science. Also, sports efficacy factors model must be applicable in practice, as well as adequate for research. The development of a paradigmatic model requires upgrade of measuring instruments (nonstandard specific and situational tests) that have high prognostic efficacy. On the other hand, the hypothetic model of interaction of athlete and/or team efficacy factors can be observed through the interaction of a greater number of modules (Figure 2). The first level of internal athlete and/or team efficacy factors is their potential efficacy (momentary level of development of basic and specific anthropological features that are the assumption of total game efficacy) of athletes and teams. Here the basal and specific anthropological characteristics represent predictor variables within the interactional model. The second level of internal factors is made of actual quality of a particular athlete (achieved level of total game efficacy) and/or team. Also, actual quality of athletes in a particular team within the hypothetic interaction model represents the criterion variable. In previous research no relevant basal or specific anthropological factors were determined, nor the degree to which they determine competition efficacy of athletes in different sports games. Also, no differences were found in the influence of specific anthropologic features on accomplishment in sports games, and no criterion systems for assessing actual player quality, except in basketball, water polo, and soccer (Trninić, Perica, Dizdar, 1999; Trninić, Dizdar, 2000; Hraste, Dizdar, Trninić, 2008; Ćorluka, 2008). It is assumed that the forming of the system and criteria for expert evaluation of athlete's actual quality with associated relevance coefficients (ponders) for particular types of players is necessary for diagnostics, selection and development of players. This requires new methodological approaches for evaluation of total situational effect in team sports games (Trninić, Dizdar, 2000; Trninić, Dizdar, Dežman, 2000; Trninić, Dizdar, Dežman, 2002a, 2002b). When speaking of internal efficacy factors, we primarily mean the structure of potential efficacy and actual quality of particular types of players and/or teams (Figure 2). In addition, the term *potential player efficacy* consists of levels of development of basal and specific anthropological characteristics that affect athlete's game efficacy. Potential efficacy is divided into partial (momentary level of development of the motoric-functional abilities and morphological treats) and total (level of development of all the relevant anthropological or psychosomatic treats). Also, the in-game efficacy can be divided into partial (factors are noted by a static record of final actions, and are called situational efficacy indicators and total (factors of actual player quality that are evaluated by experts using a certain system of criteria).

The basis of investigation of the total in-game efficacy is set by a group of researches (Trninić, 1996; Trninić, Perica, Dizdar, 1999; Trninić, Dizdar, 2000; Trninić, Dizdar, Dežman, 2000; Trninić, Dizdar, Dežman, 2002a, 2002b). We believe that in the system of assessment of potential and momentary level of performance quality or actual player quality, one should primarily focus on the dynamic, not static evaluation. Further more, player quality and the quality of cooperation and confrontation that is determined by adequate tactics, level of mutual cooperation and micro social relations primarily determines potential team efficacy. So, the internal factors also comprise the level of interplay in all phases of the course of the game, emotional and functional relations between players, and coaches leadership behaviour. Besides the internal, there is also an assembly of external or surrounding factors that directly or indirectly affect potential player and/or team efficacy.

External factors comprise: sports training, potential and actual opposing team player quality, opponents' tactics model, playing conditions, social environment, home or guest court, sports federation/alliance, school, interaction family-athlete, interaction coach-athlete, leadership mode, interaction family-coach, friends, cultural diversity, media, public opinion, adequacy of the game tactics model, system of organisation, system of expert policies and logistics of sports institutions, functional relations between players, relations within the club, micro social conditions in the team, conditions for organisation of the sports preparation process (Fig. 2). Further more, external factors cannot be observed as a whole, a single assembly of influences, but should necessarily be divided into at least two components: general (basic conditions, level of education and organisation of the expert, organisational, and technical staff, and the level of development of the profession and science, family influences, social experiences) and specific (actual quality and opponents tactics model, refereeing criterion, spectators' influence, playing conditions…). The question is- what is the influence of general and specific factors on the variability of potential athlete efficacy and on potential team efficacy. It is assumed that the specific factors (like the effect of a sports activity or a single sports game) affect the level of development of athlete's potential differently. Hence, the effects of certain sports on changes of athlete potential cannot be, and are not equal, since the demands on total athlete potential are different, and accordingly the efficacy equation for a single sports activity is different too. So, for example, the bigger the number of technical-tactical elements within a sports activity, and the more complex their mutual relations, the more complex is the efficacy equation. Therefore, the interaction of external and internal factors differentially effects the development and change of potential efficacy of an athlete and/or team, dependent also on participants gender.

