THE PREDICTIVE VALUE OF VARIABLES FOR THE EVALUATION OF TECHNICAL-TACTICAL ELEMENTS IN HANDBALL

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Abstract

The predictive value of the set of 43 variables, designed for the evaluation of handball technical-tactical elements, was tested on a sample of 91 handball matches of the Croatian Championship 1st League for women of the 1995/96 competition season. Twelve teams were categorized in three qualitative groups according to the final rank at the end of the season. The basic parameters of the variables within each qualitative group of teams were determined, as well as the parameters for the entire sample of teams. A three-way factor analysis of variance (MANOVA) was applied in order to determine the predictive power of the game indicators to discriminate between the teams according to the following criteria: the team's pertaining to different qualitative groups, the opposing team's membership to different qualitative groups and the play of domestic/visiting teams. It was established that the constructed battery of 43 variables successfully discriminated between matches of the teams pertaining to different qualitative categories of the teams, matches of the opposing teams pertaining to different qualitative categories of the opponents, and matches played at home and away. However, the differences in play among the teams of different qualitative categories and the opposing teams of different qualitative categories were not established. No difference in play was found among teams of different qualitative categories when playing matches at home or away, neither were the differences proved among the opposing teams differently categorized when playing at home or away. No interaction among all three classification variables were established.

Keywords: handball, 1st national league for women, game performance analysis, technical-tactical elements, predictive value, three-way factor analysis (MANOVA)

Zusammenfassung

Prädiktabler Variablenwert zur Abschätzung von technisch-taktischen Spielelementen des Handballspiels

Aufgrund des Mustersatzes von 91 Handballspielern der Ersten kroatischen Damenliga im Jahr 1995./96. wurde der prädiktable Wert im Gefüge von 43 technisch-taktischen Variablen zur Abschätzung von Spielelementen erarbeitet. Zwölf Mannschaften wurden in drei Kategorien geteilt, nach ihrer Tabellenposition am Ende der Saison. Es wurden Hauptgrössen der Variablen jeder Mannschaftskategorie wie auch Gesamtgrössen der Mustermannschaften festgestellt. Dreifaktorenvarianz wurde ausgerechnet, um die Prädiktabilität der Spielindikatoren bei der Diskriminierung einer Mannschaft gemäss folgenden Kriterien festzustellen: Mannschafts-zugehörigkeit der betreffenden Kategorie, Zugehörigkeit ihrer Gegner einer bestimmten Mannschaftskategorie und Spiel der Gäste bzw. Gastgeber. Es wurde festgestellt, dass durch das 43-Variablengefüge das Spiel der Mannschaften aus unterschiedlichen Kategoiren erfolgreich diskriminiert wurde und, dass dadurch auch das Spiel am Eigen- oder Gastfeld unterscheidet wurde. Es wurden aber keine Unterschiede im Spiel der Mannschaften aus verschiedenen Kategorien bewiesen. Es gab keine Unterschiede im Spiel der verschiedenen Mannschaftskategorien auf Eigen- oder Gastfeld und es liessen sich keine Unterschiede unter den Mannschaftskategorien feststellen. Es zeigte sich auch keine Interaktion zwischen allen drei Klassifikationsvariablen.

Schlüsselwörter: Handball, Damenliga, Spielanalyse, technisch-taktische Spielelemente, prädiktabler Wert, Dreifaktoren-Varianzanalyse

Introduction

The general problem in team sports analysis is how to estimate the quality of the playing performance of a team, as well as how to identify the factors responsible for a decrease in a team's competition efficiency. The nature of the hindering factors[1] varies a lot: it can be recognised within the scope from the faults in the playing performance of the own team, over the playing characteristics of the opponents and the effects of the referee's decisions till the conditions in which the match is held and many others. The greatest problem is how to analyse the game efficiency of a team in a competition situation against the opponent, when both teams strive for the same goal - to win the match. The endeavours of both teams are the same, but they act in opposite directions.

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The process of assessing or evaluating the indicators of competition performance efficiency is a demanding assignment for the coach - he must be a proficient expert with comprehensive knowledge and experience. In addition to that the accurate measurement of individual contributions to the team performance in the situation-related conditions of the handball game is required, because players do not behave quite the same in a competition and in training or practice situations. The evaluation of the players' and team's performance in emotionally saturated situations of competition is a very demanding and difficult task due to the enormous number of events in the game. The coach cannot observe and process everything that happens on the court. That deficit of the objectively processed information about the players induces a situation in which the coach can hardly reach a rational decision on their playing performance.

Performance indicators, used nowadays, are inadequate for a thorough description of the match events, particularly because there are no standards of the game efficiency/nonefficiency measurements. Nevertheless, they are still very helpful to coaches and players, although the interpretation of statistical indicators of the playing performance is a rather complex task and requires a certain level of additional knowledge of data processing methodology. The analysis of the data processing results should reveal to what extent are the faults in play induced by the technical performance imperfection of the own team members and, on the other hand, to what extent are they induced by the successful defence of the opponents or by any other factor.

The problem and previous researches

The subject of the research is an estimation of technical faults in the handball game played by Croatian 1st league women teams. The research has no ambition to explain all the aspects of this complex game; it is restricted to the evaluation of the technical-tactical elements in the attacking phase of the handball game. According to that, a battery of variables was constructed and presented at the convention[2] of handball coaches . Further analyses are directed towards the applicability estimation of the variables.

In the available literature researches can be found based on the registration of different events during different handball matches, i.e. in real competitive situations.

