

## RESEARCH OF COLLECTIVE SPORT GAMES IN THE FIELD OF KINESIOLOGY AND SPORT SCIENCE IN THE WORLD AND IN CROATIA

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Review paper

### Abstract

Choosing a representative scientific papers in four collective sports games (water polo, basketball, handball and football), we tried to elucidate the conceptual and methodological approaches to domestic and foreign authors-scientists in studying the phenomenon of group games. Different schools (English, French German and Croatian) have different concepts or very similar methodologies. Their common feature is that their analysis is always partial, never comprehensive, and from such analysis and could not arise models required and necessary for the training of the above collective sports games. We assume that the reason for this "slavery" equation specifications sporting activities, especially in Croatian authors. We believe that the need for new scientific paradigm in the study of collective sports games because previous studies have not offered sufficient and insufficient for optimal modeling of collective sports games.

**Key words:** collective sports, concepts, methodological approaches, a new paradigm

### Introduction

#### England

Reilly and Thomas in 1976 were the first authors in the world to apply a systematic analysis of matches in top sport combining the techniques of manual recording and images of audio tapes, detailed analysis of player movement of the first England football league.

Based on these images they recorded the amount of work players at different positions, the distance traveled during a game and calculate the total amount of elapsed time in the game. These early works have become a reference and model standards for many later researchers (T. Reilly and A: M. Williams 2005). The scores analysis or analysis of notes (notational analysis) is a methodology of objective registration of real events in the competition. It consists in a consistent and reliable way of quantifying sporting events. It is used to analyze the game based on the notation-recording events in matches and includes technology. Technical and tactical elements of the game often are used to analyze the tactics and strategies in collective games. The technology itself has been taken and modified from the methods and approaches used in ballet, dance and music.

It is particularly interesting that this technology allows the detection and identification of the structure of the game players and teams. The resulting information is organized so that the coaches facilitate the planning tactics of the game. Technology Notation analysis systematic and its comprehensiveness allows technical and tactical evaluation, analysis of the total movement of players and is used to create a database of players and teams.

#### France

From the works of L'enseignement des jeux sportifs collectifs (Claude Bayer 1995) shows that the French systematic approach to the analysis of collective sports. Team sports are observed in the context of social events and attributed them exceptional pedagogical value, which is not independent of the state and politics. Team sports (principally those which are successful on the international level) analyze the technical and scientific level in the light of learning, predominantly through a pedagogical approach. Team sports are analyzed systematically and analytically but also comparatively. The focus of their interests and analysis are: playground, rules, collectives, techniques, tactics and strategies, and in the light of pedagogy, didactics, sociology, psychology and kinesiology above. According to the size and specific intervention approaches in the analysis, it could be said that in one, and that a substantial part, have methodological direct points of contact and similarities in approach with the performance and modulating our work and this is the reason that lays particular emphasis on their contribution to our approach solving the model of collective sports games.

#### Croatia

The study author Pavičić (Pavičić, 1991) has been discussing the possibility of a formal definition of collective sports games water polo. He chose the approach that the phenomenon of the match breaks down into simpler parts. This procedure established concepts in which it is possible to define and describe all the essential features of the game. Basic concepts and definitions of the categories are: playground, tactics, techniques, images, and object.

The playing field is bounded space in which to place match, in which different areas: attack (A), forming a space attack (A) and space defense (D), so that from the perspective of the situation of a team game space is determined and ranked stretching variable subspaces. Game plan the team as a collective in the entire duration of the match the tactics of the game, and implemented the division of tasks that each player performs and thus each player, in the realization of tactics games teams, has a special characteristic role. A set of tactics game is divided into subsets: individual and collective tactics, which is still divided on the tactics of the game in attack and tactics of the game in defense.

Activities players which exhaust all possible behavior of players during the match, with the basic assumptions and limitations, are called the repertoire of games. It is divided into sets of elements of individual behavior of players who are called repertoire of techniques and individual tactics of water polo, and all elements of the behavior of two or more players, as a group, called a repertoire of elements tactics. Elements techniques make, in principle, open a collection that is divided into mutually p, subsets based on the criteria that determine the situation in the game, tactics games and other criteria.

Commissioned a global game plan or tactics, players in the game are in the situation of successive deciding what game to match defined as a typical sequence of decisions players. Taking into account the total number of players participating in the game and the fact that the game takes place in real time, it has the characteristic of a continuous process, but the course of the game is approximated by sampling or registering values of the relevant variables in certain, predefined, time points of the process. This representation of a continuous process is reduced to a series of discontinuous in time registration that name - photo - basic entity registration. Figures so registered for the entire course of the match, and the image itself are certain facilities, all the players of both teams and the ball. Dynamic elements of the game show operations of summation and different positions of objects in two adjacent images. Thus obtained, the dynamic elements of the game are: the speed and direction of objects, the radius of movement, typical lines of movement, estimate the energy consumption of a player and the player's actions.

The image is spatially determined the planned coordinates of all objects of the image. The variables or attributes of objects are: zones of influence of objects, moving objects, the direction of movement of players, the radius of movement of players, the line of movement of players, ball movement, and estimate the equivalent energy consumption player summarizing action object player. Every action in the situation left by the selection of one element from the repertoire of technique elements waged tactics game team.

The situation in the game classifies the following conditions objects - players: movement, receiving the ball, passing the ball, shot, cover, detection and idle. Choices of actions directly depend on the situation in the game. Description of the situation, the default tactic in this way, directly determines the ability to choose the player's actions. In the match of all possible situations taxonomies and classified according to the elements: Phase games, positions in the playground, the position players, ball possession, the position of the other players, so far in the game, the decisions of judges. Types of local situations that we need to construct a separate local models in the attack, for example: a counterattack, end the game and taking a free kick in the attack, and in the defense: play goalkeeper, cover, cover the player with the ball, cover and control a certain area of the field, download players, prepares counter, game play is interrupted, and more. For each of the local situation is considered to be well-defined separate model and treated as a separate game.

Thus the observed game can be differentiated into several separate models games: model which is determined by overall team tactics since the main goal of the game - a global model, and the range of models that describe the specific local situation in the game - local models. Elements techniques to the most general level are classified into only two classes of different types of player movement and class manipulation to control the ball. Moving players realized tasks: winning the space field, the release control of rival players and covering, respectively, control an opponent to attack. The class element techniques that allow for the task manipulation ball include: passing the ball between players of the same team, receive added ball, dribble, shot, e.g. elements of techniques aimed at the realization of defense. Parts of the model can be exported as an autonomous module in functional cooperation dedicated perform the following tasks: assessment of the situation, control the exercise of skill, control the exercise task, control and regulation of resources, and overall control of achieving a goal.

