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# STRUCTURAL ANALYSIS OF KNOWLEDGE BASED ON SPECIFIC ATTRIBUTES OF THE GAME OF BASKETBALL

**Abstract**

The purpose of this work was to determine the structure of latent factors, to identify and analyse groups of game tasks under specific attributes and variables, to classify the tasks into relatively homogenous groups, and to determine the differences between the acquired groups of tasks. In order to achieve the above mentioned it was necessary to construct a measuring instrument (questionnaire) for the registration of knowledge in the game of basketball. For the characterisation of entities, 16 specific attributes were chosen, according to which ten competent experts performed the assessment. Within the research space, factor analysis under component model was used, along with Guttman-Kaiser criterion and OBLIMIN rotation. Three latent dimensions in the space of specific game attributes were isolated: information component, energy component (game intensity) and socio-motor interaction.

Along with factor analysis, hierarchical method of classification was used, where the tasks in the space of specific game attributes were classified into three homogenous groups. In the space of specific attributes three groups were acquired and they were interpreted as A, B and C.

- Group A – tasks that demand high energy component, low socio-motor interaction and low information component,
- Group B – tasks that demand above average information component, a bit lower energy component and below average socio-motor interaction and,
- Group C – tasks that demand high level of socio-motor interaction, low energy component and medium information component.

Objectively scientifically arranged groups of associated data can directly influence the creation of curriculum and syllabus for basketball players training, evaluation of players' performance, and they make the foundation for the realization of further researches in the field of team sports games analysis.

**Key words:** TASKS / ATTRIBUTES / EXPERTS / FACTOR ANALYSIS / CLUSTER ANALYSIS / DISCRIMINANT ANALYSIS

## INTRODUCTION

Basketball is a team sports game that can be presented as an arranged sequence of tasks (Trninic, 1995, 1996, 2006; Dezman, Trninic, & Dizdar, 2001; Trninic, Karalejic, Jakovljevic, & Jelaska, 2010). Further, contemporary basketball practice shows that, on the level of individual and collective tactics, game plan in the match is accomplished by performing game tasks. The description of game tasks presents a group of principal and specific basketball knowledge arranged in time (Trninic, Trninic,


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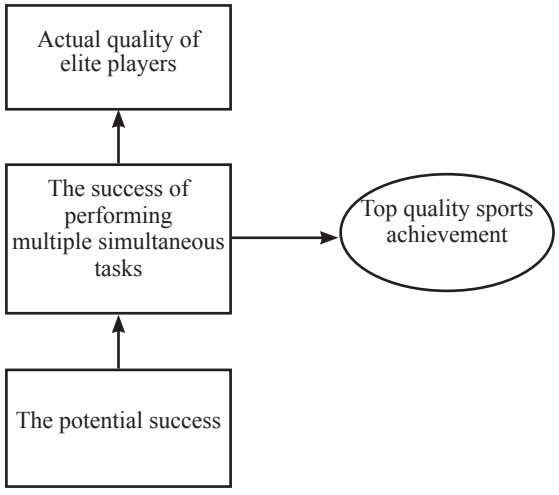
& Jelaska, 2010; Trninic, Karalejic, Jakovljevic, & Jelaska, 2010). Systematic studying of demands in one basketball game position precedes the attempt of rationalization of directing technical-tactical preparation (Trninic, Dizdar, & Jaklinovic-Fressl, 1999). Principal techniques of coaches and scientist–practitioners are systematic observation of players during their technical-tactical activities, directed interview with an elite player of certain position, and structured interviews with managers that are familiar with the game structure. It is important to point out, from the point of evaluation of actual quality of players, whether certain player successfully performs tasks in all phases of game course, and to what extent certain player can and/or helps in the system of assisting in the game (Trninic, Perica, & Dizdar, 1999; Trninic, & Dizdar, 2000; Trninic, Dizdar, & Dezman, 2000, 2002; Dizdar, 2002). Thus, the development of the game of basketball is linked to the growing complexity of game tasks that require various skills, abilities and specific features that directly influence the success in the game (Trninic, Jelaska, & Papic, 2009a, 2009b; Trninic, Kardum, & Mlacic, 2010).

The tasks can be analysed according to various specific attributes of the game of basketball like: complexity, different forms of significance, tasks realization speed, players' position on the court, position with regard to the ball, opponent and basket, game overview, aggressive tasks realization, realization responsibility, cooperation in game tasks realization, communication in tasks performance, game tasks risk, and its energy and information demand (Trninic, 1995). Every game task demands principal and specific characteristics that connect and cover all the aspects of the game of basketball (Trninic, 1995; Trninic, Perica, & Pavicic, 1994).

In elite basketball, success of simultaneously performing multiple game tasks has special significance in direction and selection within certain positions (Trninic, 2006). On the other hand, in the context of managing the development of elite athletes in team sports, it is important, besides being successful in simultaneously performing multiple game tasks at certain position, to determine set of predictors (variables of potential success on the basis of which diagnoses and prognoses of players' success is conducted) which determine the development level of principal and specific abilities, features, knowledge and skills that are responsible for successful performance of game tasks (Trninic, 1995, 2006). Trninic, Trninic, & Papic (2009), Trninic, Jelaska, & Papic (2009a, 2009b) suggest, from the point of view of situational approach, expert coaches and scientist-practitioners, that based on success of simultaneous performing multiple game tasks of prediction and criterion variables, selection of top players and teams should be conducted (Picture 1). It is important to point out that the demands of high class team sport are directed to the connection of individual and team game, general and specific tasks, individual and collective responsibility and efficiency. It is probable that hypothetic ability of simultaneously performing multiple tasks in certain team sports game is the most important feature of elite players and both individual and team performance and top sports achievement depend on it (Picture 1).

Picture 1 Ability of simultaneously performing multiple tasks in certain team sports game is the most important feature of elite players and both individual and team performance and top sports achievement depend on it




Hernandez (1987) in his own dissertation specifically analyses game actions, specific game attributes from the point of cooperation – confrontation. Further, he states that the development of game action is the consequence of motor interaction among opponents, where team mates cooperate between themselves and the opponents confront this cooperation with the intention to achieve favourable result (Trninic, Papic, Trninic, & Vukicevic, 2008; Trninic, Papic, & Vukicevic, 2008). He covered theoretical model of game action analysis and the study of

methodology that enables registration of complete parameters that directly affect the game of basketball. These parameters he defines as: technical actions, game rules, game space, and motor communication and motor strategy. Also, he sets the following premises: motor abilities enable a player to learn and realize the technique, basketball game technique represents the instrument for the realisation of game actions, and group of game actions and the connections between them make structural system of the game of basketball. It is probable that the structural complexity (number of actions and their complexity) of the game of basketball, as well as selection of one out of several possible game actions, recognizing the opponents' attentions and prediction of game course are more demanding in the game of basketball then in sports of small or medium complexity. Hernandez (1987) claims that the decision capacity, regarding the complexity of the game of basketball, is a primary system that determines game situations solutions. It can be assumed that the game of basketball demands knowledge structure made of all elements of the game, strategy and tactical variants which are accomplished by game tasks and have to be organized in optimal and system way (Trninic, Papic, & Trninic, 2010). He makes the following conclusions: studying the development of game action from the aspect of technique-tactics and defence-offence, is shown to be inadequate to comprehend completeness of the development of game action and parameters that make the game action. On the other hand he observes cooperation/confrontation as a new model of analysis and he marks specificity as a confrontation between opponents (Trninic, Trninic, & Papic, 2009, Trninic, Jelaska, & Papic, 2009a, 2009b). Also, Javier (1992) states that the game of basketball can be reduced to parameters: space and subspaces of the court, ball, game time, score counting, goal (basket), game rules, level of motor interaction, technique, tactics and strategy.