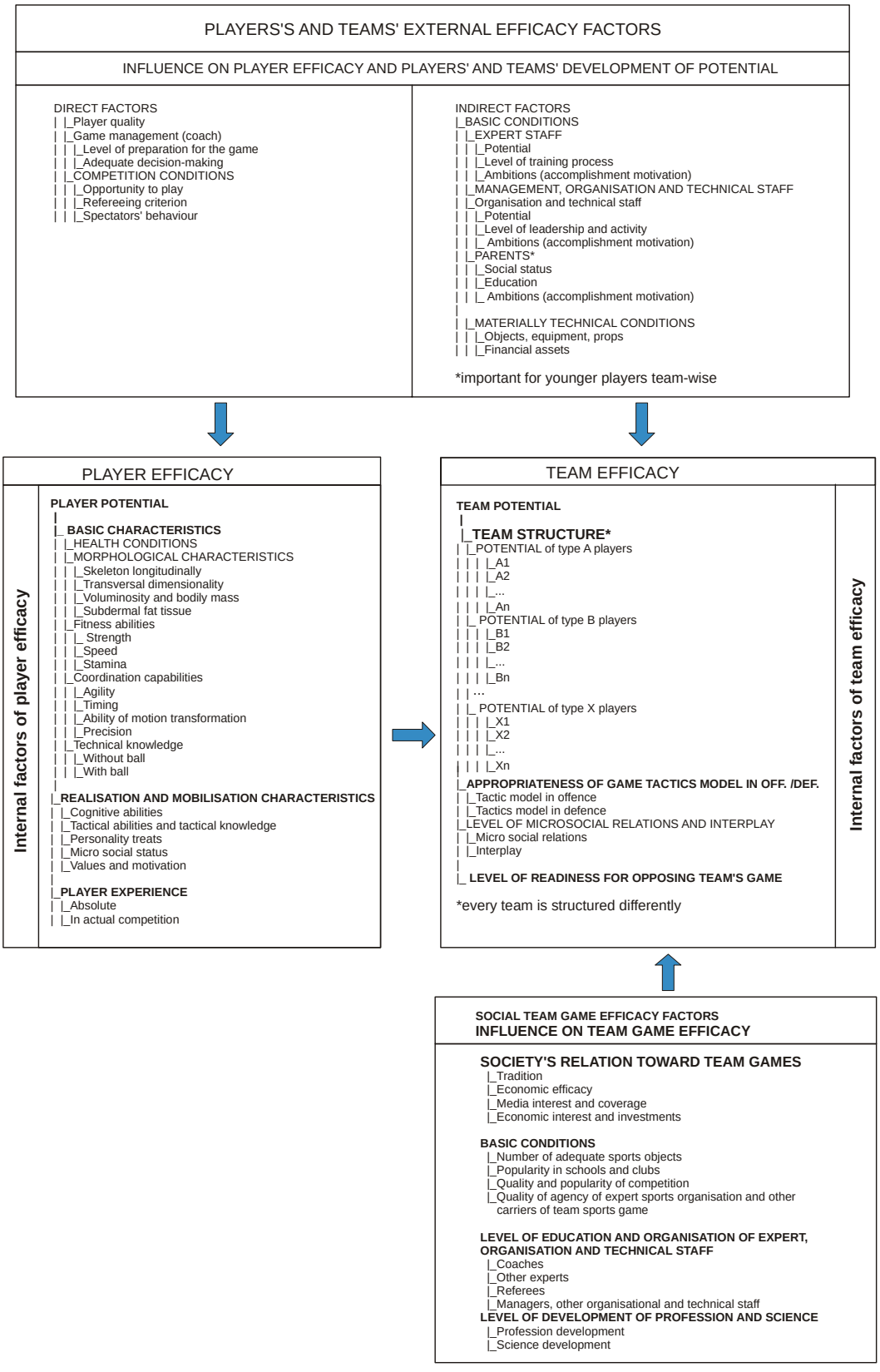

Figure 1 – example of a paradigmatic frame for a simplified tree model of a team sports games efficacy factors structure (according to Dežman, 1998)

In accordance, the factors act together differently then they do separately. Horga (1993) claims that it is possible that one factor overrides the effect of another, or enhances it. It is clear from the stated that external factors can empower or deafen the continuity of development and maturing of the athletes, and that there is a great number of interactions between internal and external sports efficacy factors.