Scenarios of cooperation called modules that are described in steps: perception of the environment and the assessment of the situation (S), separated from the base elements of those techniques to the evaluated situation possible (M), consult (T) and select a new task or continue to exercise the task in progress, consult (R) and cast elements that cannot be performed, in a separate set of elements determine the probability of selecting each element and reject all those who are below the specified threshold, in accordance with (A) select one element technique (in rank, chance or by preference), corrugated state resources with the help of (R) and then perform an action. Local situation is defined as a separate game that defines objects pictures of fields: the position (X, Y), orientation (1, 0), the movement, and the zone of influence, energy level and status (free, endangered).

Repertoire of games is: in the attack (movement, acceptance ball, dribble, raising the ball, passing, shot) and defense (movement, covering players, coverage area, starting the player with the ball, a false start, cutting, download). Each object (player) estimated their relationship to each remaining object in the image assessment of the situation is carried out for each pair and then ranked in order of importance given to the assessment of the variables: distance, orientation, movement, interference zones of influence and status for your own energy level. The problem of modeling of a player in team sports, the level of professional sport, with us, dealt with the relatively small number of authors. Here is an overview of the most important such works.

### **Problematization of game notion**

The game is a term describing the way of spending time. Activity that in itself has no purpose and not for the benefit, pecuniary or otherwise, about the players who take part in it. They play all the (play all - is another matter); children and adults, men and women, from all classes; rich and poor, educated and uneducated, workers and engineers, doctors and maids, etc. For participation and game is sufficient condition: the desire to play, knowing and obeying the rules of the game, and, time available for the game. The outcome of the game (win - loss) for the players is an important consideration but not the only decisive for participation in the game. The result is determined by its meaning and sociability, e.g., social meaning, games, and he is therefore on the meaning of a given society and valued for participants and observers, and society. Of course this can be very different for each player, each team, for each observer individually, or even society in which players (collective / team) belongs. The match represents and enjoys spending time. After it is different from the labor / work that is done for profit, and from art, which is a way of expressing ideas, structured and has a clear goal. Of course the distinction game and the game are not always visible or clear. These are basic facts sufficient to consider these topics, and will be further deepened. However, interesting is certainly considering the history of theories pertaining to the game and brief they will be considered. There are two important authors associated with the notion of play Johan Huizinga and Roger Caillois. In *Homo Ludens* Johan Huizinga, Danish historian and university professor, and cultural theorist, discusses the importance of gaming element culture society. Huizinga is a new and very inspired way of dealing with this subject. Although he discovered the game and where else it never before, he deliberately omits descriptions and classifications of the games. According to him, all games have the same needs and maintained the same psychological attitude. His study is not focused on the game description and classification of games, but the study of the impact of creative features of game dynamics in the domain of culture.

It is, more precisely, the dominant qualifications creative spirit of the principles of the game in the domain of culture. He concludes: Summing up the formal characteristics of the game they can be classified into leisure activities that are consciously outside "ordinary" life, because "not serious", but at the same time absorb the player intensely and utterly. It is an activity that is not related to any material gain or profit, or games, for him, promote social grouping. They try to surround secrecy and expression of its diverse than just us common world at the same time using the conversion or other means. Huizinga suggests that it plays a primary, though not sufficient, condition for creating parts of culture in general. At this point of the controversy about the title of his book "The Play Element of Culture" when, after the appearance of wider controversy, a word of, the title, changes in and to said that his goal is not to determine the place of games in culture, but to determine how culture bears the character of the game. Another important author is his major and multiple contributions, theorist Roger Caillois.

He has a reputation as the greatest theorist, writer and philosopher who deals with topics ranging from psychoanalysis and sociology to anthropology and art, and of the many recognized as one of the most influential thinkers on topics game and play. Most of Caillois's book concerning the play and game is a direct criticism to Huizinga. It extends more content-oriented concepts games to include a range of cultural forms. Inspired by the idea and study the game itself and of itself Caillois established our well-known taxonomy form of games that is applied to a whole range of well-known form of games. In his book *Les jeux et les hommes*, he formed four different structures (patterns) in each game. These are: 1) Agon - competition / game, competition; 2) Alea - a chance; prospects, the risk, the possibility that something happens related to the probability of events, and the chances for success in the future; 3) Mimicry - imitation. The word is derived from the Greek language, mimetic imitation, and 4)ilinx category games that consists in an effort to achieve stability of the current distortions of perception, which then causes a kind of vertigo and panic in otherwise composed consciousness and which is similar to the type of spasm, obsession, or shock which distorts reality with sudden obsession; 5) Vertigo (Latin Vert; dizzying or spinning movement) is a kind of blurring of consciousness with a sense of movement, even though it actually does, resulting in disorders of the vestibular apparatus in the inner ear.

It is often associated with nausea and vomiting and the problem of standing or walking. Callois does not think that they completely cover the entire range of contexts of meaning the game, but, as it establishes the basics for sociological model of social organization. It also defines the need for the distinction between formal: the rules of the competition - (A) ludus and anarchic spontaneous games, marked with (B) paidia.

Agon and alea are opposite and sometimes complementary approaches and attitudes, but both are subject to the same law as the creation of conditions for the player's full and pure equality as they are not possible in real life. The game is therefore an attempt to compensate perfect situation in the confusion of modern life. In the match (game) role, merits or chances are clear and indisputable. Equally implicitly assumes that everyone has to play with exactly the same expectations for proof of superiority, or as otherwise, on the other scale, with the same chances of winning. Either way, he escapes from the real world and creates another. The individual, in fact, cannot escape from themselves and become someone else. It is mimicry. Each game assumes temporary acceptance of illusion, if itself is not an illusion in these circumstances creates a closed, conventional, and, in a certain way, imaginary universe. Pretending both for them and for others to be someone else, forgetting, and pretending temporarily leaving its own personality.

The rules are inseparable from the game of the moment when they become institutionalized. Since then become part of their nature, are transformed into productive and specific culture. However, freedom is central to the game and so stimulates peace of mind and fantasy. This freedom is essential motive, power and basic to most complex and carefully organized form of games.

Collective sports games have their place in the classification of games by Caillois. Located in the area of competition (ludus) and spontaneous games (paidia), in the context of competitive sport (Agon), the opportunities (Alea), simulation (Mimicry) and experiencing (ilinx - Vertigo) Each individuality allows that in the context of the above highlight and realized. The ratios of the components in this model are directly dependent on the current situation generated by the type of competition, ranking events, concrete match, and the ultimate goal of the competition, the role and position of players within their team. .

	AGÔN (Competition)	ALEA (Chance)	MIMICRY (Simulation)	ILINX (Vertigo)
PAIDIA Tumult Agitation Immoderate laughter	Racing Wrestling } not regulated Etc. Athletics	Counting-out rhymes Heads or tails	Children's Initiations Games of illusion Tag, Arms Masks, Disguises	Children "whirling" Horseback riding Swinging Waltzing
Kite-flying Solitaire Patience Crossword puzzles	Boxing, Billiards Fencing, Checkers Football, Chess	Betting Roulette		Volador Traveling carnivals Skiing Mountain climbing Tightrope walking
LUDUS	Contests, Sports in general	Simple, complex, and continuing lotteries*	Theater Spectacles in general	

N.B. In each vertical column games are classified in such an order that the paidia element is constantly decreasing while the ludus element is ever increasing.