Ferrari et al. (1991) observe uniqueness of motor skills through two types of knowledge: practical and conceptual knowledge. They state that the practical knowledge kept in prototype sets that are called skills, schemes and motor programmes, is inherent in the activity itself so it is not represented in conscious memory. Conceptual knowledge represents information about adequate circumstances where a certain motor scheme can be applied, so it is available to conscious memory. In connection with that, conceptual knowledge can refer to two groups of cases: individual past experience of movements performance, which requires activation of information stored in long-term memory and using of individual general cognitive abilities in determination of necessary characteristics of the intended movement related to intended or given goal.

The aim of this study is determination of structure of latent factors, identification and analysis of the group of game tasks within the group of specific attributes or variables, classification of tasks into relatively homogenous groups, and determination of differences between the acquired groups of tasks.

## METHOD

Basketball literature, coaches, scientists, players and others who study the game of basketball are the carriers of basketball knowledge. Among them, it is possible, on the basis of previously set criteria, to determine those who can be called **basketball experts**. Expert opinion is one of the most relevant ways of analysis and evaluation of events in basketball match and game quality of individuals – basketball players, so it is used in scientific works as a reliable criterion (Brooks, Boleach & Mayhew 1987; Swalgin 1993; Jakovljevic 1995; Karalejic 1996; Trninic, Dizdar & Dezman 2002, Jakovljevic, Karalejic, & Radovanovic 2007). Basketball expert can only be a person who was a basketball **coach** or a **player**. Principle criteria, according to which basketball experts were determined in the research, were the following:

- Expert – **player** had to be a member of a team that won first place on some European club championship (EuroCup, Champions Cup, Radivoj Korac Cup), a member of national team that won one of the medals on European Championship, World Championship or the Olympic Games.
- Expert – **coach** had to have the status of coach of a team that won the first place on some European Club Championship (EuroCup, *Champions Cup*, Radivoj Korac Cup), coach or member of expert staff of national team that won one of the medals on European Championship, World Championship or the Olympic Games.

Ten experts participated in this survey; five of them were players and five coaches.

***Sample of entities***

In this survey, entities, i.e. holders of information, are game tasks. The sample of tasks was determined by the following criteria: present theoretical annexes that contain some divisions of game tasks, game systems that classify the tasks and present own experience in high class basketball practice. On the basis of these criteria we came to a large number of tasks (159), which was a practical obstacle for carrying out research of experts' opinion. By additionally structured interview with experts, second selection was made which gave the list of 79 tasks. Considering the space of research, they covered all important aspects of the game of basketball. Having in mind the fact that the total knowledge in the game of basketball with all its structure is most distinctly reflected at the level of game tasks, they are taken as entities by which the corpus of basketball knowledge would be best analysed. The analysis of specific game attributes was made for that reason.

***Specific attributes and variables***

The group of specific attributes and variables that the experts estimated are: complexity, various types of significance, speed of task realization, players position on the court, position according to the ball, opponent and basket, game overview, aggressive game tasks realization, realization responsibility, cooperation in game tasks realization, communication in tasks performance, game tasks risk, and its energy and information demand. These terms are actually functions that would provide planned quantification of some aspects of experts' knowledge about basketball tasks. For the purpose of understanding expressions and experts' coordination, i.e., obtaining methodologically correct research conditions, every attribute was developed and explained. Game tasks were assessed on ordinal scale, graded from 1 to 5 (attributes under ordinal numbers from 13 to 27. Values of certain scale modalities in these attributes were defined by definitions from Table 1 (Trninic, 1995).

Table 1 Values of certain scale modalities

| Mark | Description of modalities |
|---|---|
| **1** | attribute has no effect on the job in the game |
| **2** | slightly important attribute in the job in the game |
| **3** | attribute has medium importance in the job in the game |
| **4** | important attribute in the job in the game |
| **5** | attribute is extremely important in the job in the game |

As different from the scale from table 1, attribute complexity (under number 12.) was estimated on ordinal scale graded from 1 to 10.

**Game tasks complexity** is, from the point of view of needed knowledge, in positive correlation with the amount of details and finesses that a certain task contains. For that reason, complexity, in a way, contains marks of all remaining attributes. However, the nature of this relationship is not linear. For example, from the point of view of information complexity, it is easiest to point an open shot. It is assumed that, from the point of hierarchy, the least complex situations in information order are 1 on 1, 2 on 2, 3 on 3, and the most complex are 4 on 4 and 5 on 5. So, this attribute is not simple sum of values of other attributes. It is assumed that the mark of complexity is the mark of totality of a given task and it is valued on the scale from 1 to 10, so that the tasks that, according to experts' opinion, have higher totality get higher values on the scale. The lowest complexity is marked with 1 and the highest with 10.

**Game task significance** can be, according to basic components of successful achievement of every game concept, dismembered to the significance for: game intensity control, game results control, solving game situations in due time and continuity of game course. Therefore, we are interested in to what extent every individual task in the game of basketball reflects on: intensity control (tempo changes in the game), solving situations in the game (from the point of space-time adjustment, it can be on time, early or late), continuity of game course that makes uninterrupted transfer from one phase of the game to another and results control.

**Speed of task realisation** in the space of basketball court is very important. Success in high number of game tasks is accomplished by quick actions in a relatively small space for individual action of players (42 $m^2$ on average). In basketball it is important to perform movements and actions with the greatest speed or speed change, when the movements of offence or defence player are alternatively speeding up or slowing down with the purpose of putting an opponent player out of balance. For example, among supreme guards there are players who quickly perform tasks of transition from back to front attack field, but slowly perform tasks in the final phase of actions. On the contrary, there are guards that are slow in initial phase of transition from defence in to offence, but significantly quicker in final stages of actions. For that reason the speed of performing game tasks should be observed and assessed in the context of situational value especially as the ability which is integrated into technique, individual, group and collective tactics. Such comprehension of this attribute which is used to evaluate game tasks includes also game understanding. We believe that anticipation of the opponents and co-players' action and determination and ability of execution primarily determine speed of tasks performance. It is assumed that the speed of space and situations observation, the speed of reaction and the speed of turning tactical thinking into motor execution are the three types of speed that are mostly reflected by the speed of game tasks performance. The speed of game tasks performance is undoubtedly specific speed quality of players. Specific synthetic character of 'basketball speed' separates this attribute from simple motor speed.