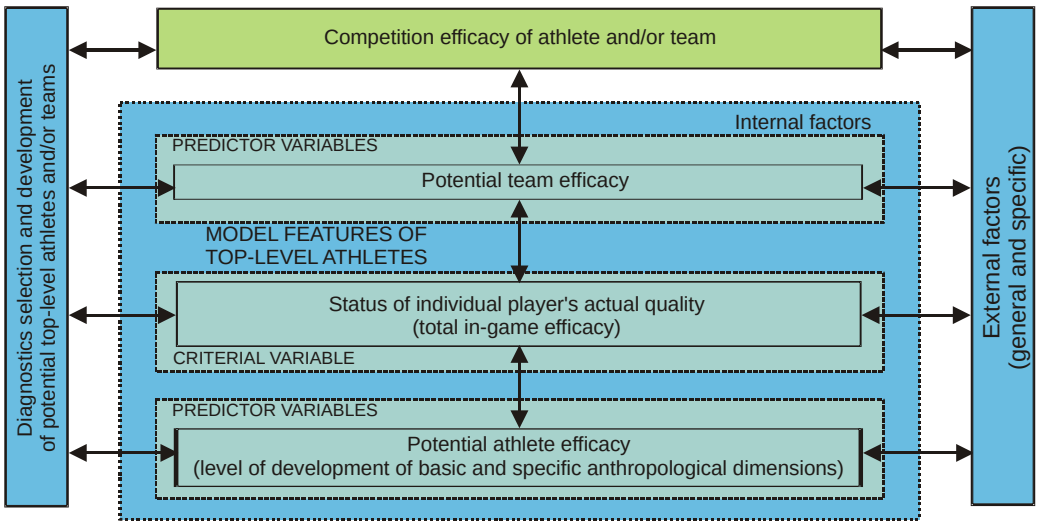

Figure 2 – Hypothetical model of interaction of athlete and/or team efficacy factors

Erčulj (1998) states that external factors influence the expressiveness of internal factors of sports efficacy, and that they have an indirect influence on potential efficacy of a player and/or team. Additionally, player's potential efficacy influences team's potential efficacy and vice versa. Hence, there is an interaction between team's and player's potential efficacy on one hand, and external factors and selection of potential top-level athletes on the other. So, in accordance with the acquired results in terms of potential efficacy and actual player quality, we conduct athlete selection (Figure 2).

The interaction between external and internal factors and the processes of sports preparation influences characteristics of a higher order that we call single player and/or team actual quality (total efficacy in a game). Here the total efficacy or total player and/or team actual quality is based on the assessment of the system of criteria that picture actual player quality (according to the position in a particular sport and the time spent in the game). The competition score within a certain competition system, that is, at the end the competition efficacy of an athlete and/or team depends on these parameters. It is assumed that the sport score is primarily an indicator of player and/or team quality (Figure 2). Based on the factors of assessment of potential efficacy and actual quality of elite athletes, we can speak of their model characteristics. Hence the normative values of the results in sport-specific tests, and the standards of efficacy in particular positions in reference to the time spent in the game represent a basis for parallel analyses of athletes and teams. Further more, we can acquire model values of team efficiency, and the model of individual efficacy of a particular type of player. So, the model features (values or normatives) for a respective category (gender, age, level of competition) consist of top-level athletes' results acquired based on the evaluations of indicators of basic and sport-specific anthropologic dimensions and based on the evaluation of the state of real quality of athletes, or total efficacy on a certain position and role in the game.