\* A simple lottery consists of the one basic drawing. In a complex lottery there are many possible combinations. A continuing lottery (e.g. Irish Sweepstakes) is one consisting of two or more stages, the winner of the first stage being granted the opportunity to participate in a second lottery. [From correspondence with Caillois. M.B.]

Figure 1. Game classification according to Caillois

**Games properties**

All the games integrate common characteristics:

- particular sequence;
- specific value objects;
- unproductive (non-production goods);
- rules of the game;
- definition of gaming space and
- completeness (Schechner, 1987). Classification of games is possible according to various criteria, such as number of players, complete or incomplete (hidden) information on the state of the game, stochastic, the average branching factor and the size of the state space. The concept of game theory is a mathematical framework for analyzing interactions between players whose decisions are dependent. In the analyzing in the field of game theory, the game is described as an interactive situation of players, and consists of:
- an abstract description of the players,
- course of their possible actions and
- desirable outcomes.

The assumption is that the players make rational decisions, e.g. to achieve their desired outcome of the game (Von Neumann, Morgenstern, 1944). Games have, in general, well-defined rules that can easily be expressed in a few sentences, and thus they are relatively easy to implement on a computer. Combinatorial complexity of nontrivial games produced immense problems. This is why it was necessary to pass several decades of research and the emergence of powerful enough computer to the machine closer to the level of human experts in the most popular games (Chess and Othello). Some games were and still are "too heavy" for computers. Such games are for example Go due to too many possible states (large branching factor), Bridge, due to lack of information (hidden information game), and Nomic (Suber, 1990), which is like a game too difficult to even make initial attempts - in every move players extension of the basic set of game rules.

One of the roles of game theory is the definition of the meaning of the term "optimal solution" for different classes of games. Most of these theories deal with uncooperative situations where each player acts independently. Such games strategy you for players and determines the actions that the player and should be performed in a state of the game. Solution of the game is then a strategic combination of  $s_1, \dots, s_n$  that meets specific requirements. In-agent systems, agent games I cannot control the outcome, and therefore only strategy "optimal solution" is not sufficient because it assumes the behavior of players based on expectations about the behavior of other players. Due to the classification of games, game-agent belonging to the class imperfect information games (Kuhn, 1953), e.g. Games with incomplete information about the state of the game. Optimal action players can therefore rely on their assumptions (beliefs) about the current state. Cooperative games appear when players form a coalition and agree on the method of election actions, for instance, vote or auction (bidding) (Von Neumann & Morgenstern, 1944; Luce & Raiffa, 1957, Matarić, 1997). Collective sports games are well-defined type of sport. A game in which two competing collective (team) takes place according to predetermined rules, in a certain interval of time; match, and in a given space; playground (Pavičić et al., 1987; Pavičić, 1991). The participants were two teams of players each different in their motor skills and abilities,

psychological characteristics and abilities, experience, and other characteristics. However, for each player necessarily knows the rules of the game, understanding of the game and the ability to perform a minimum from the repertoire of techniques of the game. The aim of the game is in the planned joint action by all the players of one team score (point). Game plan as a collective group in the entire duration of the game tactics and usually carried out by dividing the tasks that each player needs to be done. The dynamics and flow of the game (Trninić, Perica & Pavičić, 1995) can be, for one, players, approximate cycle: perception-decision-action. On the other hand, the implementation of the global game plan or tactics team is much more complex process and is usually based on some pre-arranged determinants (Trninić, 1996). It is important to note separation problem of interaction of players with the environment of problem-solving interactions of players in the group; two basic layers of game. One is: • At the level of players and its local situation and possible choice of actions (Pavičić, Lozovina & Šimenc, 1988), and others • choice of the following actions collectives from the competition all local situation (Pavičić, 1991, 1996; Stone, 1998). The challenge of the true nature of the problem of system design robots capable of coherent behavior as a team in a sports game can be easily seen from a summary of the comparison feature of the situation and the types of games (Table 1).

Table 1. Comparison analysis of basic game types

Characteristics	Type	Chess etc...	Collective sports game
<b>Environment</b>		Static	Dynamic
<b>State changes</b>		Alternately	Time
<b>Information ability</b>		Complete	Incomplete
<b>Sensors nature</b>		Symbolic	Un-symbolic
<b>Control</b>		Central	Distributed

### Previous studies

One of the main problems in kinesiology sport is a problem (im) possibility of an objective measure of the overall performance of situational players (entity) and in team sports games. Empirical research relating to the situational approach tests individual and team performance in sports games can be grouped into four typical groups that include: 1. research based on the determination of basic quantitative indicators and the inclusion of specific technical and tactical activities; 2. based research to identify the latent structure of space situational; 3. research based on determining the comparative similarities and differences between certain roles in the game; 4. Research based on subjective assessment of quality athletes of expert systems. Empirical research situational space was based on the assumption that the situation efficiency co variability responsible for small number of latent dimensions on the basis of which the functional point of view can interpret a game.

The aim of such study was complete insight into the interaction of situational variables and thus water game interpreted as a dynamic system. In accordance with the purpose of this paper we emphasize some foreign and some domestic. However, research from water polo, handball, basketball and football. In water polo Platanou (2004) conducted a study with the purpose of classification and quantification of activity during the matches of top water polo players. The sample consisted of 48 water polo (16 centers, 18 attackers and 14 fullbacks) players. Based on the results it was found that the activities with the highest frequency and a duration that determine water polo game: (a) suppression of the water while the body is in a vertical position (11: 08 ± 01: 47min: sec), (b) Swimming (09 : 27 ± 01: 18min: sec), and (c) contact with an opponent (05: 22 ± 01: 54min: sec). All of these activities make a total of 91% water polo game.

D'Auria and Gabbi (2008) are based on the collected video clips from the 13th FINA World Cup of the 2002 study thus classification and quantification of technical and tactical actions during a match in elite water polo team total, and the playing positions. Activities during the water polo games are defined duration, frequency and intensity of the corresponding subjective. Based on the obtained results it was found that the activities with the highest frequency and a duration that determine water polo game: (a) swimming in transition  $64.0 \pm 15.3\%$ , (b) swimming in a positional attack and defense  $13.1 \pm 9.2\%$ , (c) contact with the opponent  $14.0 \pm 11.6\%$ , and (d) hold position (vertical position)  $8.9 \pm 7.1\%$ .