Kampomann, Sassenberg and Westphal (1975) were in Münster, in the period 1973-1974, observing 67 handball matches of male teams and analysed the factors responsible for the performance efficiency of teams. Their analysis included the teams pertaining to three different quality levels: federal, regional and school. They observed: the duration of combinations on the attack and efficiency of the completion of attacks. The teams of a higher qualitative level keep the ball in their possession manoeuvring with it until the probability of scoring becomes rather high and obvious. The teams of a lower qualitative level spend time combining on the attack untill the convenient shooting chance appears. The duration of the combinations in a scoring range zone in front of the opponent's goal area is not a decisive factor of a team's success. The probability of successful outcomes of attacks is not increased by the increment of that duration.

At the 1976 Olympic Games Šafarykova and a group of authors (1978) monitored the closing activities of the attackers in 14 matches of male teams and 7 matches of female teams. They investigated the positions on the court from which the goalshootings had been attempted by the winners and by the losers and specially by the Czech male players. They established 14 factors decisive for the game efficiency. They concluded that players of both sexes finish the attack more often by goalshooting than by losing the ball (men 77.4%, women 71.3%). The number of balls lost in the attacking phase was one of the factors which decided the outcomes of the matches in both sexes (male winning teams 25.9%, female 32.3%).

Ignjatova (1982) observed the motor activities of female handball players at three different qualitative levels of competition according to the playing positions on the court. She monitored seven elements: passing, goalshooting, dribbling, speeding-up, falling-out on the attack, falling-out on defence, jumps on the attack. All elements showed a tendency of increasing numbers with respect to the competition level, except for dribbling, meaning that players of a higher competition rank dribble the ball less. The different relationship of factors was established in the play of players in the first line of the attack (wingers and pivot): with the increment of qualitative level the number of passes to the pivot and the number of attempted goalshootings from the goal-area line decreased, while there were no changes in the winger's play. The maximum number of passes was performed by the center back player, while all the back court players executed nearly the same number of attempted goalshootings. In the lower level qualitative group it was noticed that all the court positions contributed and participated almost equally in the play. The picture changed a little with the

2 The set of variables was presented (N Viskić-Štalec, B.Brčić, Ž. Jaklinović-Fressl) for the first time at the XXI[st] seminar for handball coaches in Pula, 3-8 January 1997 and published in the proceedings book.

increment of the qualitative level because the specialisation started to dominate and the back court players have possessed the ball for most of the time.

Trošt (1983) collected data on the matches of the Slovenian handball Championship League for men in the season 1981/82 and observed: the number of attacks, the duration of attacks and counter-attacks, fast breaks, faults on the attack, goalshootings, the defensive blocking, goalkeeper's saves and serious fouls. He concluded that successful teams have a larger number of successful attacks and counterattacks, the larger number of fast breaks, they score more goals and block more goalshootings than the less successful teams. He rejected the hypothesis that the duration of the attack is longer in more successful teams. The number of saves, serious fouls and faults made on the attack were not significant for any differentiation between the successful and unsuccessful teams.

Späte and associates (1983) compared fouls made by male handball teams during the matches of the 1979 and 1981 World Cup (the old rules of the game) and six matches of the final tournament of the 1982 World Championship, which were played under the new rules regulation. The analysis of fouls revealed that the winning (successful) teams committed more infringements of the rules when obstructing the attacks of the less successful (losing teams) opponents.

On a sample of 14 male handballplayers of one team Šimenc, Vuleta and associates (1996) investigated the player's performance efficiency (on the attack and on the defence) according to the specific playing positions in the game by employing a battery of 18 variables. They observed the following groups of players: goalkeeper (2), winger (5), back court player (5), and pivot (2). They found out that the most efficient playing position is that of the back court player with respect to the contribution in the attack (52% out of the total team's scores) and in the defence phase of the game (the number of balls gained and blocked away). The efficiency of goalkeepers was 45.7%. They were successful in savings: 23.4% goalshootings from the position of the left back court player, 16.5% from the position of the centre court player, 18.2% from the 7m-line, and 9% from the position of the right winger. They received 54.3% goal scores: 20% from the position of the pivot, 15.2% from the 7m-line, and 9% from the position of the right winger. The efficiency of the wingers was estimated at 28% and of the pivots at 19%. The whole team made the largest number of technical faults in the attacking phase of the game; out of the total number of faults, 56% were inaccurate passes of the ball.

Viskić-Štalec, Brčić and Jaklinović-Fressl (1997) analysed the handball game through the video-recordings of 91 handball matches of the Croatian Championship 1st League for women of the 1995/96 competition season. The set of 43 technical and tactical elements was designed for the evaluation of technical faults in the handball game with the purpose of determining the effect of balls lost on the attack on the match outcome. It was established that the set of variables was capable of differentiating three qualitative groups of teams. The first qualitative group of teams had in almost all the variables the smallest average of technical faults (catching errors, passing faults, entering the goal area and offensive fouls). At the same time they were the most efficient in all the variables concerning goalshooting. The teams belonging to the third group had the highest average of free throws from the 9m-line, while the members of the first qualitative group had the lowest average. In total, the fewest faults were registered in double catching and holding the ball for more than three seconds. It became obvious that some types of goalshooting were rarely employed, especially goalshootings from the ground with the hip level underarm shot and with the head level overarm shot. All the observed teams from all the qualitative groups attempted goalscoring through the jump shots equally on average.

Research objectives

The basic objective of this phase of research in the handball game was to determine the predictive value of the constructed set of variables for observing the technical-tactical elements in real handball competition conditions.

The second objective was to estimate the predictive value of the constructed set of variables to discriminate between the domestic/visiting teams, to discriminate between teams pertaining to different qualitative groups, and to discriminate between the opposing teams pertaining to different qualitative groups of opponents.