**Player's position on the court** is a court position occupied by a certain player. It is valued according to the possibilities of solving certain game tasks. The position of a certain player on the court determines formation and space between players, so it is a condition for defence and rebound balance and proper time reaction in the game.

**Player's position according to the ball, opponent and basket** during evaluation of game tasks, should basically show what their importance is for the tasks that exist in the phase of transition and set defence. For example: keeping relation between the ball and offence player, between the ball and the basket and between the basket and the opponent, or in the phase of transition and set offence, for example, the selection of the position between the ball and defence player or between basket and opponent is important.

**Game overview** is the ability of a player to use visual field in a way to create total image or sequences of images in the game, which covers the ball, co-player, opponent and basket. The term image is defined as principle category of game registration, and game course as a set sequence of images. Every offence player must see the other nine players, especially direct opponent. Only in the case when he has good game overview, can he successfully solve and realise certain game situations. Observation skill depends on the amount of players' 'concentration', and to what extent they spot they own and opponent players, and also 'holes' in the opponent's play (spotting of players' positions in space). Successful solving and realisation of certain game situation will depend on these factors. Game overview can simply be interpreted as a player's ability to see contours and movements of the player and the ball that are in direct line in front of him or peripherally.

**Aggressive game tasks realization**, i.e. the intensity of 'attacking' the opponent is very important in game tasks performance. For example: to attack offence player in transition and set defence (by pressuring the ball, pressuring movement and pass lines), because defence has to dictate entrances and flow of movement lines in transition and set offence or 'to attack' defence position and its weak sides. Aggressiveness in entrance and movement lines flow during the offence is the imperative of contemporary basketball, and also are the tasks that enable it. The amount of aggressiveness that is necessary for successful performance of given task is assessed in this attribute.

**Responsibility for game task realization** is necessary in every game task. Behaviour criterion is extremely important. Every player is obliged to follow the set game concept and solve problems according to this. Responsibility is a general criterion, set by game concept. For example: the criterion of set offence can be ball control until the desired open shot. Every player has its game role that requires fulfilment of obligatory game tasks for the purpose of reaching competition goals.

**Cooperation in game tasks realization** implies certain cooperation modalities in every phase of game course. In that sense, successfulness of some task realisation can be more or less dependent on cooperation. The tasks that can be performed individually are expressed by mark 1 on the scale, while tasks whose performance is conditioned by mutual action are expressed with mark 5.

**Communication in game tasks performance** is necessary in an organized game with collective competition and demands for balance between defence and offence, and in most game situations the communication has to be quick. The communication can be verbal or non-verbal and it is directly reflected on increasing game organization speed. Communication in performing all tasks in transition and set defence is not just the first rule for adjusting defence position in relation to the ball and the opponent, but it is also the condition for 'future' game reaction. Besides, communication is very important for performing game tasks in transition and set offence with entrance speed, movement line flow and in solving and realisation of certain game situations. The need for communication is not equal in all game tasks, so the tasks for which communication is more important will be marked with higher values on the scale.

**Game tasks risk** is decreased in an organized game and the responsibility of certain players is increased. In a free game, risk is increased while responsibility is decreased. For example: unorganized transition offence with long pass is more risky than transition offence with two passes or than dribbling the ball through the middle. Probably the most risky are the game tasks that enable 'breaking' organized entrances and movement line flows, as well as tasks that do not allow more than one shot in offence (they carry greatest danger for losing defence balance or for irregular game contact). For example: if a player starts movement in basic defence stance for one second before the ball moves, he will surely lose defence balance. Or, if he goes one second after a passed ball starts moving, in large number of cases he will find himself in a situation of personal fault. So, early or late timing disables successful performance of game tasks and increases risk degree. It is evident that to a certain extent risk can be foreseen and determined. Besides the risk of choosing specific task in given situation and the risk of tasks itself – not depending on the situation (which is the subject of our questionnaire), there is a concept risk made by principles on which it was founded, for example, defence system.

**Game task demand** refers to energy and information component. Task demand according to quantity and movement intensity is expressed by energy component. Information component consists of an amount of necessary technical-tactical knowledge for successful game task performance.

### *Quantification procedure of experts' responses*

In the space of specific attributes quantification is carried out by simple joining the appropriate ordinal scale values of registered response of experts.

### *Measuring instrument analysis*

Term measuring reliability stands for formal methodological parts of scientific research which can be used to check scientific procedures and contribute to more objective research. In the construction of measuring instrument, attributes and variables are structured within one whole. We can mark them as **specific attributes**. Specific attributes are derived on the basis of certain hypothetical latent dimensions and game tasks performance depends on them.

### *Data analysis*

Data analysis was planned to enable determination of structure of basketball knowledge corpus and to check the construction of measuring instrument for gathering and registration of expert basketball knowledge. In the rows of data matrix, which was subjected to analysis, are the carriers of information – entities (tasks in the game of basketball). In the columns of data matrix, every task is described by the line of attributes or variables. Attributes of objects are most commonly described as coordinate axes in multidimensional space. Within this space, entities are represented as points. The degree of agreement of experts' opinion about unique subject of measuring was determined by reliability coefficient *alpha.* All attributes which were shown not to achieve satisfactory agreement in experts' opinion, were excluded from further analysis. In the work we applied analysis which determined basic indicators of validity and reliability and also inner consistence of variables: RMS

– estimation of common variance amount, Cronbachov alpha – reliability measure, MSA – sample adequacy measure, and MACOV – minimal amount of common covariance.

Factor analysis is used as a help method for discovering theoretical or constructive validity of the questionnaire. Significant number of factors was determined according to GK – criterion (Guttman – Kaiser) of correlation matrix of observed variables. Final factor solution was acquired by the application of OBLIMIN - leaning rotation and matrices of parallel projections (set) and orthogonal projections (structure) as well as the matrix of correlation between factors were calculated. The result of the group of experts' opinion for all attributes in the analysis was determined as Z-score on the first main attribute component.

In the analysis of inner tasks structure, group analysis as a formal algorithm study and method for grouping or classification of objects was used. The object was described either by group of measurements (attributes) or by its connectivity with other object. The aim of grouping was to find reasonable and valid way of data organization. Grouping analysis is the process of sorting objects into subgroups that make sense in the context of a given area. After procedure application, the objects were organized in an efficient representation that describes the population where the sample was taken from. Grouping is a type of sorting that is applied to final group of objects. The objects were presented as points in dimensional metric space, and the closeness of pairs of objects was expressed by Minkovski metric as Euklidean distances (Jain, and Dubes, 1988). For the grouping method, the sorting in non-overlapping subgroups of intrinsic hierarchical type – exclusive intrinsic hierarchical grouping was chosen. Sorting objects into groups and graduate gathering of those atoms forms larger and larger groups until all objects become one group (cluster).