It is also important to note that explicit defining of sport-specific variables, as well as defining the criteria system of the total efficacy of athletes in team sports games, seems to be an inadequately explored field (Trninić and Dizdar, 2000). So, the values that include the athlete and/or team must be based on data acquired on a sample of top-level athlete and/or teams. The question here, the one all expert coaches should know the answer to, refers to the level of development of features of athlete's potential, and how well does it suffice the high standards of efficacy in actual quality in a certain position in the sports game. Further on, it is relevant to be able to distinguish the successful from the unsuccessful athletes and which features of team's potential and its actual quality distinguish the elite from other teams. Here it is important to note that the potential efficacy (internal factors) and rational management of the sports preparation process serve a crucial role in the long-term development of athletes and/or teams. The primary function of diagnostics and sports preparation (Figure 2) is to improve the readiness of the player and the whole team for competition. Here it isn't just the competition result that counts, but also the level of effort put forth to develop individual and team performance in all game course stages. This is evident in the readiness of the player to successfully complete the tasks within a role in a particular sports game. Finally, the goal is to reduce the differences between what an athlete can (potential efficacy) and does (actual performance). Accordingly, it is not all about the competition result, but what is also important is the way that the individual and the team play, how the system of preparation is conducted, and how much the players and the team are making progress during different cycles of sports preparation. Hence, the final outcome of the sports preparation cannot be observed exclusively through the final sports result. For many expert coaches, the final result of the training system is how prepared the athlete is for performance, and how close was athlete's performance was to the level of competence and/or potential (Wooden and Jamison, 1997).

The differences between total potential and momentary status of actual quality of athlete and/or team (which is the result of an expert subjective evaluation, based on a criteria system and an objectively measurable situational effect) show us how much certain athletes and/or teams can progress (Trninić, Papić, Trninić, 2009). The model of hierarchical structure of athlete and/or team efficacy factors can be formalised with the following system of nonlinear equations:

$CAQ = F_1(CAE, IF, EF, DAS)$
$IF = F_2(PAE, PTE)$
$MFPT = F_3(IF, CAQ)$

Hence, the competition efficacy of ann. athlete and/or team can be described by an equation,

$CAE = F_{tot}(DAS, MFPT, EF)$ that is,
$CAE = F_{tot}(DAS, F3, (IF, CAQ), EF) = F_{tot}(DAS, F_3(F_2(PAE, PTE), F_1(CAE, IF, EF, DAS)), EF)$

where we have: CAQ- condition of actual quality of a certain player (player in particular positions in the game) and/or team; CAE- competition athlete and/or team efficacy; IF- internal factors; EF- external factors; PAE- potential athlete efficacy; PTE- potential team efficacy; MFPT- model features of player and team; DAS - diagnostics and selection of potential top-level athletes.It is evident that the presented system of equations is not dependent on the time variable, but is shown through general functional relations.

Methodological aspects

Assessment and prediction of sports efficacy demands a multivariable approach, because there is always a great number of characteristics simultaneously connected to sports efficacy (Horga, 1993). In sports kinesiology, research and decision-making of expert coaches are necessarily based on data of a large number of different variables acquired from elite athletes. In the process we use mathematical statistic procedures with which the data can be simultaneously analysed. In research in the field of sports kinesiology, we also come across nonlinear relations of variables, so the multivariable procedures can be based on nonlinear models. So for example, we use multivariable regression, out of many multivariate techniques and procedures in sports kinesiology, when we have many predictorial and many criterial variables (Figure 2). Further on, he states that the precision of the equation of sports efficacy specification primarily depends on the whole research methodology. Accordingly, he indicates that the results will be of differentiating quality, based on the different approaches to a concrete research. Silva et al. (1981) state that the validity of predictions of top-level athlete efficacy can be confirmed only when you have identified a set of psychological, physiological and motoric factors for a group of top-level athletes during repeated investigations. The basic problem of previous attempts of defining components of sports efficacy is apparent in the insufficient coherence of obtained data in order to unquestionably conclude what the model of athlete and/or team efficacy comprises of.