The third objective was to estimate the predictive value of the constructed set of variables for the identification of the classification variables interactions (the quality of the observed team, the quality of the opposing team and the impact of playing at home or away).

The data acquisition

The evaluation of one team's playing performance was executed during one match. The competent estimator[3] assessed the elements of the game

3 It is important in this kind of data acquisition that the estimation is carried out by a competent estimator - an expert in the handball game (an eminent player, coach or referee).

according to the video-recording of the match, by using the referees' decisions as a criterion in the registration of most variables, and manually registered them on a paper in a kind of shorthand form. To do that the estimator had to stop repeatedly, slow down or rewind the video-recordings of the 91 matches. The "shorthand" records were totalled and conveyed in a table previously prepared.

A sort of the "evaluation training phase" proceeded the whole process of data collecting, so that some matches were assessed on several occasions. A high consistency of evaluations was established. In addition, a randomly selected sample of several matches was estimated by two independent expert estimators. In that case the concordance of evaluations was absolute.

The estimator registered the following: technical-tactical faults made by each player in the attack phase of the game, number and type of goalshooting, and number of scores. Then the number of free throws from the 9m-line and the number of penalty throws were registered as well.

The expression *technical faults* implies here any noneffective/unsuccessful performance of any handball technical and tactical element. Likewise, the playing performance of the opposing team members is estimated in the same match.

The expression *lost ball* is understood here as losing the possession of the ball during the attack phase of the game, i.e. the very point in time in which the opposing team gained possession of the ball (the opponents being till that moment in the defending position). A ball bounced back from the defensive block, goalposts or goalkeeper is not considered as a lost ball, if the attacking team regained possession of it.

Population and sample of entities

The population of entities was defined as a set of *matches* played by the women's teams in the 1st Croatian Handball League, whose matches were available in a video-recording form of the actual competition.

The sample comprised 91 matches for the 1995/96 competition season; out of the total number, 58 matches represent the same teams being home teams once and visiting teams for the return match. All the match events were registered and evaluated afterwards by means of the video-recording.

For the sake of analysis the teams were categorized on the basis of the following classification variables:

- the team pertaining to a qualitative group (three classes)
- the opposing team pertaining to a qualitative group (three classes)
- playing at home or away (two classes) .

In accordance with that, the twelve 1st league handball female teams were arranged into three qualitative groups, each group consisting of four teams, according to the following criteria: the final number of winning points and the position in the final rank-list of the 1995/96 competition season:

- 1st qualitative group: *Podravka, Graničar, Kraš* and *Čakovec*
- 2nd qualitative group: *Split, Karbon, Zvečevo* and *Osijek*
- 3rd qualitative group: *Dalmacija, INA, Rovinj* and *Zamet*.

Sample of variables

The play was evaluated by forty-three (43) technical-tactical variables.

1. Total number of scored goals (GOL_DATI).

2. Total number of goals scored by the opponent - goals received (GOL_PRIM).

3. Number of balls lost through poor catching - fault in ball catching (HVATANJE).

4. Number of balls lost through inaccurate passing (DODAVANJ).

5. Number of balls lost through the fault made in walking- the attacker carries the ball and makes too many steps while holding the ball in his hands (KORACI).

6. Number of balls lost through catching/touching the ball twice (double catch) - double catch and illegal dribble (DUPLO_HV).

7. Number of balls lost through holding the ball more than 3 seconds and touching the ball with the lower leg or foot (DRZANJE).

8. Number of balls lost through faulty passing in the fast break/counter attack (DOD_KONTR).

9. Number of balls lost through the faulty passing to the pivot (DOD_KRUZ).

10. Number of balls lost through entering the goal area - line, crossing the goal area (LINIJA).

11. Number of balls lost through an attacker running/jumping into a defender - offensive foul (PROBIJA).

12. Number of balls lost through the passive play of the attacking team (NEAKTIV).

13. Number of unsafe, not quite optimal passes (NES_DOD).

14. Number of fumbling catches (When imperfect passes and fumblig catches are concerned, the number of poorly performed technical - tactical elements of catching and passing is registered. In that case the ball is not lost, but the bad performance affects the flow of the play by interrupting the rhythm of the build-up and gaining the aim of the attack. In

this variable lost balls snatched away just for a short moment, but afterwards retained by the attacking team, are included as well.) , (NES_HVAT).

15. Number of balls lost through the unsuccessful completion of a clear, a 100% safe scoring chance (ZICER).

16. Number of goalshootings blocked away (see the explanation in variable 14), (BLOK)

17. Number of balls lost through the successful implementation of the defensive blocking (BLOK_IZG).

18. Number of balls lost through the opponents' successful snatching the ball away (PRESJEC).

19. Number of attempted goalscoring by jump shot (SUT_SKOK).

20. Number of scored jump shots (GOL_SKOK).

21. Number of attempted goalscorings from the ground with the shoulder level overarm shots (side throwing), (SUT_RAME).

22. Number of scored shoulder level overarm shots (GOL_RAME).

23. Number of attempted goalscorings from the ground with hip level underarm shots (SUT_KUK).

24. Number of scored hip level underarm shots (GOL_KUK).

25. Number of attempted goalscorings from the ground with head level overarm shot (SUT_GLAV).

26. Number of scored head level overarm shots (GOL_GLAV)

27. Number of attempted goalscorings with the dive shot and shot after catching the rebounded ball (SUT_PAD).

28. Number of scored dive shots and shots after catching the rebounded ball (all attempts from the pivot position; rebounded ball shots from all the playing positions), (GOL_PAD).