For the purpose of clearer determination of differences between the set groups in the space of attributes or variables, we used canonical discriminative analysis which, by the structure of discriminative functions and position of group centroids on discriminative function, most briefly shows differences between the set groups.

# RESULTS AND DISCUSSION

### *Metrical characteristics*

Table 2 shows principle indicators for determining metric characteristic of specific attributes or variables.

Table 2 Metrical characteristics of specific attributes-variables.

| VARIABLES | RMS | ALPHA | MACOV% | MSA |
|---|---|---|---|---|
| **SLOZEN** | .311 | .810 | 34.349 | .777 |
| **ZNINTEZ** | .229 | .721 | 27.864 | .639 |
| **ZNREZUL** | .216 | .705 | 24.142 | .666 |
| **ZNPRAVO** | .181 | .614 | 22.940 | .571 |
| **ZNKONTI** | .178 | .605 | 21.036 | .603 |
| **BRZINA** | .322 | .814 | 37.931 | .754 |
| **POZIGRA** | .188 | .586 | 33.139 | .393 |
| **POZPROT** | .147 | .491 | 19.045 | .474 |
| **PREGLED** | .217 | .696 | 25.839 | .664 |
| **AGRESIV** | .350 | .834 | 40.491 | .798 |
| **ODGOVOR** | .261 | .763 | 29.805 | .730 |
| **SURADNJ** | .339 | .830 | 35.134 | .849 |
| **KOMUNIK** | .340 | .829 | 37.161 | .823 |
| **RIZICNO** | .307 | .806 | 34.311 | .781 |
| **ZAHENER** | .418 | .872 | 47.676 | .841 |
| **ZAHINFO** | .188 | .617 | 25.880 | .534 |

According to the insight into reliability coefficients results (Cronbach alpha), we determined that generally one lower level of reliability was acquired, which speaks about lower degree of agreement in basketball experts' opinion in the space of specific game attributes. However, certain number of variables (complexity, speed, aggressiveness, responsibility, cooperation, communication, risk, and energy demand) still achieved minimal degree, enough for the usage of this attributes in further analyses. These values move within the range of .76 to .87. Remaining attributes are within the range of .49 to .72, and they are not on a satisfactory level of reliability. These are all the attributes that refer to significance for game intensity control, for game results control, for solving game situations on time, for game course

continuity, information demand and three attributes connected with game overview, court position and position according to the ball – opponent and basket. These results are rather surprising, because these three variables were assumed, considering their importance, to be clearly defined and that experts would achieve high degree of agreement of opinions. Attributes that were noticed not to have agreement in experts' opinion were not included in further analysis (players position on the court, position according to the opponent, ball and basket, game task significance for game intensity control, game results control, solving game situations on time, game course continuity, game overview and game task demand – information). That is why it is necessary to define the given attributes more precisely in future researches, because they are very important for the research of the game of basketball.

### *Factor analysis*

Table 3 shows central and dispersive values of specific attributes, and parameters of normal distribution.

Table 3 Descriptive statistics of specific attributes

| VARIABLES | `X | MIN | MAX | S | KURTOSIS | SKEWNESS |
|---|---|---|---|---|---|---|
| **SLOZEN** | .00 | -.79 | 2.09 | 1.00 | -.57 | .99 |
| **BRZINA** | .00 | -.99 | 1.59 | 1.00 | -1.55 | .42 |
| **AGRESIV** | .00 | -1.49 | 1.31 | 1.00 | -1.42 | -.19 |
| **ODGOVOR** | .00 | -1.54 | 1.45 | 1.00 | -1.29 | -.04 |
| **SURADNJ** | .00 | -1.48 | .07 | 1.00 | -1.59 | -.37 |
| **KOMUNIK** | .00 | -1.42 | 1.11 | 1.00 | -1.63 | -.23 |
| **RIZICNO** | .00 | -.78 | 1.40 | 1.00 | -1.63 | .59 |
| **ZAHENER** | .00 | -.97 | 1.61 | 1.00 | -1.48 | .44 |

Table 4 Correlation matrix of specific attributes or variables

| VARIABLES | SLOZEN | BRZINA | AGRESIV | ODGOVOR | SURADNJ | KOMUNIK | RIZICNO | ZAHENER |
|---|---|---|---|---|---|---|---|---|
| **SLOZEN** | 1.00 | | | | | | | |
| **BRZINA** | .07 | 1.00 | | | | | | |
| **AGRESIV** | .22 | **.56** | 1.00 | | | | | |
| **ODGOVOR** | **.58** | .05 | .14 | 1.00 | | | | |
| **SURADNJ** | .34 | -.19 | -.22 | .35 | 1.00 | | | |
| **KOMUNIK** | .30 | -.11 | -.07 | .43 | **.82** | 1.00 | | |
| **RIZICNO** | .59 | .40 | .41 | **.67** | .25 | .32 | 1.00 | |
| **ZAHENER** | .18 | **.63** | **.74** | .03 | -.19 | -.09 | .23 | 1.00 |

In correlation matrix (table 4) relatively good correlation of analysed group of attributes can be observed. From total number of 28 correlation coefficients at the level of significance .01, 14 correlation coefficients are significant, which is 50%. The measure of significant correlation coefficients goes from .21 to .82, so it can be concluded that the analysed group is suitable for determination of latent structure. The bigger correlation (.82) is between the attributes *communication* and *cooperation*, which could be assumed, considering the fact that largest number of tasks in the game of basketball requires interaction through the actions of cooperation and opposition. The game of basketball is of social-metric nature, i.e. the result of interaction between players of one or both teams, which basically defines functional structure of the game of basketball (Hernandez, 1987). Correlations between variables *speed* and *aggressiveness in task realization* are noticeable (.56), *speed of task realization* and *task energy demand* (.63), and *aggressiveness in task realization* and *task energy demand* (.74), according to which it can be assumed that these three attributes in mutual correlations are going to construct a latent dimension in the basis of which lies energy component (game intensity). Besides, there are relatively high correlations between the variables *task complexity* and *task realization responsibility* (.58), *complexity* and *task risk* (.59) and *task risk* and *task realization responsibility* (.67), which indicates to probable existence of latent dimension in the basis of which lies information component. From the above mentioned, future latent structure of analysed group of attributes can be noted.

Table 5 Typical values of extracted components

| COMPONENT | λ | λ% | λkum% |
|---|---|---|---|
| **1** | 2.98583 | 37.3 | 37.3 |
| **2** | 2.52126 | 31.5 | 68.8 |
| **3** | .91381 | 11.4 | 80.3 |

By factor analysis of specific attributes under the component model, correlation matrix was factorised within the exploration strategy, so three latent dimensions that use 80.3% of total manifest space variance were extracted. Thereof, the first latent dimension uses 37.3%, the second 31.5%, and the third 11.4% of total variance. According to this, it can be seen that space co variability of some manifest attributes is relatively high.

