PERFORMANCE INDICATORS OF TEAMS AT THE 2003 MEN'S WORLD HANDBALL CHAMPIONSHIP IN PORTUGAL

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Abstract:

The research on situation-related efficiency or performance was conducted on a sample of 60 handball matches (i.e. 120 records of activities performed exclusively during attack). Twenty-four different national teams were divided into four preliminary groups of six teams. The aim of this research was to analyse the factors of situational efficiency in handball, as in the following: (1) differences in the variances of situational factors among teams and (2) the contribution of standard performance parameters to the criterion of success in handball matches defined as a goal difference in the match's final score. The sample of predictor variables encompassed the frequencies of shot effectiveness parameters, assists and technical errors. The criterion variable was defined as the final outcome of matches. Multivariate analysis of variance was used to determine the differences that were statistically significant ($p < 0.01$) among the variances of the observed standard parameters of situational efficiency. Each preliminary group was observed separately. A series of regression analyses was used to define the contribution of predictor variables to the successfulness of the teams. Although the level of the contribution of separate parts of the situational efficiency varied across the groups, the statistical significance was determined in all of them on a high statistical significance level ($p < 0.01$) with the determination coefficients which explained the common variance of the predictor system and the criterion (a goal difference) within a range of 0.73 – 0.84. However, it was not possible to create the general model of competition efficacy, because the structure of it varied across the teams and matches.

Key words: *team handball, male seniors, national teams, performance indicators, world championship, preliminary round, competition efficacy model*

Introduction

The hierarchical model of the structure of performance in handball describes action or situational efficiency, that is, performance of handball players at the third level of the pyramid defining the final outcome of a handball match and, consequently, their general sport achievements in a competition as well (Milanović, 1997). That situational efficiency of players, or of a team, can be observed in different phases and subphases of play in a match. The main phases of handball play are attack and defence, depending on the ball possession. Two transitional phases, the phase of returning to the defence and the phase of a counter-attack, are derived from the main ones (Vuleta, 1997).

A goal scored, being the ultimate aim of any attack of both teams, is the result of the total, cumulative individual activities of the players, their group and team activities performed in play on attack. In line with the rules of the game, it is the only game element to which the nominal numeric value is assigned that defines the cumulative engagement of both teams in a game (Rogulj, 2000, 2003; Vuleta, Gruić, & Ohnjec, 2005), thus directly structuring the outcome of a match.

Performance parameters are, as a rule, collected at major competitions by means of either the existing methods of registration during a match and/or a competition (the International Handball Federation, IHF, or the European Handball Federation, EHF, prescribed parameters, that is, the outcomes of play actions), or in any time after the match or competition by reviewing video recordings (Ignjatova, 1984; Vuleta & Šimenc, 1989; Vuleta, Šimenc, & Delija, 1996; Taborsky, 1996; Brčić, Viskić-Štalec, & Jaklinović-Fressl, 1997; Czerwinski, 1995, 1998, 2000). Variable events or game situations, or the flow of the game in each match is a result of unique, specific interactions and a manifestation of synergies of a large number of interwoven abilities and attributes, of a network of the technical-tactical knowledge and the skills of the players of both opponent teams whose aims are the same: to beat the opponent by scoring more goals than the op-

ponent (meaning at the same time to receive fewer goals than the opponent). But it is also the result of interactions of the coaches and the entire logistic team, as well as of the substitutes on the bench, of the referees and their decisions, even of the spectators. Therefore, each match of two opponents produces only similar, never identical match courses or a result progress (Vuleta, Milanović, & Sertić, 1999; Rogulj, 2003).

World Championships and other major competitions of national selections are usually of a short duration, with an extremely high competition tempo, meaning that each team play six to eight, or even more matches in ten or fourteen days. It is one of the reasons, among other kinesiometric ones, why the results of performance analyses can be interpreted and accepted only within the context of the observed type of competition (Dežman & Tkalčić, 2002; Gruić, Vuleta, Milanović, & Ohnjec, 2005). Trends in the development of the game of handball, game rules modifications and changes in performance of game elements, introduced for the sake of play speed and attraction enhancement, produce even greater technical and tactical variability that automatically make the definition of a smaller number of basic factors responsible for the performance of the handball players difficult to obtain. Nevertheles, such analyses give us an insight into the trends in play configuration and flow; certain regularities still may be noticed.