Thus Šimenc, Vuleta, & Kurjaković (2000) found differences between successful and unsuccessful teams based on 17 situational parameters water polo games, observed during the 22 water polo matches. Here are the analysis of the results found that the negative terminal of the discriminate function is determined variables: the number of shots, blocking shots, steals, the realization of more players and counterattack. On the other hand the positive terminal of the discriminate function is characterized by variables: the number of attacks, number of shots, hit the post, and turnovers. Based on these parameters, it is possible to determine the affiliation team group defeated or victorious team with a 97.83% probability. Lozovina et al., (2002) analyzed some indicators load the game on the wing position in water polo and defined the four latent factors. The first factor determines the intensity of the activity of the wing during the match, the second frequency action in a vertical position, third extensity of activities, and the fourth time in the game in the vertical phase.

Lozovina et al., (2003) analyzed some indicators load the game at quarterback position light in water polo. In the context of the research were obtained by three latent structure defined as: the amount of action, intensity of activity in the vertical position and the real extent of work expressed through easy swimming. Lozovina et al., (2003) analyzed some indicators load the game on the position of the external players in water polo and have obtained the latent structure in relation to the intensity and types of action. In an attempt to explain the intensity is defined as two aspects: quantity action and activity level. Lozovina et al., (2004) analyzed some indicators in the game at the center position in water polo. They note the existence of three factors that explain 84.6% of the total variance. The resulting factors are defined as: the amount of action, intensity of activity in the horizontal position and the time spent in the game. The authors observed in the intensity of two aspects. One is expressed through the amount of action, and the other is expressed as the level of engagement. The third latent variable in this study is called the time spent in the game.

Takagi, Niskijima, Enomoto and Stewart (2005) on the basis of the observed 108 matches with the 9th FINA World Championships in swimming and water polo for men and women are dissected factorial structure of water polo game. Twenty-one of the selected variables for the attack and eleven for the defense were extracted ten factors which cover 83% of the total variance. The results indicate two dominant determinants that determine the winner in water polo game: the first determinant of the ability to realize counter and more players, the other determinant of the success in blocking and rescue his opponent's shots with a reduced squad. Iturriaga, Encarnacion and Jose (2007) conducted a study in order to find indicators of efficiency and counter-defense action in water polo and to analyze their relationship when determining the difference between successful and unsuccessful teams. Analyze the match 10th World Water Polo Championships did not end up a draw. The situations in the game that are defined as a counterattack and defensive action were determined coefficients which are based on the data of situational efficiency.

Based on the results revealed four indicators of efficiency and counter-defensive action in the men's water polo, and the five indicators in the women's water polo ( $p < .05$ ). Results indicate that fourteen coefficients of efficiency that have been proposed for determining the value of counter-attack and defense actions, significant differences in determining the successful and unsuccessful teams exist in eight coefficients in the male and twelve female ratios in water polo. Iturriaga, Encarnacion and Jose (2008) at the 10th World Cup matches in water polo did not end up a draw conducted a study in order to find indicators of situational effectiveness in terms of an equal number of players with or without the ball and to analyze their relationship in determining the difference between successful and unsuccessful teams. The results obtained in water polo in the men's competition point to six indicators of situational effectiveness in terms of an equal number of players when they are in possession of the ball, and the five indicators of situational effectiveness in terms of an equal number of players when they are not in ball possession.

In the category of women's water polo was found on six indicators of situational effectiveness in terms of an equal number of players when in possession and without the ball. Furthermore, it was found that on the basis of the significant differences between successful and unsuccessful teams can suggest twelve of the fourteen indicators for evaluating the situation efficiency equal number of players with or without the ball in both competitions. Based on the comparison of previous research in identifying latent structure of space situational water polo games are as follows: First defined the factor structure of the load according to positions in the game; sSecond provided the indicators of the efficiency of the game that determine the winning team;

Third provided the indicators of effectiveness of the various parts of the game those determine the winning team. A series of studies carried out to determine the differences of certain types of water polo players on the basis of basic and specific skills, qualities, knowledge and skills. For example, Šimenc et al., (1999) analyzed the structural positions in water polo players based on an assessment of some anthropological characteristics.

They found that water polo game requires: (1) a high level of coordination, precision, speed of reaction, movement frequency, the speed of a movement, explosive strength, repetitive strength, agility, aerobic and anaerobic lactate non-lactate capacity in all positions in the game; (2) a high level of absolute power with the past, external players, and center-back; (3) medium-high level of flexibility and anaerobic capacity for all position players; (4) high degree of balance in all positions; (5) high level of static strength for the position of the center and quarterback and low for positions doors, external players and wings; (6) high level of transversal dimensionality of the skeleton and the volume of the body for the players in positions and center-back, while for the players on the goal, wings and external low transversal dimensionality of the skeleton and a low level of negative volume and mass of the body; (7) low negative levels of subcutaneous fat for the players in positions and center-back, and for the players on the goal, wings and outer secondary negative level. Gusić, Lozovina & Lozovina (2003) found that the structure of the movement in the vertical and horizontal phase in a water polo, and considering ways, intensity, frequency and time as equivalent load the game it is possible to analyze the differences between players with different tasks defined roles center and wing. Center marks and the wing frequencies of duels, frequencies with players more / less, time spent in duels, and quantity of light swimming. Winger defines and differentiates from the center frequencies of maximal and sub maximal swimming, quantity of meters in maximal and sub maximal swimming and total time spent in the game with player more / less. Platanou (2004) conducted a study with the purpose of classification and quantification of activity during the game to playing positions in elite water polo. The sample consisted of 48 water polo (16 centers, 18 attackers and 14 fullbacks) players. The results indicate that the frequency and duration of activities significantly depend on the playing positions. Lozovina, Lozovina & Pavičić (2007) reported differences between positional game in the vertical and horizontal phase during matches in situational conditions with regard to methods, intensity, frequency and time as equivalent for effort. Were determined and explained the differences in five different positions, and associated with a number of actions, levels of load and the amount of movement in the horizontal and vertical stage of the game.

Light defenders and centers each are significantly different in the maximum and hyper maximum loads in a vertical stage of the game. Such loads are statistically different from severe defenders, wingers and attackers. What are common severe defenders, wingers and attackers, and what do not differ much time is spent in the game with player more / less, all modes of swimming, swimming all intensities and total number of shares. This for them typical loads them statistically significantly different from the light guard and center. Common to all types of players in the total amount of swimming and shares a light swim. D'Auria & Gabbi (2008) on the basis of the collected video clips from the 13th FINA World Cup of 2002 conducted a study with the aim of classification and quantification of technical and tactical actions during a match in elite water polo team to playing positions. Based on the results it was concluded that the frequency and duration of activities significantly depend on the playing positions in women's water polo. External player in the most marked amount of swimming, while central attacker in comparison to other positions in the field most of the time spent in contact with an opponent. Embracing research based on determining the differences and similarities regarding positional water polo, were established and explained the differences with regard to the quantitative indicators of activity in the situational conditions. Also identify the differences and similarities of certain positions in water polo with regard to practical and functional abilities and morphological characteristics. Scientific-technical assessment of the quality of top athletes is very complex in collective sports games.