Table 6 Main components and communalities

| VARIABLES | K1 | K2 | K3 | $h^2$ |
|---|---|---|---|---|
| **SLOZEN** | .74061 | -.16940 | -.35229 | .70130 |
| **BRZINA** | .43109 | .68449 | .22574 | .70532 |
| **AGRESIV** | .52446 | .69682 | .12193 | .77549 |
| **ODGOVOR** | .75170 | -.29753 | -.37522 | .79436 |
| **SURADNJ** | .44269 | -.72284 | .44207 | .91390 |
| **KOMUNIK** | .53454 | -.62799 | .48702 | .91729 |
| **RIZICNO** | .85833 | .02770 | -.24183 | .79598 |
| **ZAHENER** | .43924 | .72961 | .30331 | .81725 |

High value of communalities (**h2**) is noticeable. They move within the interval from .70 to .91, which indicates high percent of valid variance that each attribute shares with one or more extracted factors (table 6).

Table 7 Matrix of parallel projections of variables with oblimin factors (assembly matrix)

| VARIABLES | INFORMATION COMPONENT | ENERGY COMPONENT | SOCIO-MOTOR INTERACTION |
|---|---|---|---|
| **SLOZEN** | .84541 | -.02311 | -.00835 |
| **BRZINA** | -.01447 | **.84205** | -.00464 |
| **AGRESIV** | .14079 | **.82741** | -.07956 |
| **ODGOVOR** | .89280 | -.12863 | .04026 |
| **SURADNJ** | .00792 | -.07348 | .93785 |
| **KOMUNIK** | .01529 | .06573 | **.96046** |
| **RIZICNO** | .79579 | .24487 | .03136 |
| **ZAHENER** | -.08585 | **.92774** | .04800 |

First latent dimension – **INFORMATION COMPONENT OF THE GAME OF BASKETBALL** (first factor, tables 7 and 8) is determined by attributes or variables: *responsibility* (.88), *risk* (.86) and *complexity* (.84). It refers to the relations of an individual to the game concept and illustrates his relationship towards game tasks. It is probable that in the game of basketball more complex tasks require higher degree of responsibility and risk. It is assumed that conceptual responsibility includes risk, and all that makes certain degree of game complexity. Game tasks require combination of responsibility, risk and utilitarian decision making.

Table 8 Matrix of correlations of variables with oblimin factors (structural matrix)

| VARIABLES | INFORMATION COMPONENT | ENERGY COMPONENT | SOCIO-MOTOR INTERACTION |
|---|---|---|---|
| **SLOZEN** | .83715 | .16317 | .31981 |
| **BRZINA** | .16787 | .83967 | -.15330 |
| **AGRESIV** | .29120 | .87172 | -.16619 |
| **ODGOVOR** | .88011 | .05975 | .40452 |
| **SURADNJ** | .35154 | -.23114 | .95338 |
| **KOMUNIK** | .39802 | -.09416 | .95516 |
| **RIZICNO** | .86136 | .41355 | .29495 |
| **ZAHENER** | .13542 | .90081 | -.14259 |

Second latent dimension - **ENERGY COMPONENT (GAME INTENSITY)** is determined mostly by projections of attributes or variables: *aggressiveness* (.87), *demand for energy* (.90) and *speed* (.84) in game tasks realization. In the second factor, very low correlations with negative unary operator can be noted with the attribute communication (-.23) and cooperation (-.09), which indicates that higher game intensity requires lower level of cooperation and communication, and also lower helping reciprocity. Tasks of high level of realization intensity estimated through attributes speed and aggressiveness of task realization and demand of energy are correlated to solving and realization of certain situations and

courses of actions within the phases and concepts of the game that require lower level of socio-motor interaction.

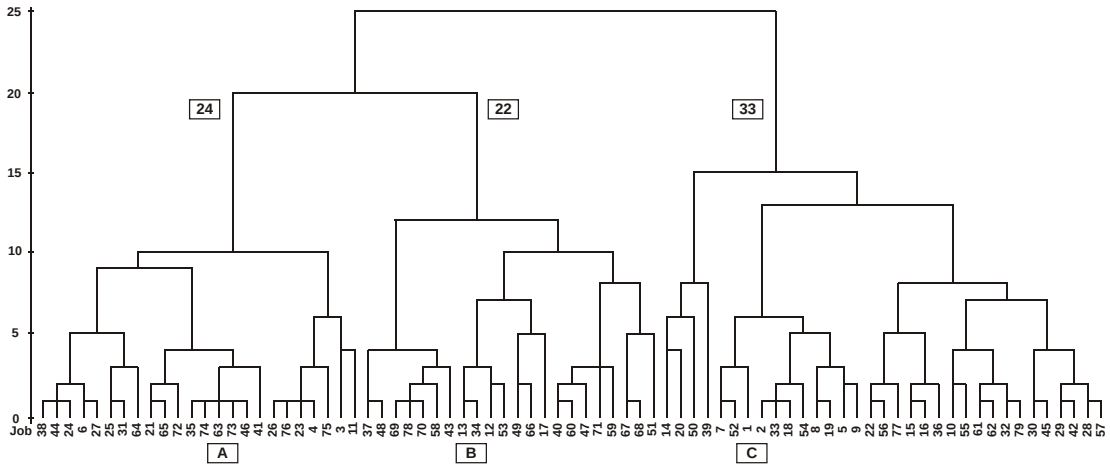
Third latent dimension (third factor) – **SOCIO-MOTOR INTERACTION** is primarily determined by positive projections of attributes: *communication* (.96) and *cooperation* (.95), which are necessary for most tasks in the game of basketball. This hypothetical factor illustrates communication in the field of motor activity, as well as interaction among the participants of complex kinesiological activities through the model cooperation-confrontation, which supports the thesis of Hernandez (1987) that basketball is the game of socio-motor nature. As it is previously said in the description of inter correlation matrix, basketball is a game of socio-motor nature which implies that communication in performing game tasks provides more successful cooperation, which is manifested in solving and realisation of certain game situations, and consequently more efficient confrontation against the opponent. Considering the space and the object of the game (ball), the game of basketball between the opponents takes place in a common area (as opposed to, for example, volleyball where spaces for teams are separated), where simultaneous actions of players in the connection with the moving object (ball) is present; from the aspect of game course where cooperation and communication make a kind of socio-motor interaction (simultaneous course of two-side conversion defence/offence and offence/defence).

Table 9 Correlation matrix between oblimin factors

| | INFORMATION COMPONENT | ENERGY COMPONENT | SOCIO-MOTOR INTERACTION |
|---|---|---|---|
| **INFORMATION COMPONENT** | 1.00000 | | |
| **ENERGY COMPONENT** | .21866 | 1.00000 | |
| **SOCIO-MOTOR INTERACTION** | **.38352** | **-.16995** | 1.00000 |

It is assumed that behind the connection of first and third factor (.38) stands common marker (table 9), this being information component. It is interesting to notice negative correlation (-.17) between second and third factor which means: the higher socio-motor activity component, the lower energy component of the same activity and vice versa.