Supervision and control of a handball player's efficiency encompasses an analysis of the relevant technical-tactical parameters. Its goal is to apply the obtained results directly to the selection of training programme contents and loads. These contents and loads should provide a respective work quality level and, in turn, improve performance in the phases of both attack and defence (Vuleta, Šimenc, & Sertić, 1997). The definition of attacking efficiency segments, with special emphasis on the shot effectiveness, constitutes the essential precondition for the specific and situational training modelling in which the computer advances are supposed to shorten the path and the time necessary for registration, selection and presentation of the information relevant and interesting to the public, experts and scientists of different profiles (Vuleta, Gruić, & Ohnjec, 2005).

So far several research studies have adressed the issues treated in this paper. Šafarykova and associates (1978) observed the finalization of the phase of attack at the 1976 Olympic Games. Fourteen (14) factors determined shot effectiveness's contribution to the final outcome and the differences among the teams of different quality level and different gender. The attacks were more often ended with a shot taken (men 77.4%, women 71.3%) than with a technical error (e.g. technical errors of the victorious teams - men 25.9%, women 32.3%). Ignjatova (1982) observed the motor activity of female handball players on different playing positions and at three performance quality levels. Seven standard technical elements were analysed and the following was obtained: all the technical elements showed the tendency to be more frequent at a higher level of competition, except the element *dribbling the ball* (better players dribble the ball less). A series of descriptive analyses with the same character followed. Taborsky (1996) analysed the 1995 Women's Junior World Championship in Brazil. Average shot effectiveness was approximately 60%.

Czerwinski (1995) analysed the contribution of the particular technical-tactical elements performance to the final outcome of a match. Efficacy of defence, the number of counter-attacks and the number of organized attacks made a statistically significant positive contribution to the final outcome of the matches. Czerwinski (1998) assessed shot efficiency from the statistical records of the 1998 Men's European Championship held in Italy. Average total shot efficiency was 53.7%, of the seven-meter throws 71%, of fastbreaks 75.3%, etc. Czerwinski (2000) also performed a statistical analysis and remarked on the game character based on the European Championship in Croatia. A new approach in performance analysis of team sports was presented by Jošt and associates (Jošt, Pustovrh, Ulaga, & Leskošek, 1999). The expert system for longitudinal talent evaluation was offered as a possible system or source of indicators for future selection.

Vuleta and Šimenc (1989) analysed descriptively the particular parameters of situational efficiency of the national handball team (of the former Yugoslavia) at the 7th World Junior Handball Championship held in Rijeka in 1987. Most goals were scored from the pivot playing position and the centre backcourt position. The lowest shot effectiveness was registered for the right wings. Vuleta, Šimenc and Delija (1996) conducted a performance analysis of players of the Handball Club "Medveščak" that competed in the Croatian first national division. The finding was that backcourt attackers and goalkeepers performed best. Vuleta with associates (Vuleta, et al., 1999) explored the latent structure of the game of handball (26 attributes of the game of handball based on 134 elements of technical-tactical activity). Three general structured factors were found: performance in the phase of attack, performance in the phase of defence, and the goalkeeper's performance. Rogulj (2000) analysed the differences in the situational parameters of the game of handball in terms of result achievements of the teams at the 1999 Men's World Handball Championship in Egypt. In 2003 the same author explored the efficiency of tactical models in handball. The differences among performance variables were statistically significant. The assessed set of variables polarized

the observations well in terms of performance and result achievements. Vuleta and associates (Vuleta, et al., 2005) explored the influence of score progress in a match on the final outcomes of matches. The influence of the goals scored in the first, second, and third 15-minute-long time periods, defined as the goal difference, was statictically significant. Gruić (2006) conducted a research on the standard parameters of competition performance standardized for the World Handball Championships. The statistical significance of the contribution of particular performance variables to the prediction of the final outcomes of matches was obtained. Dizdar, Trninić and Milanović (1997) observed the same issue in basketball and Marelić, Rešetar and Janković in volleyball (2004).