In the research directed at the components of efficacy in sports activity (sports efficacy specification equations), Matycin and Daškevič (1988) claim that the test-subjects should be elite athletes. however, by analysing previous research on sports games, it is easy to notice that there aren't a big number of studies done on samples of elite athletes in team sports games that encompass basic and sport-specific variables. This is especially important because of the assumption that in case of elite athletes, specific anthropologic characteristics are the adequate predictor of actual athlete quality (Figure 2). It is probable that the connection of specific anthropological features to actual athlete and/or team quality is bigger if the level of competition's quality is higher. Such manner of understanding athlete and/or team efficacy factors requires application of the situational efficacy theory. The situational efficacy theory in a particular sports game, in different levels of competition differentiates in relation to the importance of particular parameters of situational efficiency (Trninić, 2006). This is why, from the aspect of methodology, it is necessary to create a construction of specific measuring instruments for team sports games, which will involve primarily researchers from fields of kinesiology, biomechanics, neurophysiology, motoric control, anatomy, psychology and methodology. Without the mentioned step, it is impossible to neither define sport-specific anthropological features nor establish relations between basal and sport-specific variables of athletes (an assembly of predictor variables) and their actual quality (criterial variable) in particular sports game. This is because scientists and expert coaches assume that the basal and anthropologic status of an athlete (potential efficacy) explains a significant portion of the variability of the actual player quality in team sports games. Fore-mentioned unresolved methodological problems resulted in indisposition to determine the influence of basic and sport-specific anthropologic variables on player and team actual quality and competition efficacy. Thus given kinesiological problems have disabled the formulation of an adequate equation of efficacy in team sports games. Also, no scientific research was conducted that would establish the influence of the system of integral sports preparation on actual quality of top-level athletes.

Therefore, scientific ascertaining of relations between indicators of fitness, psychosocial and technical-tactical preparation and the variable of actual quality of top-level athletes in team sports games has not been conducted in the research so far. Moreover, from the methodology aspect, it is crucial to resolve mentioned problems, which requires reinforcement of measuring instruments primarily aimed at: evaluation of sport-specific variables, development of methods for assessment of total efficacy in a sports game, approximation establishment of external factors on competition athlete efficacy and sport result in team sports games. Likewise, Horga (1993) states that the research of components of efficacy in sports activity is conducted on very different groups of examinees.

And then Horga (1993) points out that there is more then enough of works of this type in contrast to research that involve top-level athletes. Seemingly, previous research was conducted mainly on students, younger athletes, and on samples of athletes of medium quality level, instead on samples of top-level athletes. Accordingly, it is necessary to point out that the sample is considered representative if by its basic characteristics it resembles the basic assembly, meaning, if the sample is a smaller version of the basic assembly (Šošić and Serdar, 2000). Therefore, the possibility of generalisation of results of the experiment, and all sorts of scientific research depends on the features of the test-group sample (Mejovšek, 2008). It is clear that there are some very different samples that do not allow generalisation of the result aimed at components of efficacy in sports activity. Another kinesiological problem is that specific and different approaches to research of sports efficacy components do not allow acquired results to be generalised to the mentioned population. Danish and Hale (1981) provide us with a number of factors which could influence sports accomplishment. From their point of view, all research should be methodologically directed on studying neuropsychological, biophysical, psychosocial and intrapersonal factors. From the aspect of methods of scientific investigation, determining the latent structure of sports activity parameters, the indicators of training, is possible through factorial analysis. Also the structure and classification of athlete types, sorting tasks within phases and game tactics models, and the modes of technical-tactical functioning can most appropriately be conducted by discrimination analysis and hierarchical cluster analysis, while for testing sport's factorial structure and the specification equation, until now regression analysis was standard procedure. So, the efficacy equation in team sports games can be achieved experimentally- by applying regressive and statistic methods that can define partial contributions of certain factors in relation to athlete efficacy that is evident in the level of athlete's performance and competition efficacy. Accordingly, the connection of sport-specific anthropologic characteristics with actual quality of athletes in team sports games is possible to make by using multiple regression analysis. It is also important to point out the necessity of investigating the role of basic and specific anthropological features of athletes in successful accomplishment of missions within the phases of the course of the game and the tactics model, and that under conditions of cooperation and confrontation and high pressure of competition.