Picture 2 Classification of tasks: dendogram according to Ward method

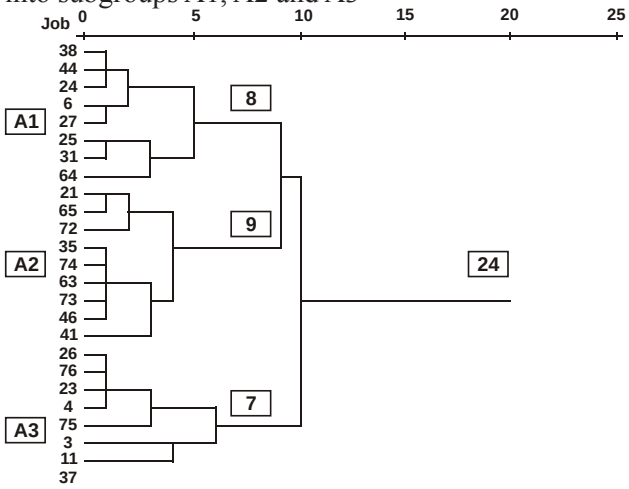


From the dendogram (picture 2) it is visible that at the distance 20 two clusters can be isolated, while at the distance 15 three groups can be separated. These two clusters, at the level 20, are unequal according to number of tasks. As it can be seen from dendogram, they are structured in two separate groups. We conclude that the optimal interpretation of inner hierarchical structure of tasks would be the one at level 15, i.e. in three groups. Of course, each of the groups has its own inner structure.

We performed the interpretation of acquired clusters after discriminative analysis in the space of specific attributes. In fact, for the nature of specific attributes we think that final interpretation of the acquired groups should be performed after inspection of the structure of discriminative functions.

**GROUP A**

In group A (Picture3) 24 tasks were classified into subgroups A1, A2 and A3




Picture 3 Group A

**GROUP A – Tasks list**

6. Setting and determining pressure intensity in front defence line
24. Preventing vertical or in-depth dribbling
25. Isolation (removing) an opponent player from the game after pass
27. Participating in ball takeover: ball interception, 'steal', 'loose' ball, shot blocking
31. Quick and safe transfer of the ball against pressing defence
38. Slowing opponents actions by closing pass line at side positions
44. Defence of counter attack by preventing pass at side or wing positions
64. Positioning for offence fault at the rotation of helping side vertically or horizontally

**GROUP A2 – Tasks list**

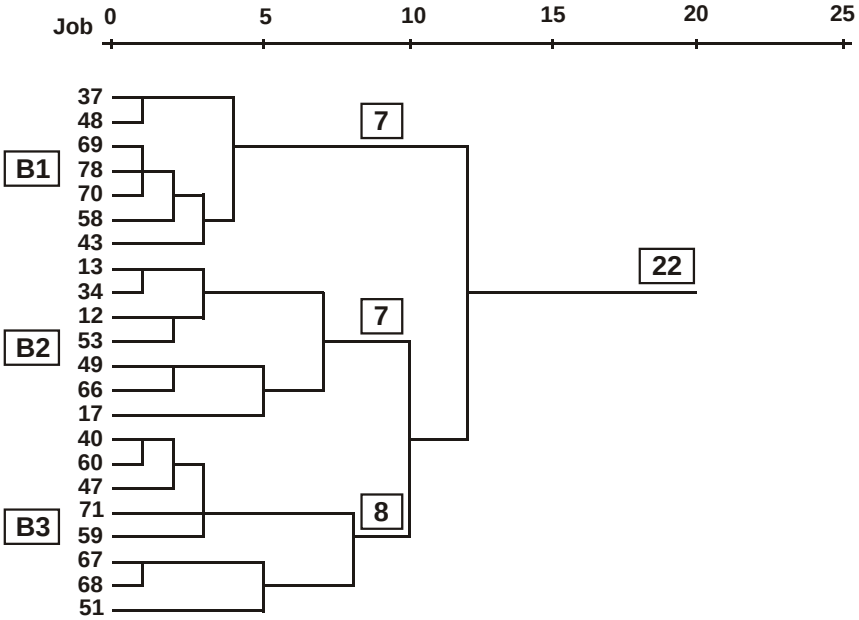
21. Two on two play with different types of cooperation and communication in offence: pass and go, backdoor cut, feint or dribbling guidance of defensive player who holds offence player with the ball on the block, emptying the side of offence
35. Closing start counter attack phase or preventing reception of first pass in preparation for or beginning of counter attack
41. Blocks avoiding
46. Inner threat or the threat beneath the basket
63. Preventing or obscuring moving and passing line towards the 'heart' of the paint
65. Helping small forward, shooting guard or possible second centre in defence
72. Closing the back of the defence front line by sprinting below the ball line in the paint
73. Breaking the centre's blocking line and shooting guard's movements
74. Defensive positioning in front of or beside on the position of small post (on the side of the ball) and/or rotation to the second centre from the position on the help side

**GROUP A3 – Tasks list**

3. Feeding the team by offence assists
4. Pressure in front defence line with the prevention of penetrating first defence line
11. Scoring when needed in the situations with time pressure and game results pressure
23. Slowing the opponents' actions by stopping, withholding or directing offence
26. Helping on relation shooting guard-shooting guard, shooting guard-small forward and shooting guard-centre
75. Making double team in the court corners according to the game situation
76. Defences from pick & roll by braking block line and vertical run out to dribbling line

**GROUP B**

In group B (Picture 4) 22 tasks were classified into three subgroups B1, B2 and B3.




Picture 4 Group B

**GROUP B – Tasks list**

37. Usage of inner cuts with the purpose of playing 1:1 in zone A or positioning for offence rebound
43. First runs into counter attack by sprinting in opponent's 'back' and thus covering side line
48. Frequent position making by playing without the ball for inner game.
58. Activity after block with the purpose of opening pass line for the reception of the ball or offensive rebound
69. Overrunning of opponent defence as a fourth player and positioning in A or B zone for ball reception before the defence regroups
70. Overrunning of opponent defence as a fifth player and positioning in the role of security player on the free throw line in transition from defence to offence and mediator for attack rotation
78. Continuous moving and cuts in 'holes'

**GROUP B2 – Tasks list**

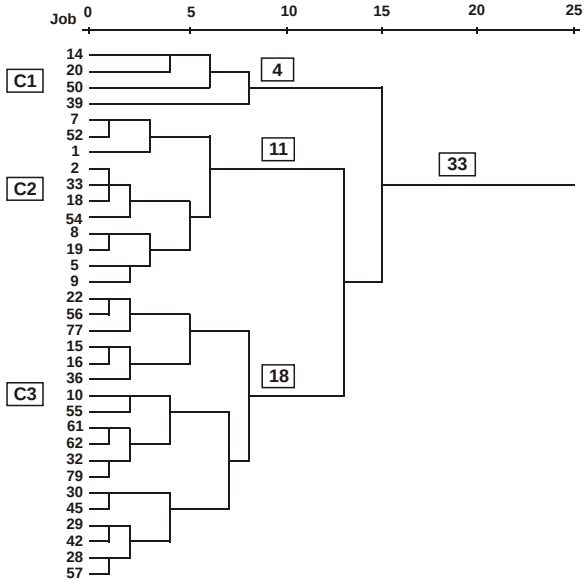
12. Quick transfer of the ball in the front field of the court
13. Penetrating front line of pressing defence
17. Breaking through the crowd (two, three, four players) and finding 'holes' in defence
34. Penetrating first line of defence of counter attack and creating power in numbers and space
49. One on one face-to-basket playing on free throw line
53. Scoring beneath the basket and from half distance
66. Blocking the shot with bouncing the ball in the direction of number 1 or number 2 or catching the blocked ball before it hits the floor