The main objective of this paper was to analyse the elements of attack situational efficiency in handball, this time from the 2003 Men's World Handball Championship. Regarding the differences in situational efficiency of attack models among teams, the authors presupposed that the variances of the observed performance parameters would differ among the groups in the preliminary round of the competition. For the sake of possible generalization on the various levels of comprehension, the previously referred differences will be inspected as the first partial aim of this paper. The second partial aim of the research was to analyse the level of contribution of the situational parameters to the achievements of the teams defined as the final outcomes of matches (the goal-difference values; victory, defeat, and tie included).

The issues of the research were to determine the statistical significance of the differences among the variances of the predictor variables of the four observed groups in the preliminary round of the competition, and to determine the statistical significance of the contribution of the predictor variables to the successfulness of the teams described by the criterion variable.

The authors assumed the results would allow for conclusions that would highlight a better perspective on the issues related to the performance parameters collection and interpretation in handball, as well as on the relevance of certain tasks in play, assigned to individual players or to the whole team.

Methods

The sample of cases was comprised of 60 matches played by 24 national teams (meaning there were altogether 120 records of play in attack) in the preliminary round of the 2003 World Handball Championships for Men in Portugal. Teams were divided into four qualification groups (A, B, C and D; final standings of the teams are presented in brackets). Six teams in a group played in the round-robin system, meaning there were 15 matches per each group. The first four teams from each group qualified further for the main round of the competition consisting of 16 teams.

A	B	C	D
SPAIN (**4**)	GERMANY (**2**)	CROATIA (**1**)	SWEDEN (**13**)
YUGOSLAVIA (**8**)	ISLAND (**7**)	FRANCE (**3**)	DENMARK (**9**)
POLAND (**10**)	PORTUGAL (**12**)	RUSSIA (**5**)	SLOVENIA (**11**)
KUWAIT (**20**)	QUATAR (**16**)	HUNGARY (**6**)	EGYPT (**15**)
TUNIS (**14**)	AUSTRALIA (**21**)	ARGENTINA (**17**)	ALGERIA (**18**)
MOROCCO (**23**)	GREENLAND (**24**)	SAUDI ARABIA (**19**)	BRAZIL (**22**)

The set of predictor variables consisted of the frequencies of either successful shots (goals scored) or shots missed, which were taken by backcourt players, wingers and pivots from their playing positions and from fastbreaks, as well as of their assists and technical errors. Situational efficiency of players as described by the predictor variables is presented in Table 1. All the results included in the research fall under normal distribution. These variables were registered as the IHF standard statistical procedure performed by the group of trained statisticians. Official system of IHF (International Handball Federation) was PHMS – Pictorial Handball Match Statistics (produced by the Chinese Handball Federation). Within the same year it was replaced by WIGE system (produced by the German Handball Federation) which broadened the scope of statistical procedures in handball.

Table 1. The sample of the predictor variables (1-10) and the criterion variable (11)

1	**FS_S**	Field shots (goals) scored - backcourt positions
2	**FS_M**	Field shots taken, missed - backcourt positions
3	**LS_S**	Line shots (goals) scored - pivot playing position
4	**LS_M**	Line shots taken, missed - pivot playing position
5	**SS_S**	Side shots (goals) scored – wingers' position
6	**SS_M**	Side shots taken, missed – wingers' position
7	**FB_S**	Fastbreak goals scored – counter-attack
8	**FB_M**	Fastbreak shots taken, missed – counter-attack
9	**ASST**	Assists
10	**ERR**	Technical errors in attack
11	**GOALDIFF**	Final goal difference

The variable *technical errors* (ERR) should be additionally explained. It refers to all individual, group or collective actions in attack that ended with an unwanted conversion of the ball possession being the result of either a technical error or a rule infringement (making more than 3 steps while holding the ball, double-dribble, "carried" ball, forbidden body contacts, offensive foul, incorrect passes and poor ball receptions; all these enable the opponent to intercept passes or to perform throw-ins, etc.)

The **criterion variable** for the purposes of this paper was defined as *goal difference at the end of a match.*

Data analysis methods. The central and dispersion parameters of the performance indicators were determined. The differences among the groups were determined by multivariate and univariate analyses, and regression analysis was used for computing the contribution of the set of predictor variables to the criterion variable.

Results

Table 2 shows the parameters of descriptive statistics of the standard and the derived performance parameters from the 2003 Men's World Handball Championship in Portugal.

The results of the multivariate analysis of variance for the intergroup differences among the variables of performance are presented in Table 3.