29. Number of attempted goalscorings with lob shot - throwing the ball over the goalkeeper (SUT_LOB).

30. Number of scored lob shots (GOL_LOB).

31. Number of attempted goalscoring shots after breaking-through - i.e. the attacker possessing the ball penetrates the defence wall through the gap between at least two defenders, by fake or strength implementation, in order to attain the clear scoring chance from close range (SUT_PROL).

32. Number of scored shots after breaking-through (GOL_PROL).

33. Number of attempted goalscorings at the conclusion of the counter-attack (fast break, extended fast break and complete fast break), (SUT_KONT).

34. Number of scored shots at the conclusion of the counter-attack (GOL_KONT).

35. Number of free-throws executed from the 9m - line, i.e. from the free-throw line (FAUL_9M).

36. Number of penalty throws (FAUL_7M).

37. Number of attempted goalscorings with the dive shot from the penalty line (UDAR_7MP).

38. Number of scored dive shots from the penalty line (GOL_7MP).

39. Number of attempted goalscorings with the overarm shot from the penalty line (UDAR_7MM).

40. Number of scored overarm shots from the penalty line (GOL_7MM).

41. Number of warnings - yellow card (ZUTI).

42. Number of suspensions - 2 minutes (ISKLJUC).

43. Number of disqualifications - red card (CRVENI)

Methods of data processing

The means and standard deviations, as well as the minimum and maximum of events in each variable were computed[4] for every qualitative group and for all the teams together.

The three-way factor analysis of variance (MANOVA) was calculated by crossing the following nominal variables: the team's membership to different qualitative groups, the opposing team's pertaining to qualitative groups and host/guest groups.

A factor experiment (the analysis of variance for a three-way classification of data) is a method to select the classes (levels) of the variable and the combination of classes of the different variables to be included in an experiment. A complete factor experiment is one in which observations are made for every combination of the factor classes. In a factor experiment, when the difference in the classes means of one factor depends on the different classes means of the other factor, we say that these factors interact. If the difference is independent, then there is no interaction between the factors.

The results of the multifactor multivariate analysis should be observed as the decomposition of variances/covariances to the parts correspondent to the classification factors and their interactions. In this analysis the variances of the following factors were observed:

- KVALKLUB, three qualitative levels/classes of teams

4 Data were processed at the Faculty of Physical Education by means of the statistical software package *Statistica*, version 5.0.

- KVALPROT, three qualitative levels/classes of opposing teams
- TEREN, two playing-fields, at home and away.

There is a total number of 3x3x2 = 18 combinations of variables' variances. Each factor-level combination is observed within every factor (KVALKLUB, KVALPROT, TEREN), the interactions of the first order (KVALKLUB-KVALPROT, KVALKLUB-TEREN,KVALPROT-TEREN) are observed afterwards, and at the end, the interactions of the second order (KVALKLU-KVALPROT-TEREN). Factors are included one by one and the variables are observed in interactions of different factors.

Hypotheses

In this research the following null hypotheses will be tested:

- H_{O1}: No difference in play of the teams (or variables' means utilised for the game estimation) pertaining to the different qualitative groups (KVALKLUB).
- H_{O2}: No difference in play against opposing teams pertaining to the different qualitative groups (KVALPROT).
- H_{O3}: No difference in play of the teams playing at home or as visitors (TEREN).
- H_{O4}: No difference in play of the teams pertaining to the different qualitative groups when playing against the opponents pertaining to the different qualitative groups (interaction KVALKLUB - KVALPROT).
- H_{O5}: No difference in play of the teams pertaining to the different qualitative groups when playing at home or as visitors (interaction KVALKLUB - TEREN).
- H_{O6}: No difference in play against the opposing teams pertaining to the different qualitative groups playing at home or as visitors (interaction KVALPROT - TEREN).
- H_{O7}: No difference in play of the teams pertaining to the different qualitative groups when playing against the opposing teams pertaining to the different qualitative groups at home or away (interaction KVALKLUB - KVALPROT - TEREN).

For each hypothesis the respective alternative one exists. The research should reveal if there are any differences and which variables are responsible for their existence.

Results and discussion

On the basis of the results shown in Table 1, it is possible to conclude that the first and the basic condition for the playing performance evaluation, i.e. the variability of data, has been complied with. The number of the analysed entities, as well as the correct selection of variables certainly contributed to that. The real value of the variables should be revealed in this and future researches.

Table 1: Mean ($\bar{x}$), minimum (min), maximum (max) and standard deviation (s) for all the teams together

Variables	All teams n = 178		
	min-max	$\bar{x}$	S
GOL-DATI	8-41	23.17	5.77
GOL-PRIM	8-41	23.17	5.77
HVATANJE	0-9	1.99	1.60
DODAVANJ	0-8	2.33	1.93
KORACI	0-8	1.71	1.57
DUPLO-HV	0-4	.31	.57
DRZANJE	0-3	.39	.65
DOD-KONT	0-5	.92	1.09
DOD-KRUZ	0-5	.74	1.02
LINIJA	0-8	1.53	1.41
PROBIJA	0-6	1.58	1.24
NEAKTIV	0-9	.37	.98
NES-DODA	0-9	2.69	1.97
NES-HVAT	0-8	2.30	2.04
ZICERI	0-9	1.23	1.29
BLOK	0-8	1.58	1.67
BLOK-IZG	0-4	.66	.93
PRESJEC	0-9	2.06	1.89
SUT-SKOK	7-36	18.77	5.30
GOL-SKOK	2-17	8.04	2.86
SUT-RAME	0-9	1.88	1.62
GOL-RAME	0-5	.76	.99
SUT-KUK	0-8	.96	1.50
GOL-KUK	0-3	.24	.55
SUT-GLAV	0-5	.33	.70
GOL-GLAV	0-2	.15	.40
SUT-PAD	0-10	3.70	2.07
GOL-PAD	0-9	2.63	1.68
SUT-LOB	0-5	.43	.81
GOL-LOB	0-6	.21	.63
SUT-PROL	0-12	4.21	2.56
GOL-PROL	0-12	3.16	2.02
SUT-KONT	0-19	5.13	4.49
GOL-KONT	0-16	4.10	3.68
FAUL-9M	5-74	37.18	15.51
FAUL-7M	0-12	4.94	2.26
UDAR-7MP	0-12	2.04	2.15
GOL-7MP	0-12	1.56	1.86
UDAR-7MM	0-12	2.96	2.43
GOL-7MM	0-10	2.25	2.03
ZUTI-KAR	0-4	1.89	.72
ISKLJUC	0-10	4.28	2.14
CRVENI	0-4	.10	.41