**GROUP B3 – Tasks list**

40. Solving offensive rebound as a second or third rebounder in a team
47. Solving offensive rebound as a first rebounder
51. Scoring or forcing of personal fault in the inner game in 1:1 situations, playing back to basket
59. Positioning for inside or front position for offensive rebound
60. Offensive rebound covering in the moment when the ball leaves shooter's hand
67. Positioning for the selection of inner position for defensive rebound or of positions in front of opponent player, i.e. between the opponent and the basket
68. Solving defensive rebound with the protection and pressure on the ball before first pass
71. Preventing or slowing down of first outer pass of a rebounder or interfering the angle of first outer pass

**GROUP C**

In group C (picture 5) 33 tasks were classified into three subgroups C1, C2 and C3




Picture 5: Group C

**GROUP C1 – Tasks list**

14. Signalizing game organization during offence setting
20. Readiness and patience in waiting for ball reception throughout attack continuity without the ball
39. Scoring open shots
50. Taking the tall player out of the paint for the releasing or opening the paint

**GROUP C2 – Tasks list**

1. Organization and control of offensive game
2. Ball control until desired open shot
5. Selection and in-time pass to best positioned player
7. Determining the moment of changing speed and aggressiveness of the game during the game
8. Using co-player depending on the game situation, i.e. depending on the quality and rhythm of players during the game
9. Communication from the position of defence leader with the command (verbal or non verbal) about defence change
18. Forcing defence to make double team (doubling), threat teaming (tripling) and thus opening outer shot for number two or three, or for inner players
19. Cooperation with power forward and centre
33. Organized counter attack closure
52. Control of the middle of the paint and control of the board_
54. Solving double team or threat teaming in back-to-basket play by passing to a 'free' player on the loaded or weak side of offence

**GROUP C3 – Tasks list**

10. Communication from the position of specific situation where the 'director' is last line of defence
15. Changing direction and speed of offence by dribbling from loaded to weak side
16. Quick offence rotations by passing from loaded to weak side
22. Making blocks without the ball on relation short-high player for obtaining situations tall-short
28. High closing of access to the basket and step in the 'holes' of defensive rebound triangle for long bounced balls
29. Participating in the organization of defensive rebound
30. Opening for the reception of first pass or second pass in the starting phase of counter attack
32. Determining counter attack closure from middle court position
36. Playing at a low post position when the offence player is held by a shorter defence player
42. High guard of access to the basket
45. Outside quick first pass towards number 1 after score or missed shot or shot from free throw
55. Mediation (relay) for offence rotation from loaded to weak side of offence
56. Making successful blocks for shorter players and deblocking for reception of the ball or offensive rebound
57. Maintaining relation ball – defence player – offence player in defence, on a player without the ball
61. Helping in the game against aggressive defence
62. Helping in releasing shooting guard from directing him towards the corner by making block on defence player who holds player with the ball
77. Making strong and aggressive blocks
79. Enabling ball transition in play against pressing defence – safety player

### *Discriminant analysis*

By using canonical discriminatory analysis in the space of specific attributes on the sample of three acquired groups of entities, the existence of two discriminatory functions was determined, statistically considerably making distinctions between the groups (table 10). The values of coefficients of canonical correlation (Rc) and Wilks' lambda (Wλ) indicate quite a fine group discrimination. In first discriminatory function there were higher discrimination that describes 61.45 % of the variance in discriminatory space, while in the second function there were 38.55 % of the variance left and it has somewhat lower discriminatory power.

Table 10 Typical value (λ), variance percentage (λ%), Wilk's lambda (Wλ), canonical correlation (Rc) test for testing the importance of canonical correlation ($\chi^2$), number of degrees of freedom (DF) and level of importance (Q)

| | λ | λ% | **Wλ** | **Rc** | $\chi^2$ | **DF** | **Q** |
|---|---|---|---|---|---|---|---|
| **1*** | 2.4036 | 61.45 | .1172 | .8404 | 155.456 | 16 | .0001 |
| **2*** | 1.5077 | 38.55 | .3988 | .7754 | 66.655 | 7 | .0001 |

Table 11 Correlation of variables with discriminatory functions (structure matrix)

| **VARIABLES** | **F1** | **F2** |
|---|---|---|
| **ZAHENER** | .53504 | .43609 |
| **SURADNJ** | -.50015 | .38606 |
| **BRZINA** | .49671 | .38459 |
| **AGRESIV** | .45941 | .42449 |
| **RIZICNO** | -.01121 | .65411 |
| **KOMUNIK** | -.50022 | .61401 |
| **ODGOVOR** | -.21027 | .43965 |
| **SLOZEN** | .01173 | .42074 |