The reason is multi-factorial nature of complex sports activities where it belongs and water polo. In the context of empirical research Lozovina (1983) suggests that to assess the quality of water polo can be applied two measurement procedure, relating to the assessment of toys success in offense and in defense. Based on expert judgment by five independent experts and coach first national league, are given grades on a scale from 0 to 5 points. The scores are related to the value of every single player on the basis of an assessment of situational performance and real quality players in the defense and stage attacks on positions in water polo game. The rating is success in offense related to the presence or absence of the following characteristics: properly perform technical elements; efficiency with a player more; tactical setup of the game; success in the implementation of this general impression. Rating successes in the defense referred to the following characteristics: properly perform technical elements; Duel-game; blocking, covering, counterattack; tactical setup of the game and the general impression. Šimenc (1993) defined the assessment of real quality evaluation of water polo coaches of all 12 clubs first national water polo league. Based on the monitoring of 22 primary circuits, coaches are experts of each player assessed a unique mark that contained all the

relevant traits and abilities that determine the actual quality of the player: technique in defense and attack, tactical maturity and physical preparation. The scores are presented to 1-5 on the way to grade 5 is a top class player, score 4 above average players first national league, score three average players score two sub-par players first national league and score one player of such quality that does not deserve a place in the team, which competes in the First federal League. Elbel and Allen (1941) proposed a method for assessing individual and team success based upon the registration of events in the game (success factors) that have a positive or negative impact on the final result. Each factor was subjectively evaluated scores proportional importance in relation to their contributions. Unfortunately, no data collected on the opposing team during the match, nor is the process of data collection implemented consistently across three competitive seasons. Furthermore, it was found that many of these factors often appear in the game, so it is likely to affect the outcome of the match.

They therefore consider that the proposed model can be used in evaluating the performance of individual players and teams. In addition, they already distinguish individual and team aspect of the game (the contribution of individual player's situational performance area) which enabled better analysis of basketball games. Pavičić (1991) proposed an innovative approach to solving modal kinesiology problems, especially in the field of sport games. It was based on the empirical analysis by the model in water polo games in relation to the basic elements of the registration of the game and the technique and tactics. Join the game established image or series of images which give the action, and spatially defined positions of the objects it contains. Besides the position, location, determine: object type, zones of influence, the movement of which is defined direction, radius and typical lines of movement. For object player, defines the terms: position, orientation and equivalent energy consumption. Elements of the techniques grouped into two basic categories: the different types of movement which the subject is moving in space and elements of movement for the ball. Tactics is also divided into two levels: global, which refers to the overall local and tactics related to the partial situation in the game. Thus mounted model that forms the basis in formulating expert systems is described established vocabulary water polo languages with established variables that define situations and certain relations situations and actions.

#### *In basketball*

Blašković & Milanović (1983) to assess the quality of basketball players used the following criteria: (1) its efficiency techniques - defined by the degree of acquisition and sophistication of motion structure that ensures the rationality of basketball players' movements from the viewpoint of kinematic and dynamic parameters;

(2) an assessment of the performance of players in the attack phase - is intended for the assessment of a player's ability to meaningfully aligns own actions (with the ball and without the ball) with the offensive actions of the team; (3) evaluation of the performance of players in the defense - for the evaluation of maneuverability and harmonious action of each player within the different types of defense activities of the team; (4) evaluation of individual creativity - the result of the creative activity of players in the game, especially from the standpoint of the level of improvisation defensive and offensive actions within the set strategic fit; (5) evaluation of responsibility - is defined by the degree of tactical discipline than the agreed method of play; (6) score of engagement in the game - is the evaluation effort, sacrifice, and the scope and intensity of movement in the course of the game; (7) ratings of behavior - for the assessment of a player's ability to control his own behavior in an emergency, as well as assessing the tendency to provoke an incident situation; (8) a general assessment of the success in the game - based on the general impression of gaming quality for each participant. Dežman (1993, 1993, 1996) developed a model of expert system that covers the most important factors that directly affect situational success playing basketball. The model is usable in most of selecting younger players and in monitoring the success of training. Swalgin (1994) proposed a system of evaluation of performance of individual players named Basketball evaluation system (BES) bearing in mind the structure of basketball game and the necessity of specialization of players with regard to the position in the game. Furthermore, in particular the specific standards for evaluating performance of an individual player with regard to the place and role in the game. Ivković (1995) analyzed the correlation between variables to estimate the speed of keeping the ball and successful game players. A sample of the seven criteria variables intended for assessing the performance of players is as follows: score success techniques, evaluation of the success of the game in attack, score performance in defense, score creativity, responsibility score, score and score engagement creativity. The subjects were given a score from 1 to 5, we observed six independent experts to four games. Dežman (1996) to estimate general (global) toys success of junior basketball players used the five categories (grades 1-5) that reflect the level of success playing, responsibility, toys stability or consistency and success playing in the older age group. Erčulj (1996) on a sample of 25 players at the cadet level conducted a study to determine the prognostic validity index of absolute and relative efficiency (proposed Dežman, 1993) to assess the quality of basketball players, as determined by judgmental five basketball experts with a high degree of objectivity (0.93). It is found that the index of absolute efficiency successful measure of the quality of basketball players ( $r = 0.83$ ) than the index of the players efficiency ( $r = 0.62$ ).



Erčulj (1997) on a sample of 22 cadet national team Slovenia who have competed at the European Championships, assessed the relations of morphological - motor potential (estimated by ND and DEX expert systems) and the performance of players (estimated grades from 1 to 5 of the pilot and main trainer) and situational effectiveness player (estimated absolute and relative index toys efficiency, according to Dežman (1993). There was: a high correlation between the results obtained by both expert system, a high correlation between the results of morphological - motor potential and success in the game, medium high correlation between morphological - motor potential and index of absolute efficiency in the game. The correlation between the performances of players with an index of absolute efficiency in the game amounted to 0.79 with an index of relative effectiveness in the game 0.58. Gréhaigine et al., (1997) proposed an original process of assessing the performance of individual players in the attack in a variety of team sports (basketball, handball, rugby, soccer, volleyball). They defined two derived indicators: efficiency and volume of the game, a combination which gives insight into the real toy success, based on the study of the action of players during the match. This study recommends the use of general monograms in different team sports to reach individual results situational performance combining both indicators. Knowing the results of the assessment is imminent process of teaching learning because each player faces the strengths and weaknesses of your game that encourages problem solving approach understanding of the game of basketball, and thus the development of tactical thinking. Described the assessment process focuses on the events and actions in the game, which reflect the success of situational player, can be detected during the game and serve as a feedback for the correction of the game, and thus to improve the overall performance of situational team. Swalgin (1998) conducted a study to determine the validity of the two models for the assessment of situational effectiveness in basketball. The first model is a computerized statistical model based on the normal distribution. This model evaluates the effect of players based on nine indicators of situational success in the game and the overall assessment in terms of the position in the game and the time spent in the game. Ratings for each indicator situational performance and overall performance are on a scale from 0 to 4. In the framework of this research group of top basketball coaches (n = 18) rated the overall effect of 45 players in the NCAA - league on Likert measurement scale, where: A = 4.0; -A = 3.67; + B = 3.33; B = 3.0; -B = 2.67; + C = 2.33; F = 2.0; C = 1.67; + D = 1.33; D = 1.0; -D = 0.67; F = 0.0. The second model evaluates the total performance of players on the basis of weighted indicators of situational performance which is a group of top basketball coaches (n = 18) evaluated the importance (weighting) in terms of the position in the game.