Further analysis of the contribution of the attack performance parameters to the final successfulness of teams was assessed separately for each of the four preliminary round groups.

Table 2. Descriptive statistics of the performance parameters of the teams playing at the 2003 WC in Portugal

		TOTAL				VICTORY				DEFEAT			
	N	**MEAN**	**%**	**SD**	**Sum**	**MEAN**	**%**	**SD**	**Sum**	**MEAN**	**%**	**SD**	**Sum**
FS_S	120	8.08	38.54	3.07	970	8.37	48.77	3.24	477	7.86	31.48	2.89	448
FS_M	120	12.89		7.34	1547	8.79		4.21	501	17.11		7.63	975
LS_S	120	5.71	62.50	2.95	685	6.77	66.67	3.40	386	4.70	57.02	2.12	268
LS_M	120	3.43		2.11	411	3.39		2.09	193	3.54		2.16	202
SS_S	120	4.56	55.65	3.30	547	5.56	62.16	3.76	317	3.53	47.63	2.56	201
SS_M	120	3.63		2.40	436	3.39		2.37	193	3.88		2.53	221
FB_S	120	4.19	70.55	3.21	503	5.95	76.87	3.44	339	2.56	59.35	2.01	146
FB_M	120	1.75		1.52	210	1.79		1.64	102	1.75		1.46	100
TOT_S	120	27.10	53.22	6.83	3252	31.79	62.25	6.16	1812	22.70	44.30	4.23	1294
TOT_M	120	23.82		7.34	2858	19.28		5.29	1099	28.54		6.33	1627
RATE	120	53.43		12.06		62.25		8.47		44.65		8.80	
ASST	120	12.04		6.13	1445	14.40		6.88	821	9.81		4.60	559
ERR	120	15.68		4.57	1881	14.42		4.00	822	16.74		4.91	954
GOALDIFF	120	0.00		11.93	0	9.09		8.19	518	-9.09		8.19	-518

N number of cases: **MEAN** arithmetic mean; **SD** standard deviation; **Sum** sum; **FS_S** field shots scored - backcourt positions; **FS_M** field shots taken, missed - backcourt position;s **LS_S** line shots scored - pivot playing position; **LS_M** line shots taken, missed - pivot playing position; **SS_S** side shots scored – wingers' position; **SS_M** side shots taken, missed – wingers' position; **FB_S** fastbreak goals scored – counter-attack; **FB_M** fastbreak shots taken, missed – counter-attack; **TOT_S** goals scored – total; **TOT_M** shots taken, missed – total; **ASST** assists; **ERR** technical errors in attack; **GOALDIFF** final goal difference; **%** shot effectiveness

Table 3. Multivariate analysis of variance

Intergroup differences	Wilks' Lambda	Rao's R	df 1	df 2	p-level
ABCD	**0.57**	**2.21**	**30.00**	**314.00**	**0.00**
AB	0.80	1.24	10.00	49.00	0.29
AC	0.74	1.69	10.00	49.00	0.11
AD	**0.51**	**4.76**	**10.00**	**49.00**	**0.00**
BC	0.81	1.12	10.00	49.00	0.37
BD	**0.65**	**2.64**	**10.00**	**49.00**	**0.01**
CD	**0.57**	**3.68**	**10.00**	**49.00**	**0.00**

df degrees of freedom; **p-level** value of significance threshold

Table 4. Descriptive statistics of the performance parameters across groups

		A			B			C			D		
	N	**MEAN**	**%**	**SD**	**MEAN**	**%**	**SD**	**MEAN**	**%**	**SD**	**MEAN**	**%**	**SD**
FS_S	30	7.23	35.22	2.57	8.43	37.75	3.20	8.47	41.58	3.79	8.20	39.67	2.54
FS_M	30	13.30		7.57	13.90		10.11	11.90		5.25	12.47		5.64
LS_S	30	4.97	55.84	2.99	6.30	66.53	3.96	5.77	60.48	2.18	5.80	67.21	2.35
LS_M	30	3.93		2.08	3.17		2.41	3.77		2.01	2.83		1.82
SS_S	30	3.83	52.04	2.46	5.17	59.43	5.02	5.10	57.76	2.48	4.13	52.55	2.39
SS_M	30	3.53		2.24	3.53		2.96	3.73		2.26	3.73		2.18
FB_S	30	5.10	72.86	3.72	3.37	63.59	3.32	3.43	72.52	2.78	4.87	72.26	2.67
FB_M	30	1.90		1.35	1.93		1.80	1.30		0.95	1.87		1.80
ASST	30	9.77		3.86	11.53		8.67	11.07		3.57	15.80		5.51
ERR	30	15.63		5.20	15.30		4.93	15.97		4.10	15.80		4.14
GOALDIFF	30	0.00		11.66	0.00		18.13	0.00		9.21	0.00		5.84