Efficacy equation

Therefore, an appropriate assessment of potential efficacy and athlete and team actual quality is a precondition for structuring a nonlinear equation of efficacy, and accordingly for appropriate selection and aimed development of top-level athletes. It is nevertheless important to point out that the hierarchy of efficacy factors (the anthropological determinant of athlete actual quality) is different in individual biological development periods and in particular qualitative competition levels. There is no scientific research program that confirmed the influence of potential efficacy factors on athletes' actual quality or their competition efficacy for individual biological development periods or in particular qualitative competition levels in team sports games. Accordingly, it is impossible to make a single constructive step in sports kinesiology if there are no analysis results for the influence of anthropologic features on actual athlete quality in particular team sports games defined by nonlinear models. From the practical action aspect, it is probably most appropriate to say that **the best predictor of future actual quality of an athlete and/or team their potential efficacy** (Trninić, 2006). Further more, the **multicausal model of athlete's personality and competition efficacy** is not possible to shape without an answer to the previously asked questions.

Momirović (according to Sabioncello, 1971) provides an efficacy equation with a limited number of relevant factors that affect sports efficacy:

$$Zs = A_1K_b + A_2F + A_3K_k + A_4G + \ldots + A_{k+1}S + A_{k+2}E$$

When forming the hypothetical equation of sports efficacy specification, besides the basic anthropological features we also have to emphasise the specific factor (S) that exists only for single sports, just like the error (E) and the unknown factors. It is assumed the higher the level of competition, the more important the sport-specific dimensions of athlete's personality (Trninić, Kardum, Mlačić, 2009). Therefore, there is a set of common factors for sports activities (basic or ˝wide˝ dimensions) and specific (˝narrow˝) dimensions that are the feature of particular sports activities. The goal of the kinesiological science is to discover the basic and specific dimensions which influence efficacy in a sports branch and discipline.

From the aspect of progress of sports kinesiology or sports science, it is necessary to discover sport-specific dimensions that determine efficacy for particular sports, minimise an error in assessment of importance of particular dimensions, and discover the unknown factors of the specification equation of sports efficacy to reduce the size of the uniquity. The problem of kinesiology of sports is evident in the fact that many measuring instruments generate false information (e.g. inadequate sport-specific tests of precision and agility), while science begins with measurement accuracy. Sabioncello (1977) (according to Horga, 1993) states that these sports situations also belong to sports efficacy factors: training factors (T), objective sports situation factors (S_1) (climate, opponent, referees etc.); and also sociological factors, that is, wider social circumstances in which the athlete finds himself (S_2). He also believes that with athletes we should evaluate: motoric abilities (K), cognitive abilities (C), athlete's personality in the narrow sense (L) and motivational factors (M).

Furthermore, Horga (1993) says that the mentioned factors don't have an equal contribution in the efficacy equation. And he also points out that the sports efficacy equation can be formulated as it follows:

sports situation factors athlete factors

$$SU=(A_1T + A_2S_1 + A_3 S_2)+(A_4K + A_5C + A_6L + A_7M)$$

Legend: Coefficients A_i denotes relative contribution of individual factors to sports efficacy.

Accordingly, Trninić (2006) states that the sports specification equation describes a hypothetic structure of hierarchically arranged factors of efficacy in some sports branch or sports discipline, and that it presumes volume, direction and rate of influences of the internal and external factors on the total competition efficacy. Therefore, the situational efficacy of athletes and/or whole teams in polystructural and complex sports activities is not just an indicator of actual player quality, but also a function of situation, strategy and operative tactics of opposing players, the level of faith in the training manner, individual and team level of sports shape, the level of integral preparation of athletes and teams, faith in the game tactics model, coach's leadership behaviour, functional relations in the team (quality of cooperation), the put forth effort in the game of both teams, player's adjustment to refereeing criteria and the spectators' pressure.

Here the selected game tactics model enables the optimisation of action and situational efficacy of individual players in the game (Dežman, 1988,1998; Trninić; Trninić and Papić, 2009). The efficacy of resolving situations in complex sports also depends on the quality of individual athletes of opposing teams, the quality of cooperation, that is, ˝the behaviour that maximises the outcomes of the collective˝ (Hewstone and Stroebe, 2001). Malacko and Popović (2001) state that during analyses of efficacy factors in sports activities, the data on how many factors $F_1,\ldots, F_n$ affect a particular activity represents the basic mission for explorers in the field of applied kinesiology. Further more, they emphasise that generating a hierarchical structure of anthropological characteristics of athletes is conducted through application of mathematical statistic methods (factorial, regression or canonical analyses), and that the most common formulation of the specification equation:

$$Y = \sum_{i=1}^{n} a_i F_i + ex, \qquad \text{where}$$

Y – stands for efficacy in a certain sports activity; F_i – factors on which efficacy in a certain sports activity depends, i=1,...,n; a_i – coefficients of influences of certain factors (efficacy contributions) , i=1,...,n; ex - error factor