Variables All teams n = 178

Table 2: Three-way multivariate analysis of variance: 1 - KVALKLUB, 2 - KVALPROT, 3 - TEREN

Factor	Wilks' λ	Rao's R	df 1	df 2	p-level
1	.224*	3.055*	86*	236*	.000*
2	.274*	2.467*	86*	236*	.000*
3	.569*	2.074*	43*	118*	.002*
1 2	.282	1.027	172	473	.406
1 3	.581	.854	86	236	.801
2 3	.578	.864	86	236	.783
1 2 3	.323	.901	172	473	.788

Table 2 presents the results of three-way multivariate analysis of variance (MANOVA). Significant ($p<.01$) differentiation of teams within every classification factor (KVALKLUB, KVALPROT and TEREN) is obvious, as well as it is obvious that no interaction of classification factors was obtained.

Even the first glance at the Table 3 reveals the differences among the results of the three qualitative groups. The average of technical faults in most variables is minimal, although statistically significant, with the players of the first qualitative group. The same happens with variables NES_DOD (uncertain passing), NES_HVAT (fumbling catching) and PRESJEC (lost ball-the ball snatched away). When the mean of technical faults occurences or uncertainty in the performance of the variables is concerned, the second qualitative group finds its place between the first and the third group. The third group made significantly more faults in walking.

In variables dealing with goalshooting, the most efficient are the players of the first group. For example, jump-shot efficiency percentages decline from group to group: 48.50%, 42.72%, 38.34% (the percentages are calculated from the number of scored goals through the number of attempted goalshootings). It is obvious that the third group employs the goalshooting technique called jump shot (SUT_SKOK) most often, but successful outcomes of this technique performance (the highest efficiency) are the best in the first group. The research confirmed that the jump shot is the most often used technique of goalshooting nowadays.

The characteristic of the second group is a greater number of attempted goalscorings and scored goals achieved by shoulder level overarm shots and hip level underarm shots from the ground (SUT_RAME and SUT_KUK GOL_RAME and GOL_KUK). These four variables differentiate the second group from two other qulitative groups.

The teams of the first group show the best quality and efficiency in variables SUT_PROL, GOL_PROL, SUT_KONT, GOL_KONT, the second group is the second in the rank of quality and efficiency, while the third group is at the end of the quality sequence in these variables.

Table 3: KVALKLUB (qualitative of teams) - play of teams of different qualitative categories

Variables	$\bar{x}_{K1}$	$\bar{x}_{K1}$	$\bar{x}_{K1}$	F	p
GOL-DATI	25.80	23.47	20.30	22.14	.00
GOL-PRIM	20.01	23.19	26.38	29.66	.00
HVATANJE	1.28	1.98	2.75	15.29	.00
DODAVANJ	2.28	1.95	2.64	1.96	.14
KORACI	1.52	1.27	2.35	8.13	.00
DUPLO-HV	.26	.29	.38	.66	.51
DRZANJE	.48	.33	.36	.94	.39
DOD-KONT	.91	.89	.95	.03	.96
DOD-KRUZ	.66	.63	.88	1.06	.34
LINIJA	1.29	1.78	1.66	2.05	.13
PROBIJA	1.38	1.75	1.65	1.43	.24
NEAKTIV	.35	.35	.38	.01	.98
NES-DODA	1.84	2.53	3.81	19.05	.00
NES-HVAT	1.33	2.27	3.35	18.44	.00
ZICERI	1.08	1.54	1.08	2.43	.09
BLOK	1.41	1.28	1.98	2.54	.08
BLOK-IZG	.55	.55	.87	2.24	.10
PRESJEC	1.49	2.01	2.71	7.43	.00
SUT-SKOK	17.09	17.95	21.41	11.64	.00
GOL-SKOK	8.29	7.67	8.21	.85	.42
SUT-RAME	2.19	1.96	1.42	3.68	.03
GOL-RAME	1.03	.68	.55	3.89	.02
SUT-KUK	1.50	.79	.49	7.94	.00
GOL-KUK	.42	.21	.07	6.55	.00
SUT-GLAV	.31	.38	.26	.43	.64
GOL-GLAV	.14	.13	.16	.06	.94
SUT-PAD	3.73	3.82	3.56	.22	.80
GOL-PAD	2.82	2.61	2.43	.74	.48
SUT-LOB	.57	.37	.35	1.34	.26
GOL-LOB	.24	.25	.15	.41	.66
SUT-PROL	4.92	4.27	3.44	5.04	.01
GOL-PROL	3.76	3.19	2.47	6.18	.00
SUT-KONT	7.35	5.15	2.92	22.23	.00
GOL-KONT	5.78	4.21	2.33	19.26	.00
FAUL-9M	27.28	38.29	45.95	38.94	.01
FAUL-7M	4.30	5.32	5.32	4.43	.01
UDAR-7MP	1.98	2.69	1.49	4.54	.01
GOL-7MP	1.49	2.13	1.06	4.94	.00
UDAR-7MM	2.35	2.84	3.81	6.02	.00
GOL-7MM	1.83	2.26	2.78	3.56	.03
ZUTI-KAR	1.93	1.98	1.76	1.55	.21
ISKLJUC	4.24	4.31	4.33	.03	.96
CRVENI	.09	.07	.13	.33	.71