N number of cases: **MEAN** arithmetic mean; **SD** standard deviation; **FS_S** field shots scored - backcourt positions; **FS_M** field shots taken, missed - backcourt position;s **LS_S** lineshots scored - pivot playing position; **LS_M** line shots taken, missed - pivot playing position; **SS_S** side shots scored – wingers' position; **SS_M** side shots taken, missed – wingers' position; **FB_S** fastbreak shots scored – counter-attack; **FB_M** fastbreak shots taken, missed – counter-attack; **ASST** assists; **ERR** technical errors in attack; **GOALDIFF** final goal difference; **%** shot effectiveness

The results of the regression analyses are presented in Table 5 where the relations between the set of predictor variables and the criterion variable are described by the coefficients of multiple correlations.

Partial contributions of the predictor variables to the criterion of successfulness across the groups are presented in Table 6.

Table 5. Multivariate indicators of the contribution of the predictor variables to the successfulness criterion defined as the goal difference of the final match score

GOAL-DIFFERENCE	**A**	**B**	**C**	**D**
MULTIPLE R	0.93	0.94	0.91	0.91
MULTIPLE R^2	0.86	0.89	0.82	0.82
ADJUSTED R^2	0.79	0.84	0.73	0.73
F (10,19)	11.56	15.62	8.78	8.78
p	**<0.00**	**<0.00**	**<0.00**	**<0.00**
STD. ERR. OF ESTIMATE	5.41	7.38	3.04	3.04

MULTIPLE R – multiple correlation, **MULTIPLE R^2** – coefficient of determination, **ADJUSTED R^2** – adjusted coeficient of determination, **F** – value of F-test, **p** – value of significance threshold of F-test, **STD. ERR.** – standard error

Table 6. Partial results of regression analysis of the performance indicators within the competition groups

	A		**B**		**C**		**D**	
	BETA	**p-level**	**BETA**	**p-level**	**BETA**	**p-level**	**BETA**	**p-level**
Intrcpt		0.86		0.98		0.23		0.05
FS_S	0.14	0.20	**0.28**	**0.03**	0.10	0.62	0.08	0.51
FS_M	**-0.45**	**0.00**	**-0.56**	**0.00**	**-0.44**	**0.01**	-0.12	0.39
LS_S	0.13	0.30	0.17	0.48	0.08	0.59	**0.34**	**0.01**
LS_M	0.05	0.66	-0.11	0.24	-0.21	0.12	-0.14	0.22
SS_S	0.01	0.91	0.21	0.20	0.14	0.24	0.31	0.03
SS_M	-0.14	0.38	0.04	0.80	-0.14	0.28	0.17	0.21
FB_S	**0.42**	**0.01**	0.09	0.60	**0.32**	**0.05**	**0.55**	**0.00**
FB_M	0.07	0.48	0.03	0.81	-0.15	0.29	-0.22	0.08
ASST	0.07	0.66	-0.01	0.97	-0.02	0.90	-0.01	0.96
ERR	-0.13	0.30	-0.15	0.16	**-0.42**	**0.01**	0.08	0.52

BETA – partial standard coefficient of regression; **p-level** value of significance threshold; **Intrcpt** intercept; **FS_S** fieldshots scored - backcourt positions; **FS_M** field shots taken, missed - backcourt position; **LS_S** line shots scored - pivot playing position; **LS_M** line shots taken, missed - pivot playing position; **SS_S** side shots scored – wingers' position; **SS_M** side shots taken, missed – wingers' position; **FB_S** fastbreak shots scored – counter-attack; **FB_M** fastbreak shots taken, missed – counter-attack; **ASST** assists; **ERR** technical errors in attack