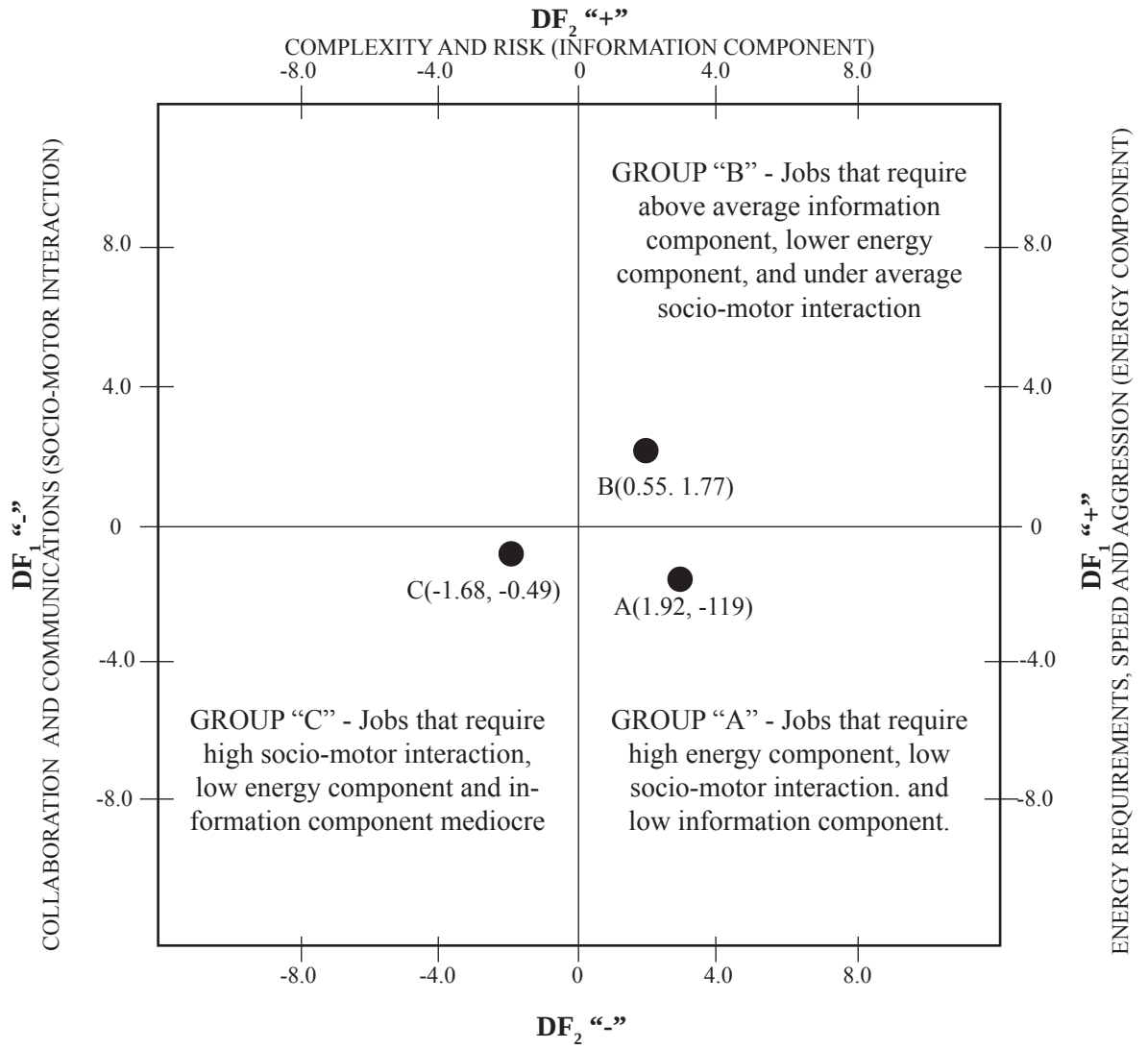
Based on table 11 it is possible to define discriminatory functions. First discriminatory function is determined with positive projections by the attributes *demand for energy* (.54), *speed of task realization* (.50), *aggressiveness in task realization* (.46) and by the attributes with negative unary operator *communication in game tasks performance* (-.50) and *cooperation in game task realization* (-.50). It is probably because with higher socio-motor interaction there is a lower energy component and vice versa. Attributes that have the highest correlation with first discriminatory function (DF1) illustrate game intensity. So, DF1 makes the group of attributes that have common marker – energy component at a positive pole. This group of attributes or variables is coherent, the most pure and the most distinctive, which isolates it from other attributes while at a negative pole it is determined by variables that illustrate socio-motor interaction. Second discriminatory function is dominantly determined by attributes *risk* (.65) and *complexity* (.42), because in relation with the first discriminatory function (DF1) they do not give considerable amount of variance, while other attributes share they variance with the first and the second discriminatory function.

According to both discriminatory functions and the position of group centroids in their coordinate system (table 12 and picture 6) it is possible to determine the differences between analysed task groups in the game. Group A consists of tasks that require high energy component, low socio-motor interaction and low information component; group B – tasks that require above average information component, somewhat lower energy component and below average socio-motor interaction and group C – tasks that require high level of socio-motor interaction, low energy component and medium information component.

Table 12 Position of group centroids in the space of discriminatory factors

| | F1 | F2 |
|---|---|---|
| **A** | 1.92655 | -1.19577 |
| **B** | .55128 | 1.77013 |
| **C** | -1.68530 | -.49019 |

Picture 6 Task position in coordinate system of the first and second discriminatory function




According to first discriminatory function, in one dimensional view, the groups stand in order A, B, C, which would mean that group A consists of high demands for energy component, thus low demands for socio-motor interaction and information component. Having that in mind group A, as opposed to group C, has the highest demand for energy component. According to second discriminatory function, in one dimensional view, the order of groups B, C, A, is noticed. Obviously, the tasks order in group B is of such quality that it requires complexity and risk.

Table 13 The matrix of entity classification on the basis of discriminatory functions

| GROUP | ENTITIES | A | B | C |
|---|---|---|---|---|
| **A** | 22 | 20 | 0 | 2 |
| | | 90.9% | .0% | 9.1% |
| **B** | 24 | 0 | 23 | 1 |
| | | .0% | 95.8% | 4.2% |
| **C** | 33 | 0 | 3 | 30 |
| | | .0% | 9.1% | 90.9% |

Discriminatory analysis represents the first step towards tasks classification, because its goal is to determine the functions that in the best way discriminate groups of entities in a way that the information are condensed. When the results of classification are analyzed (table 13), it can be seen that 92% of tasks are correctly classified. First group (A) is structured by 22 tasks, where 2 tasks are moved from the first to the third group. The second (B) group consists of 24 tasks, where one task from the second group 'runs away' to the third group. The third group (C) is constituted by 33 tasks, where 3 tasks move from the third into the second group.

## CONCLUSION

The goals of this study were determining the structure of latent factors, identification and analysis of groups of game tasks within the group of specific attributes, classifying tasks into relatively homogenous groups, and determining the differences between the acquired groups of tasks. In the connection with that, the questionnaire for registration of knowledge in the game of basketball was constructed. Sixteen specific attributes were chosen for the game tasks characterisation, according to which ten competent experts performed the assessment (Trninic, 1995). By using factor analysis, 3 latent dimensions in the space of specific game attributes were isolated*: information component*, *energy component* and *socio-motor interaction*. Hierarchical method of classification was also used, where the tasks in the space of specific game attributes were classified into three homogenous groups interpreted as A (tasks that require high energy component, low socio-motor interaction, and low information component), B (tasks that require above average information component, somewhat lower energy component and below average socio-motor interaction) and group C (tasks that require high level of socio-motor interaction, low energy component and medium information component). Within the space of specific attributes, correspondence with game principles category was acquired. Grouping the entities points to the possibilities of structuring game principles according to the markers of energy, information and socio-motor activity component. So, game tasks as entities of this work had the function of 'entry ticket' to the basketball tree for discovering upper and lower part of basketball tree over specific attributes (Trninic, 1995).

According to discoveries from this research, we can clearly see the necessity for improvement of those parts of questionnaire that refer to the space of specific game attributes (by using new technologies, video recordings, and by more explicit defining of these attributes), where, considering their importance, the experts' opinion should have greater degree of accordance. Specific game attributes cover lower part of 'basketball tree' (game principles and elements of individual basketball technique and tactics). The acquired grouping of entities, under the criterion of game course phases and positions and roles in the game, match the upper part of the tree (strategy, tactics, game states). The determined discoveries can directly influence the development of technical-tactical training programs, so they must be integrated into contemporary software solutions applied to expert analysis of technical-tactical activities of basketball players.

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