The minimum number of free throws from the 9m-line is awarded to the players of the first qualitative group. The number of free throws increases as the quality of the team decreases. Such a team is

technically and tactically inferior on the attack, so it "schemes" through the game by forcing the superior opponents to make fouls, i.e. players try to gain a free throw from the 9m-line. That free throw from the 9 m-line, which could be considered as a more tactical than a technical element of the game, powerfully reflects the intention of the defence to obstruct the actions of the set attack and, at the same time, the intention of the attackers to keep the ball in their possession as long as possible (e.g. numerical disadvantage of the attack or enormous difference in qualitaty of the teams).

The variable FAUL_7M shows similar tendencies. Markedly the most goalshootings from the 7m-line were executed by the third group players, while the first group had the fewest penalty throws (technically, and probably tactically inferior players of the third group "forced" fouls and penalty throws by their efforts to break through the defence wall of the superior teams). The efficiency of the penalty throw significantly differentiates between the qualitative categories of the teams, too. Least efficient in the realisation of the 7m goalshootings in both techniques are the teams pertaining to the third group (percentage of efficiency: 71.14% GOL_7MP and 72.96% GOL_7MM), while the variables for the second and the third group show similar tendecies (percentage of efficiency for GOL_7MP for the first class is 75.25% and for the second 79.18%; percentage of efficiency for GOL_7MM for the first class is 75.25% and for the second 79.57%).

The first indicators in the analysis of handball technical elements have confirmed the initial idea about game evaluation in the real competition conditions. The constructed battery of variables is hardly comprehensive for the thorough description of the handball game, but it surely enables the attack phase to be described in order to analyse the technical faults and their impact on the game's efficiency

In short, the set of 43 variables makes it possible to differentiate between the playing performance of teams according to their membership to the qualitative group.

It is also possible to discriminate between the team's game performance on the basis of the opposing team's membership to a qualitative group (Table 4). It is widely believed that teams adjust their performance to the opponent's qualitative. The game performance quality of the opposing teams affects the type and frequency of technical faults.

On average, the minimum of gained scores and the maximum of received goals are achieved teams when they play against the most quality group of teams. Anticipated on the basis of qualitative differences, the catching faults and the passing faults occur most frequently in the play of the opposing teams when playing against the first group. The opposing players make the minimum of passing faults when playing against the second qualitative group. That result seems to be rather unexpected.

Table 4: KVALPROT (quality of opposing teams) - play against teams of different qualitative categories

Variables	$\bar{x}_{P1}$	$\bar{x}_{P1}$	$\bar{x}_{P1}$	F	p
GOL-DATI	**20.00**	**23.19**	**26.38**	**29.66**	**.00**
GOL-PRIM	**25.80**	**23.47**	**20.30**	**22.14**	**.00**
HVATANJE	**2.41**	**1.95**	**1.66**	**3.94**	**.02**
DODAVANJ	**2.95**	**1.85**	**2.07**	**6.06**	**.00**
KORACI	1.95	1.80	1.39	2.28	.10
DUPLO-HV	**.17**	**.43**	**.34**	**3.18**	**.04**
DRZANJE	.44	.37	.36	.30	.73
DOD-KONT	.88	.94	.93	.05	.94
DOD-KRUZ	**.98**	**.72**	**.48**	**3.81**	**.02**
LINIJA	**1.15**	**1.57**	**2.00**	**5.77**	**.00**
PROBIJA	1.66	1.59	1.53	.15	.85
NEAKTIV	.34	.26	.48	.73	.48
NES-DODA	2.95	2.77	2.46	1.18	.30
NES-HVAT	**2.88**	**2.32**	**1.76**	**5.62**	**.00**
ZICERI	1.15	1.18	1.38	.52	.59
BLOK	1.80	1.69	1.27	1.58	.20
BLOK-IZG	.80	.71	.47	2.02	.13
PRESJEC	**2.48**	**2.27**	**1.46**	**5.63**	**.00**
SUT-SKOK	18.84	19.03	18.58	.10	.89
GOL-SKOK	**7.24**	**8.31**	**8.26**	**4.24**	**.01**
SUT-RAME	2.11	1.89	1.57	1.77	.17
GOL-RAME	.69	.77	.80	.21	.80
SUT-KUK	**1.36**	**.74**	**.68**	**4.23**	**.02**
GOL-KUK	.25	.25	.21	.07	.92
SUT-GLAV	**.53**	**.20**	**.23**	**4.45**	**.01**
GOL-GLAV	.17	.14	.12	.25	.78
SUT-PAD	3.87	3.63	3.45	.27	.75
GOL-PAD	2.64	2.63	2.51	.00	.99
SUT-LOB	.51	.26	.61	1.77	.17
GOL-LOB	.17	.26	.22	.31	.73
SUT-PROL	3.94	4.28	4.31	.54	.57
GOL-PROL	2.94	3.12	3.35	.61	.54
SUT-KONT	**3.21**	**4.36**	**8.58**	**26.06**	**.00**
GOL-KONT	**2.51**	**3.52**	**6.46**	**24.41**	**.00**
FAUL-9M	**43.75**	**40.92**	**27.49**	**34.79**	**.00**
FAUL-7M	4.71	5.25	5.00	.88	.41
UDAR-7MP	2.12	2.29	1.74	.98	.37
GOL-7MP	1.60	1.69	1.39	.39	.67
UDAR-7MM	2.59	3.18	3.23	1.41	.24
GOL-7MM	**1.79**	**2.48**	**2.60**	**3.07**	**.04**
ZUTI-KAR	1.80	1.89	1.97	.80	.44
ISKLJUC	**3.90**	**4.15**	**4.84**	**3.18**	**.04**
CRVENI	.06	.12	.11	.29	.74