Discussion and conclusions

The total average number of shots taken at the opponents' goal (Table 2), calculated from 120 records of play in attack, was 51 with a shot effectiveness of 53.22%. Out of the total average number, 21 shots were taken from the backcourt attackers' positions with a shot effectiveness of 38.54%, 8 were taken as side shots from the wingers' playing positions with a shot effectiveness of 55.65%, 9 shots on average were taken from the 6m-line with a shot effectiveness of 62.50%. Also, an average of 6 shots taken in the finalization of fastbreaks with a shot effectiveness of 70.55% was registered. The average number of technical errors (15.68) exceeded the average number of assists (12.04). The parameters of situational efficiency of the victorious and the defeated teams, also displayed in Table 2, confirm the actual differences in the teams' quality that defined the outcomes of the preliminary round of the competition already on a descriptive level of interpretation. Both the victorious and the defeated teams finished the phase of attack with 51 shots at the opponent's goal on average (51.07 and 51.24, respectively), but with different scoring efficiency, that is, the shot effectiveness was 62.25% and 44.3% for the victorious and the defeated teams, respectively.

The victorious teams had a better scoring efficiency from the backcourt attackers' positions than the defeated ones (FS_S 8.37 and FS_M 8.79 as opposed to FS_S 7.86 and FS_M 17.11). The victorious teams performed on average 9 (8.95) side-shots with 62.16% of shot effectiveness, whereas the defeated teams scored 47.63% of 7.41 side shots on average. The victorious teams took more shots from the pivot playing position than the defeated teams (10.16 vs. 8.24) with a significantly better scoring efficiency (66.67% vs. 57.02%). Probably due to more efficient performance in defence, the victorious teams managed more often to win possession of the ball. Consequently, they had more opportunities to perform fastbreaks and prolonged fastbreaks (together, counter-attacks) and to score more easily from counter-attacks (7.74 shots on average) than the defeated teams (only 4.31 shots on average). And their fastbreak scoring efficiency was also better than the efficiency of the defeated teams (76.87% vs. 59.4%). The number of assists and technical errors is in balance with the victorious teams (14.40 and 14.42 on average), whereas with the defeated teams technicall errors (16.74 on average) outnumbered assists (9.81 on average).

The results of the multivariate analysis of variance (Table 3) indicate the total differences of performance parameters among all four competition groups. Consequently, it is viable to assume that the generators of competition efficiency had different characteristics in each of the four groups. However, according to the results of the analyses that follow, the attack performance parameters did not differ among three groups (A, B and C). The differences were determined only with regard to group D. But that did not allow us to integrate the results from the first three groups. Namely, the final ranking of the teams from the preliminary group D marked considerably the (un)successfulness of teams at the competition. Therefore, to interpret correctly the obtained results from the analyses of the differences of variances, we had to approach each group separately.

According to the values of the performance parameters, presented in Table 4, unexpectedly low shot effectiveness from the line playing positions (pivot and wings) is obvious in group A (only 54.12% on average out of 16 shots) when compared both to the competition's average of 59.26% and to the standards that handball experts usually expect from the line-positioned players (70-90%). Most shots were performed from the backcourt attacking positions, 20.53 on average with 35.22% scoring efficiency. A relatively large average number of technical errors per match (15.63) can be ascribed, like in other competition groups as well, to the above-average number of errors committed by the low-ranked teams (throughout the whole tournament, the total number of 822 errors were committed by the victorious and 954 errors were committed by the defeated teams; Table 2).

Compared to group A, and to the average of the competition as well, a relatively better average realization from the line-playing positions (63.13%) was noted in group B (Table 4). Yet the dispersion indicators of the variable *shots taken but missed from the backcourt attackers' positions* (SD = 10.11) imply the extremely efficiency-related inconsistent offensive activity of the backcourt attackers. A larger number of technical errors (15.30) than the number of assists (11.53) probably means that shooting from the backcourt attackers' positions is superior to cooperation with the line-positioned players (and other backcourt attackers as well).

Stability of shot effectiveness indicators is the main characteristic of the best-quality group – group C (such an evaluation is based on the Championship's final rankings of the teams). Almost in all attack performance parameters of group C (Table 4), the dispersion parameters had lower values than in the other competition groups. Average shot effectiveness of backcourt attackers (41.58%) is greater than in other groups. Also, the values of standard deviations confirm a greater stability of offensive activity of both the backcourt and the line attackers. A relatively large average number of technical errors in the phase of attack (15.97) can be probably attributed to the lowest-quality teams (see final ranking) of Argentina and Saudi Arabia.