Another group of top basketball coaches (n = 18) rated the overall effect of 45 players in the first division. Results obtained performance of the players subjective assessment of 18 top basketball coaches have been correlated with the impact assessment in particular the first and second model. A statistically significant correlation in both cases (0.76 and 0.79). Trninić, S. (1995) in the thesis: "Structural analysis of knowledge in basketball game" in his structuralist approach to knowledge in basketball game represented as a binary tree. The basic categories of trees are hierarchical perspective: strategy, tactics, game state, jobs in the game, and the basics of the game and the elements of basketball technique with individual tactics. The central interest of the work is in the business of the game, which are defined as an ordered series of base game, a basketball game itself as decorated a number of tasks in the game with compiled a list of 79 tasks in the game that are described with 15 primary and 8 specific attributes. These attributes are representative describe the knowledge of the basketball game. Values of individual attributes were obtained on the basis of the acquisition of knowledge ten qualified basketball experts applying for this purpose constructed measuring instrument in the form of a questionnaire. Thus accumulated knowledge, the author analyzes the different aspects. Factor analysis determined the existence of four factors in the area of basic attributes, which is called: internal players, external players, and subspace field (C), and in the area of specific attributes of the three factors, identified as: an information component, the energy component or the intensity of the game, and sociomotor interaction. In the analysis tasks in the game which are the basic objects of interest in the work, the author opts for separate analyzes for the primary and specific attributes.

The analysis of grouping and subsequently canonical discriminate analysis, in the space of basic attributes of the author establishes the existence of four homogeneous groups of tasks; (A) work conducted internal players in the field zones A and B, and in the transition and set the attack, (B) operations performed by the internal players in zones A and B, in the backcourt and in transition and the set defense, (C) jobs performed by external players over the total area in the front and back of the field, and in the transition and the set defense, (D) activities performed by external players over the total area, the front and rear of the field, and in the transition and set the attack. In the space of specific attributes is determined by the existence of three groups. The first group (A) are jobs that require high energy component, low sociomotor interaction, as well as a low information component; the next group of (B) are jobs that require above average information component, somewhat lower energy component, and below average sociomotor interaction; in the last group (C) are jobs that require a high sociomotor interaction, low energy component, and mediocre informational component.

The author concludes that the results confirmed the hypothesis on how to structure knowledge in basketball game on the model of hierarchical binary tree of knowledge. The paper found that jobs in the game as entities bring in qualitative and quantitative terms detailed information on the collective body of knowledge about the basketball game. It is established that grouping in the area of basic attributes of the game clearly indicates the correspondence in the grouping based on the criteria phase flow of the game with the states in play that are in the model (tree) positioned above tasks in the game. Grouped according to the criterion position and role in the game clearly correspond with the category skill games. From this he concludes that it found that the tactics primarily reflects the division of roles and tasks to individual players in the game concept and designed a series of organized and mutual action in all phases of the course of play, with the purpose of achieving the set goals. Trninić, Perica & Dizdar (1999) starting from professional synthetic and analytical understanding and observing the reaction of players in the game, established criteria, define and describe the external benchmarks for assessing the performance of toys in different situations in the game. They proposed seven criteria for assessing the quality of the current top players (real competitive ability) in the phase transition and positional defense and twelve criteria for assessing the current quality of top basketball players in the transition phase and positional attack. Criteria for assessing the actual quality of basketball in the phase transition and the set of defense are defined as: the level of pressure in defense; assisting in the defense; blocking a shot, winning balls, rebounds success in the defense; success in transition defense; ability to play at multiple positions in the defense. Criteria for assessing the actual quality of basketball in the phase transition and set attacks are defined as: control of the ball; passing skill; run the ball; shot with external position; shot with internal position; free throws; extortion personal fouls and implementation; making successful blocks; attack without the ball; Ski Jumping success in the attack; success in the transition attack; playing at multiple positions in the attack. Trninić and Dizdar (2000) are by subjective assessment of 10 prominent basketball experts using the AHP - method (Saaty, 1996) identified the importance of pre-defined criteria with respect to the positions of the players in the game. This criterion system was hitherto most detailed and are determined coefficients and weighting of the criteria in terms of the position players in the game, with a very high degree of agreement (objectivity) experts (from 0.91 to 0.98). Trninić, Dizdar & Dežman (2001) are set and empirically verify the expert model for efficient routing of basketball players at certain positions or roles in the game. The sample consisted of 60 randomly selected players (12 for each position in the game) from 12 clubs of the first Croatian basketball league in the 1998/99 season.

Data were collected from 10 basketball coaches, who estimated the performance of players in the defense (7 variables) and attacks (12 variables), established by Trninić, Perica & Dizdar (1999). In addition to these variables in the study included the variable body height. Based on the results it is to be used decision-making system can be used as an aid in guiding players to appropriate toys positions or roles in the game. It was found that players have the highest grade of the overall success of toys just for the position in which he primarily played. The biggest differences are present between players who play primarily in positions 1 (quarterback) and 5 (center), and the most serious opportunity to evaluate the optimal position for players who primarily play on position 3 (wing), and then the two positions (shooting guard) and four (power forward). Players in these positions are the most versatile players, so the choices and positions through this system for such a player profile unreliable. Added variable body height proved to be a factor that has the greatest impact on directing players to their appropriate positions or roles in the game.

#### *In football*

A review of available literature scientific and professional papers in the field of football to the amenities that are processed can be taxonomied and grouped as follows: - The influence of some anthropological characteristics on the performance of the game in football; - The impact of football games on the changes of anthropological characteristics of players; - The impact of the training process on the performance of players in the game of soccer; - Construction and evaluation of basic and situational motor tests for soccer players; - The impact of situational variables on the final result of football matches; - Analysis of the efficiency of transformation processes in football; - The dynamics of micro-environment - sociogram methods; - Analysis of movement of players and teams during football match; - Analysis of physiological and functional characteristics of players. Barišić (1996) explored the importance of some anthropological characteristics of the success of players in different playing positions: goalkeeper, central defender, wing defenders, midfielders and attackers.

Based on the selected and measured anthropological characteristics were found and explained by structural differences of positions. Drastic differences were found between the keeper and the players in the field (central defender, wing defenders, midfielders and attackers). Differences were explained with respect to the primary tasks in the game and movement structures which carry out these tasks goalkeepers and players in the field. Matković et al (2003) studied the morphological differences of elite players in relation to their role in the game. Your role within the team proved to be of great importance for the interpretation of morphological data players.