Also, Malacko and Popović (2001) imply insufficient exploration of the application of the modelling method in kinesiologically anthropological research. In so doing, they claim that the mathematical-cybernetic methods are increasingly applied in sciences (biology, medicine, kinesiology, psychology, sociology, etc.). Accordingly, they believe that future lines of research should encompass the area of the answer to how appropriate existing methods and models are in the field of kinesiologically anthropological research. Also, in addition to this, we assume that with the system of differential equations we might more appropriately describe the high complexity of internal and external determinants of athlete's performance and competition efficacy, as well as their interaction in complex sports. The adequacy of an equation of efficacy is determined by the methodology of research, the selection of experts and measuring instruments, and the sample of top-level athletes in a particular sport. The question is, can the efficacy equation in complex dynamic systems (polystructural and complex sports activities) demonstrate hidden factors and relations that effect athlete's competition efficacy. The same way, from the aspect of expert coaches and practical definition of a certain team's efficacy, it is hard to define what an individual means to a certain team, that is, in what amount a single athlete makes his team-mates successful in competition, that is, how much he effects the efficacy of the team. Sabioncello (1971) says that even if all the relevant factors were to be measured and multiplied with the coefficients and summed up, we would get theoretically potential efficacy in a particular sports activity. However, if we were to do it without inserting factor S (specific features for particular sports), we would probably reckon that the result of our equation is incoherent with athlete's performance and sports accomplishment (Trninić, Kardum and Mlačić, 2009). These specific features, and probably specific or narrow personality treats too (e.g. Personality firmness, readiness for contact game, optimism and attributive style, dealing with stress strategy, ambidexterity, game understanding, playing experience, tactical discipline, tactical responsibility, cooperation…), are called sport-specific variables, and if they are included in the equation of efficacy, they decrease the possibility of error in athlete's and/or team's efficacy prediction. Clearly, the efficacy prediction accuracy rises when involving external determinants of competition efficacy. Thus, it is a kinesiologist's primary mission to reveal all relevant internal and external factors that influence the players' and teams' efficacy model. It is also important to note that the potential errors in scientific research of the efficacy equation in a particular discipline and sports branch can appear due to unacquaintance to relevant factors on which the efficacy in a particular sports activity depends. So the non-evaluation of such relevant factors contributes to magnifying errors in efficacy predictions. Milanović (2004, 2009) states that if this relation is true:

$$Rs = f(X_i, Y_j) \text{ , where}$$

X_i are factors that can be influenced, Y_j are unmanageable factors, and Rs is result in sports –

that then result in sports depends on the factors that are susceptible to training influence (low intrinsic coefficient) and factors resistant to training influence (high intrinsic coefficient). Evidently the sports efficacy specification equation, acquired through usage of the principle of reciprocal determinism and chaotic models, necessarily indicates that the result in sports depends on the factors susceptible to influence of training, and the factors resistant to training influence. So, for example, Malina and Bouchard (1991), Bouchard, Malina and Perusse (1997) state that the hereditary factors (genotype, predisposition) are different for different factors on which depends sports efficacy. Accordingly, the variability of competition efficacy in sport is affected by: variability of hereditary factors, variability of exogenous factors, variability of athlete's activity and error variability. However, in team sports games, as well as the importance of genetic potential, we must take into account the compensational approach (selective compensations of weaknesses) that enables minimisation of shortcomings of an individual from the aspect of potential efficacy. On the other hand, from the aspect of expert coach, it is possible to influence: the selection of technical-tactical knowledge and activities of a particular type of player within the game tactics model, the selective corrections of errors spotted in the game, the selective optimisation of the development of the athlete's total genetic potential, and the enhancement of particular team's and/or athlete's total efficacy (Trninić, Trninić, Papić, 2009).