The teams make the fewest double catching faults when playing against the most qualitative group of teams, while they make the maximum number of faults when playing against teams pertaining to the second qualitative group. The second result seems to be rather unexpected, but the tendencies in the other significant, particularly FAUL 9M, and nonsignificant variables, such as KORACI and PROBIJA, should be taken into consideration.

The conduct of the variable DOD_KRUZ (passing to the pivot) was completely anticipated - the maximum number of faults was made by the opponents of the most qualitative teams.

The least number of faults in entering the goal-area (LINIJA) was registered on the opposing teams of the first group, which can be explained by a relatively small number of clear scoring chances from the 6m-line, being the result of a break-through (the Tables 3 and 4 should be seen: frequency of SUT_KONT, SUT_PROL, SUT_PAD).

The uncertain passes occur rarely with all teams when playing against the inferior teams of a lower rank.

The variable PRESJEC shows the expected tendencies - the minimum number of balls was snatched away by the third group teams, the maximum number of faults (lost ball) was made against the first group teams. The better, teams of a higher quality are more successful in realisation of their own intentions (they are superior in techniques, tactics and, probably, in preparation).

In the variable GOL_SKOK it is obvious that the opponents gain the minimum of scores when playing against the best teams. The number of scores gained against the second and the third group of teams is nearly equal, although all the teams have comparable averages of attempted goalscorings by jump shot.

Hip level underarm shots were utilised most frequently against the first group teams. The efficiency in all groups is comparably equal, meaning that the opponents of the first group were least efficient in scoring by that type of goalshooting. The tendencies in the SUT_GLAV variable are similar to SUT_KUK, but the realisation is slightly different - the maximum number of scores was achieved against the second group (almost 90%), and the minimum against the third.

The variables SUT_KONT and GOL_KONT show tendencies expected on the basis of the opponents qualitative discrimination - the inferior teams have the fewest chances for goalscoring from the counterattack and the minimum number of achieved scores from the counterattack when playing against the better ones, i.e. the opponents of the third group have the maximum number of chances for goalscoring from the counterattack and they realised most of them.

The FAUL_9M variable shows that the players of the first group intercept the opponents' attacks most frequently. On the contrary, the players of the third group obstruct the flow of the opponents' attack least frequently, which can be explained as an incapability of the less qualitative teams to realise their attacking intentions.

Somewhat unexpectedly the variable GOL_7MM appears to be statistically significant - the opponents of the first group teams are least successful in the realisation of the penalty throw by the overarm shot. At this stage of statistical treatment it is not possible to explain the significance this variable has in a differentiation process of qualitative groups of opponents.

The fewest suspensions are registered with all the teams when playing against the best teams, which can be explained by the superiority of the latter.

It is also possible to differentiate between the matches of different teams following the criterion of domestic and visiting playing fields (Table 5). Statistically significant differences occured in the following variables: GOL_DATI, GOL_PRIM, KORACI, PROBIJA, ZICER, GOL_SKOK, GOL_LOB, and SUT_KONT. The teams are, on average, more succesful in goal scoring when playing at home, than away. In accordance with that there is the reverse claim - on the domestic playing fields teams receive, i.e. the opponent, visiting teams score, fewer goals than on the visiting courts.

The faults in walking are not so frequent at home as they are when playing away. The same happens with variables LINIJA and PROBIJA. Although the absolute number of these three variables' occurrences is rather low (an average of 1 to 1.5 fault per match), the statistical difference is significant. Could those differences be attributed to the subtle differences in the referee's criterion which prefers the domestic teams just a little bit more?

The variable ZICER (the clear scoring chance) shows different, unexpected tendencies - more clear scoring chances were unsuccessfully closed at home than away. Maybe the reason for such a tendency in the ZICER variable can be found in the more relaxed approach of the domestic players to goalshooting execution (see variable GOL_DATI). The visiting players are, maybe, more concentrated when attempting to score because it is more difficult for them to create a clear scoring chance.

The realisation of jump shots is statistically significant for the discrimination of play on domestic/visiting courts (it is higher at home). It is worth mentioning that teams attempt to score from jump shots nearly equally at home and away (the SUT_SKOK variable - approximate average of 19 times).

The variable GOL_LOB is significant in favour of the domestic courts, too. The domestic teams have more chances for scoring from the counterattack, but the percentage of efficiency is the same at home and away. It is obvious that the domestic teams have more chances to "run" in fast breaks and counterattacks,

but they make more faults, i.e. they are less successful.