Research was conducted in order to determine morphological differences top Croatian players who play in different positions. The sample consisted of 52 top players (5 goalkeeper, 17 defenders, 21 midfielders and attackers 9) First Croatian Football League measured 13 anthropometric measures. Data were analyzed by descriptive statistics, t-test and multivariate analysis of variance. Goalkeepers were the tallest and heaviest (182.9\_4.3 cm; 80.1\_5.1 kg), and had significantly higher body fat percentage (20.2% vs. 13-15% porters other;  $p < 0.05$ ), while the attackers and midfield players were on average 3 cm lower. Goalkeepers have had longer arms and legs ( $p < 0.05$ ), and the largest biacromial ratio (43.2\_ 1.9 cm). The lowest of all were the attackers (179.2\_6.3 cm), and the lowest values of body fat were found in defensive players (13.9%) and midfielders (14.4%). In conclusion, significant differences in morphological characteristics between players who play in different positions within the teams are established for goalkeepers, especially differences in height, weight and body fat percentage. In the area of psychomotor Aubrecht (1981) investigated the latent structure of situational measuring instruments for the assessment of pace players and thereby extracted four factors: factor maximum speed straight line running, the maximum rate of change of the direction of running, speed control movement and frequency of movement. Gabrijević (1977) on a sample of 32 participants' experimental sports school football, age 11-12 and age 13-14 years analyzed their special and situational abilities. It found that the situational psychomotor tests may well foresee complex abilities in the game. He applied the tests running speed (sprint 20 yards from the place, sprint 40 yards from the place, speed changes direction 4 x 5 m), test coordination in running the ball (SL) and carrying the ball in a semicircle, the tests of explosive strength (high jump, shot head and power rubble), precision shooting the ball foot (straight-line precision shooting targets a shot at the ball) and juggling ball. This test battery was able to define a specific running speed player, the specific precision shooting foot, specific power players.

Gabrijević (1977) conducted an investigation on a sample of 222 top athletes (52 players, 58 handball players, 54 players and 58 male players). A sample of measuring instruments to is made up of 11 psychomotor and four tests for the detection of cognitive and co native functions. Specific psychomotor was represented with 3 special situational tests for each of the sports games. As part of this research and the author's soccer players do we get by and defined the following latent dimensions: neuroticism factor general, the primary factor of intelligence, explosive strength, endurance factor in static and repetitive strength, the primary factor of precision (BEEPolaran: hand-foot) and situational factor precision (BEEPolaran: Elevation - Correction precision). On the basis of the results has defined two types of players:

- Type first - which is characterized by high capacity ball handling and precision over short distances; - Type 2 - which is characterized by highly developed racing abilities (speed, explosive power, precision to greater distance). Linacre (2001) is the basic aim of the research chose estimate for elements of techniques that are manifested in a football game, for the purpose of selection of players for the game on the basic positions in a football game: goalkeeper, defense, midfield player and striker. To estimate the importance of each element techniques for structural analysis and position players, the author used the subjective opinion of football experts. Verdenik (1981) in his work explored the connections between systems manifest and latent motor dimensions with success in football. He singled out the factor situational abilities players. The success of the game explains the separation of latent dimensions with 34% of the variance. Factor situational abilities players participated in the variance criteria with 24% and the speed factor players with 10%. Pocrnić (1999) on a sample of 22 players ( $n = 22$ ) conducted a study to determine the prognostic value, Expert model for routing, selection and monitoring of young players during the training process. Footballers were tested with 14 anthropometric and 16 motor variables. Evaluation and prognostic value of the tests, was determined by applying, computer program TALENT 1.0 and 1.2 SPEX. The success of players during the match, evaluated experts and research results confirm the importance of expert models in the process of routing, selection and monitoring of young players. Gabrijević, Jerković, Aubrecht & Elsner (1983) conducted a study using a quasi (QCR) and quasi regression (SRA) analysis of the relationship of specific-motor abilities of players and score success in football. In the space-specific motor skills Quasi canonical factor largely define the rapidity of the ball, handling the ball, hitting the ball, the power, precision shooting target, and slightly lower speed curvilinear running so this quasi factor is defined as the general ability factor trends players in contact with the ball. In the area of evaluation of the success of the game, resulting quasi factor defines a general assessment of the success of the game, score techniques, creativity and tactics in the attack, and the assessment of responsibility and engagement and the resulting factor is defined as a factor in the overall success of the game.

#### *In handball*

In handball differences in extensity and intensity of cyclic motion activities handball on different gaming sites in the game was treated by Šibila, M., Vuleta, D. and Pori, P. (2004). Load data were collected through computer-supported system SAGIT. The output data were selected by Excel and SPSS. Significant differences between gaming groups with respect to the average distance traveled during the match. Most are running through the wing, then external players, and circular attackers and at least porters.

Differences were observed for an average time of movement at an average speed in all speed categories. For a quick second category were no differences between groups of foreign players, wings and pivot players, but these three groups differed significantly from the past. Statistically significant differences were observed in all four groups, according to the average speed of movement. Vuleta (1997) in his doctoral thesis: "Physical analysis of technical and tactical content handball game" aims to identify and analyze the technical and tactical elements, their classification in groups, an analysis of the differences of these groups, and to determine their hierarchical grouping. The paper is designed and then validated instrument to collect data on the elements about all technical and tactical elements of the collected opinions of experts. Sample entity is made up of 134 handball technical and tactical elements of the game, and each is described by 26 variables.

In the latent space it found three significant dimensions; success in the attack phase, the success in the defense and goalkeeper efficiency. The analysis of hierarchical clustering determine the existence of the following four groups: (A) the technical and tactical elements in the attack without the ball, (B) the technical and tactical elements in the attack with the ball, (C) the technical and tactical elements in the defense and (D) technical tactical elements goalkeeper in Apparent space, and, in the latent space, four groups interpreted as follows: (a) the technical and tactical elements of the past, the basic structure of the element in the defense and attack, (B) the technical and tactical elements in the defense, (C) technical and tactical elements that precede the kicking and the different types of shooting, (D) the technical and tactical elements that are the foundation of the first phase of positional attack or preparing and setting up for the organization of the game.