Conclusion

From what we have seen here, it is clear that it is necessary to advance the procedures for assessment of sport-specific variables of anthropological status since specific tests adequately differentiate efficient and inefficient athletes, but are also an appropriate indicator of athlete's potential efficacy. Besides that, it is important to develop methods for objective and subjective assessment of athletes' actual quality in team sports games, and to define and explain the influence of the basic sport-specific variables on the efficacy of athletes in team sports games. All this is a precondition to forming an adequate efficacy equation in team sports games. It is assumed that, based on basic and sport-specific variables, it is possible to explain a significant portion of the variability of the total athlete efficacy in team sports. It is probable that the influence of the sport-specific prediction variables on the total team and athlete efficacy grows with the increase of the level of the competition system. It is clear from this article that it is necessary to selectively modify the model of athlete and team potential efficacy, using new relevant factors of team sports games efficacy. Thus it is important to include not only the internal, but external factors of sports efficacy as well. The goal of the kinesiological science is to explore external and internal determinants of sports efficacy, and to reduce the athlete's performance and competition efficacy prediction error. Further more, it is important to point out that the measurement problem, primarily concerning external factors, is the most complex area in the field of sports kinesiology. So it is impossible to define external determinants of efficacy without approximating the efficacy of the athlete and/or the team. It is probable that the possibility of predicting and reducing error is significantly smaller in assessment of external then internal factors of the efficacy model. Also, the error factor in the prediction is determined primarily by expert knowledge and experience as the most relevant and irreplaceable instruments in assessing efficacy factors of players and teams. Accordingly, the dominant patterns of explanation and comprehension of the efficacy specification equation in complex sports should probably be the nonlinear models, the theory of mutual influence of external and internal factors in sports efficacy, and the theory of the dynamic and functional approach. This is one of the possible modes of dealing with the factor structure of sports efficacy. Thus, it is important to note that every theoretical progress encourages new research that contributes to development, modification and evaluation of situational theories in sports kinesiology. The proposed hypothetical efficacy model isn't definite, but should be regarded as a starting point for empirical investigations, based on which the model will be changed and upgraded. The conversance and the understanding of internal and external efficacy factors in sport are preconditions of appropriate structuring of the nonlinear equation of sports efficacy. In further research, it would be recommended to construct a proposition of a nonlinear model of sports efficacy factors, based on the hypothetical interactional model, that would be tested by a number of future investigations.

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KINEZIOLOŠKI, ANTROPOLOŠKI I METODOLOŠKI ASPEKTI JEDNADŽBE USPJEHA U MOMČADSKIM SPORTSKIM IGRAMA

Sažetak

Redefiniranjem pristupa oblikovanja jednadžbe specifikacije čimbenika uspješnosti u polistrukturnim i kompleksnim sportovima te utvrđivanjem modelnih obilježja sportaša različite dobi dobivaju se važni izvori informacija za primjerenu dijagnostiku i selekciju budućih vrhunskih sportaša kao i za racionalno upravljanje procesom sportske pripreme. Znanstveni i stručni pristup oblikovanju modela uspješnosti u polistrukturnim i kompleksnim sportskim aktivnostima mora obuhvatiti unutarnje i vanjske odrednice sportaševe izvedbe i natjecateljske uspješnosti. Predložen je hipotetski dinamički model uspjeha koji eksplicitno pokazuje utjecaj unutarnjih i vanjskih varijabli na konceptima teorije dinamičkih sustava. Hipotetski model čimbenika uspješnosti pokazuje da su sportska izvedba i sportsko postignuće pod utjecajem unutarnjih i vanjskih varijabli u skladu sa konceptom recipročnog determinizma. Uvođenjem većeg broja relevantnih sportsko-specifičnih varijabli te vanjskih čimbenika vjerojatno bi se povećala predikcijska vrijednost i valjanost modela uspješnosti sportaša i momčadi. U skladu s time nužno je kreirati model čimbenika uspješnosti u sportu koji bi obuhvatio bazična i specifična antropološka obilježja koja u najvećoj mjeri determiniraju stvarnu kvalitetu sportaša. Pretpostavlja se da bi suradnja znanstvenika i ekspertnih trenera mogla generirati povratne informacije koje će omogućiti daljnji razvoj ekspertnih sustava te prijedlog nelinearnih modela čimbenika uspješnosti u sportu.

Ključne riječi*: modeli, sportaši, ekipni sport, učinkovitost, sustavna teorija, metodologija*

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