Table 5: Estimation of the influence of playing on the home/visiting court on the game performance

Variables	$\bar{x}_D$	$\bar{x}_G$	F	p
GOL-DATI	**25.24**	**22.14**	**9.36**	**.00**
GOL-PRIM	**22.14**	**24.24**	**9.36**	**.00**
HVATANJE	1.90	2.11	.87	.35
DODAVANJ	2.29	2.30	.00	.98
KORACI	**1.40**	**2.03**	**7.83**	**.01**
DUPLO-HV	.26	.37	1.85	.17
DRZANJE	.39	.39	.00	.98
DOD-KONT	.99	.84	.86	.35
DOD-KRUZ	.70	.75	.13	.71
LINIJA	**1.35**	**1.79**	**4.60**	**.03**
PROBIJA	**1.40**	**1.79**	**4.37**	**.03**
NEAKTIV	.23	.49	3.04	.08
NES-DODA	2.77	2.67	.14	.70
NES-HVAT	2.31	2.32	.00	.97
ZICERI	**1.44**	**1.03**	**4.48**	**.03**
BLOK	1.46	1.70	.90	.34
BLOK-IZG	.61	.71	.55	.45
PRESJEC	2.15	1.99	.37	.53
SUT-SKOK	18.80	18.84	.00	.95
GOL-SKOK	**8.53**	**7.58**	**5.32**	**.02**
SUT-RAME	1.67	2.05	2.61	.10
GOL-RAME	.71	.79	.25	.61
SUT-KUK	.86	.99	.36	.54
GOL-KUK	.16	.31	3.12	.07
SUT-GLAV	.32	.32	.00	.99
GOL-GLAV	.12	.17	.54	.46
SUT-PAD	3.65	3.76	.10	.75
GOL-PAD	2.62	2.62	.00	.98
SUT-LOB	.48	.38	.75	.38
GOL-LOB	**.31**	**.12**	**3.75**	**.05**
SUT-PROL	4.44	3.97	1.51	.22
GOL-PROL	3.14	3.14	.00	.99
SUT-KONT	5.59	4.69	2.69	.10
GOL-KONT	4.38	3.84	1.40	.23
FAUL-9M	36.12	38.52	1.94	.17
FAUL-7M	5.21	4.75	1.94	.17
UDAR-7MP	2.17	1.94	.50	.48
GOL-7MP	1.71	1.41	1.19	.28
UDAR-7MM	3.18	2.82	1.05	.30
GOL-7MM	2.52	2.06	2.48	.12
ZUTI-KAR	1.81	1.97	2.41	.12
ISKLJUC	4.06	4.54	2.33	.13
CRVENI	.05	.14	2.19	.14

It seems that a team of a certain quality performs in every match adequately to that quality regard less of the opponent's quality or regardless the fact that the match is played at home or away. Variations in the observed variables are too small to generate any significant differences. There are some tendencies, which failed to differentiate significantly between the domestic and visiting teams, but we still regard them as valuable indicators: the penalty throw scoring chance appears more frequently at home (referees award more 7m throws to the domestic teams). The other goalshooting techniques (except the jump shot) - shoulder level overarm shot, hip level underarm shot, are more employed by the visiting teams. In addition, they make more passes to the pivot (SUT_PAD) and gain more scores through dive shots.

However, the differentiation of matches in interaction within any pair of classification factors was unobtainable by the utilisation of the observed set of variables. Consequently, in the interaction of teams pertaining to the different qualitative levels and opposing teams being of different qualitative levels technical faults in the game flow did not show any significant changes. It was not possible to discriminate between teams on the basis of interaction of all three calsssification factors together. The mentioned outcomes of statistical treatment provoke special attention and testing by the utilisation of additional statistical techniques in future researches.

Generalisation possibilities

The results obtained in this research should be generalised with some reserve. From the kinesiometric point of view, it should be mentioned that data were obtained under nonstandardised conditions. The alteration of opponents, playing-fields (at home/away), referees or spectators substantially changes the conditions under which the matches were played. The necessity to observe the events in a context of specific conditions of a handball match contradicts the requirements of the measurement theory. These requirements were complied with, as far as was possible, by observing a relatively great number of matches, particularly pairs of matches where two teams alternated in the roles of a host and a guest. It is very important to point out that data were collected in a league - system and not in the cup system of competition[5]. In addition, the procedure of events registration was standardised.

It is not possible to generalise the results for the male Croatian handball 1st league teams. A further investigation should be conducted for that population and for all other handball populations. Some inferences are certainly valid for all categories of handball teams, but that claim should be tested in future.

Conclusion

On the sample of 91 handball matches of the 1st Croatian Championship League for women in the 1995/96 competition season the predictive value of the battery comprising 43 variables, designed for the evaluation of technical-tactical elements of the handball game, was tested. The teams were categorised into three qualitative groups according to the final season ranking position The basic parameters of the variables within each qualitative group of teams were determined, as well as the parameters for the entire sample of teams. A three-way factor analysis of variance was computed in order to determine the predictive power of the game indicators for the discrimination of teams due to the following criteria: team's membership to different qualitative groups, opposing team pertaining to different qualitative groups and the play of home/visiting teams.

It was established that a constructed battery of 43 variables successfully discriminated matches of the teams pertaining to the different qualitative categories of teams. It successfully discriminated between matches of the opposing teams pertaining to the different qualitative categories of the opponents, too. The matches played at home or away were differentiated, as well. So the first two objectives of the research were obtained in that manner.

However, differences in play of the teams of different qualitative categories when playing against the opposing teams of different qualities were not verified. No differences in play were found between the teams of the different qualitative categories when playing matches at home or away, neither were the differences proved between the opposing teams differently categorized when playing at home or as visitors. No interaction among all three classification variables was established.

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5 The tournament (cup) system of competition allows only a different level of inference in comparison with the league system of competition. The generalisation of data collected in a cup type of competition should always be taken into consideration with greater caution than the generalisation of data collected in a league system of competition. Results obtained in a tournament could be considered almost as randomly obtained and the consequence of that is the requirement for more repeated measurements at different tournaments, if the inference certainty is to be increased.