Canonical discriminate analysis analyzed the differences group of technical and tactical elements and got in apparent space: first the function which is dominated on one side phase flow of the game in the set defense is the other position players in the attack phase (external attacker (playmaker) and line forward. 2. function primarily by the variable phase of Defense (intermediate and ultimate defender) and playground zones (B, C) and the elements without the ball, and at the opposite pole: the attack phase (elements with the ball, field the attack, the attack phase and complexity of performing technical tactical elements, and in third position: on the one hand certain variables inherent to the goalkeeper, and on the other, are attacks (C, B) and the elements in place. in the latent space are also three discriminate functions; first on the positive side the success of the game in the phase defense, and on the negative, efficiency and success in the past phase of the attack, the second on the one hand determines the

effectiveness of past and on the other, the efficiency in the attack phase, third on the positive side of energy use and efficiency in the attack phase. The author concluded that there are three relatively homogeneous and interdependent factors handball games, namely: the success of the game in offense and the defense, and the efficiency of the goalkeeper. Also, it was a hierarchical relationship in contributing to various technical and tactical elements of success in the game. Some conclusions about the priorities of structure movements that describe the function of each typical gaming site in the handball game. The research possibilities formal definitions Games (Pavičić, 1991), chose the approach that the phenomenon of the match breaks down into simpler parts. This procedure was established by a new categorical and concepts in which it is possible to define all the essential features of the game and is able to describe "all actions, all the players, under all possible circumstances" Such basic concepts and definitions of the categories are: playground, tactics, techniques, image, and object. The playing field is bounded space in which to place match. Looking at the space field in terms of tactics games it is possible to divide the space: space attack (A), forming a space attack (A) and space defense (D). This division cannot be fixed to determine the area. From the perspective of the game situation one team may be within this area to determine ranked subspaces.

### Epistemological link

Complexity theory is applied in the fields of natural, social and human sciences in different, sometimes contradictory ways. Some attribute this theory the value of a new paradigm that is emerging as a challenge to traditional Newtonian present world (Thom, 1975, Capra, 1996). Complexity theory deals with the problem of how to fully furnished complex system emerges spontaneously (emerge) from the chaotic situation. In this way, complexity theory and meta-theory combines the theory of disaster and chaos. At about the same time there are two similar theories: the theory of catastrophes (Thom, 1971) and chaos (Gleick, 1987). Catastrophe theory deals with the sudden changes from one minimum potential state of stable equilibrium to another. When a small, almost insignificant contribution significantly, catastrophic, change of state of the system. Catastrophe theory deals with several changes of state of the system from one stable state to another, while chaos explores the unstable state of the system. Chaotic systems are sets of subsystems that are flexible because they can be quickly and unpredictably can switch between different states. Nonetheless, even chaotic systems can be unpredictable, they are deterministic. It can be concluded based on the fact that two of the same systems with the same initial conditions produce identical results. Complex systems are not only complicated static objects, but non-linear, spontaneous and self-organizing systems (Waldrop, 1992).

Such spontaneous emergence of new forms of self-organization is called the emergence of complexity. What theory of complexity makes it unique is its ability to take into account the structure, coherence, and self-organization of such systems. Adjustment (adaptation) is one of the main properties of complex systems. Complexity theory deals with adaptation and awareness of changing circumstances and consequently the production of new solutions (Allen, 1994). Instead of just passively respond to events, complex systems, and the interaction with its environment. In theory, the complexity of systems is viewed as networks simultaneously and in parallel active agents. Same agents should be understood as a plurality that includes both individuals and collectivities. In this way, agents can be both individuals and families, or sports teams, depending on the level of observation. Regardless of the level, such an environment is the product of interactions of agents in a given system. The system consists of constant action of one agent and the corresponding reactions of others. Therefore, the environment is always dynamic. In order to achieve coherence of behavior and adaptation, it is necessary that the agents are dispersed, e.g., decentralized. For the theory of complexity is of central importance to the coherent behavior can only come as a result of constant competition and cooperation of agents and given environment (Waldrop, 1992). In any adaptive complex system can be many organizational levels. The individual agent in various one will be so only a building block from which was built in the second to the next level. For example in collective sports games, one player will at one level of observation to be an agent, while the next several such agents - players do new agent that can be e.g. subgroup for his role in the game, eg defenders, while in the following all agents subgroup for her roles do collective agent teams. Complex systems continuously and in accordance with the learned lessons revise and reformat your building blocks on each level and in a similar way as it happens with modification, reorganization and adaptation in the evolutionary process. How it sees Waldrop (1992) was that it is a cell, neuron, body, politics or the economy, the processes of learning, development and adaptation are the same at all levels of the organization.

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Complexity theory and its subject looks unpredictable and creative emergence of order from the chaotic situation in the natural biological, cultural, social, and other systems. Adaptive self-organization occurs in the population through the exchange and interaction of independent agents through competition and cooperation that them into a state of increasing interdependence, and that will lead to emersion of new structures. This emergence of new structures in addition to rising levels of complexity and sets the foundation for establishing a new level of complexity.

## Conclusion

From a wider repertoire of scientific papers in the field of water polo, basketball, handball and football in our country and the world, we have conducted the selection and analysis of scientific papers preferring primarily state that the achievements at the Olympics, World and European Championships in the collective sports games, and for which would be "school" could be said to have a similar, but different, approaches to understanding, accessing, analyzing, methodical and methodological approach to the issue of collective sports games. From the analyzed content should be noted that the data collected by different methods, while the methodology of data processing were the same or very similar. In scientific papers in the field of team sports in our country and in the world, there is no systematic quality and identical orientation towards solving common problems, and treatments are generally partial.

The only authors who are systematically access the formation of the model of collective games, to our knowledge, were Pavičić and Trninić. Unconstitutionality and partial entry in the scientific analysis of collective sports games in Croatian authors consequence of the approach based on equations specifications collective sports games, which is the Croatian scientific kinesiology approach to present today, and since the early seventies. It is obvious that a new scientific paradigm in the study of collective sports games because previous studies have not offered sufficient and insufficient for optimal modeling of collective sports games.

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## ISTRAŽIVANJA KOLEKTIVNIH SPORTSKIH IGARA U PODRUČJU KINEZIOLOGIJE I SPORTSKE ZNANOSTI U SVIJETU I U HRVATSKOJ

### Sažetak

*Odabirom reprezentativnih znanstvenih radova u četiri kolektivne sportske igre (vaterpolo, košarka, rukomet i nogomet) pokušali smo rasvijetliti konceptualne i metodološke pristupe domaćih i stranih autora-znanstvenika u proučavanju fenomena kolektivnih igara. Različite škole (engleska, francuska njemačka i hrvatska) imaju različite koncepte ali vrlo slične metodološke pristupe. Zajednička karakteristika im je da su im analize uvijek parcijalne, nikada sveobuhvatne, pa iz takovih analiza i nisu mogli proisteći modeli potrebni i neophodni za usavršavanje navedenih kolektivnih sportskih igara. Pretpostavljamo da je tome razlog „robovanje“ jednadžbi specifikacije sportske aktivnosti, posebno kod hrvatskih autora. Mišljenja smo da je potrebna nova znanstvena paradigma u proučavanju kolektivnih sportskih igara jer dosadašnja istraživanja nisu ponudila dovoljno i nedostatna su za optimalno modeliranje kolektivnih sportskih igara.*

**Ključne riječi:** kolektivni sportovi, koncepti, metodološki pristupi, nova paradigma

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