Along with relatively stable dispersion parameters of the observed performance indicators in

group D (central tendency parameters are similar to the average values in group C), it is important to point out the average number of assists and technical errors (both variables 15.80), meaning that their ratio was 1:1. This information indicates the permeability of defences on the one hand, and non-defined situational efficiency of backcourt attackers on the other. A plausible explanation lies in the probable oscillations in the quality of ball circulation (precision, speed and timing of passes) in different matches, even in a single match.

The values of coefficients of multiple correlations (Table 5), ranging between 0.91 and 0.94, were tested by F-distribution for df1 = 10 and df2 = 19, with statistical significance at the level of $p < 0.01$. A common variability of the set of predictor variables and the criterion variable varies from group to group in the interval of 82-89% (multiple R^2 = <0.82, 0.89>), or in the interval of 73-84% (adjusted R^2 = <0.73, 0.84>). The rest of 16-27% of the unexplained variance of the match final outcomes can be explained by the influence of quantitatively not defined factors. Rogulj (2003) performed an analyses of the contribution of predictor variables comprised of the characteristics of a team (multiple R=0.76), a group (multiple R = 0.60) and the individual (multiple R = 0.82) tactical performance to the successfulness of teams. The results obtained by the group of authors (Gruić, Vuleta, Milanović, & Ohnjec, 2005; Vuleta, Milanović, Gruić, & Ohnjec, 2005; Gruić 2006, etc.) for a definition of the contribution of variously defined performance parameters to the successfulness of teams provided the similar scope of explanations of variances of criterion variables (multiple R = 0.72-0.94 for the shooting and technical performance predictor variables and multiple R = 0.67-0.95 for the score progress predictor variables).

In group A (Table 6) the variable *shots taken, but missed from the backcourt attackers' positions* (FS_M) had a statistically significant (p = 0.00) negative influence (BETA = -0.45), and the variable *goals scored from counter-attacks* (FB_S) a statistically significant (p = 0.01) positive influence (BETA = 0.42) on the goal difference at the end of the preliminary round matches. Based on the aforementioned results it is possible to conclude that the more successful teams, that have a smaller number of inefficient field shots, had a better quality of shot selection, mostly determined by the systematic and organized play actions in the phase of attack.

Systematic and organized attack implies the adherence to certain play principles. The main preconditions of attacking efficacy are maintenance of width and depth of the attack and a rather quick circulation of the ball. The mobility of players is accentuated in individual attacking actions. Defensive formations and/or the defenders' performance can be destabilized by alternations of attacking rhythm and tempo. In the context of collective tactics that principle had probably the greatest impact on the scoring efficiency of the backcourt attackers in group A. Due to the inability to comply with this principle, the lower-quality teams were possibly forced to shoot at the goal before they had managed to build up a systematic, organized, collective attack, or they were forced to shoot under the pressure of the passive play rule. The individual tactical actions of the backcourt attackers, not integrated into the systematically built open opportunities for performance of shots, resulted expectedly in missed shots. Therefore, the negative contribution of the variable *shots taken, but missed from the backcourt attackers' positions* (FS_M) to successfulness is understandable.

The characteristics of successfull teams with better fastbreak scoring efficiency are: adequate defence system selection, quick reaction to the opponent's unsuccessfull shot, fast running (by sprint and by "sharp" and accurate ball transmission) and a good selection of shooting techniques

The negative relation between the two variables is obvious. The predictor variable *shots taken, but missed from the backcourt attackers' positions* (FS_M) has negative reflections on the performance of teams, expressed as goal difference, who have lost possession of the ball due to the space-related advantage achieved by the former defenders whose initial standing position (they are facing the direction of a fastbreak that is to happen next to the conversion of the ball possession) is better than the starting position of the attackers whose backs are turned to the direction of returning to defence after they have lost possession of the ball. If the defenders anticipate the game development well to the point when a field shot is performed, and with the precondition that they have high reactibility to audio and visual signals, the frequency of successfull counter-attacking performances (activities) will be proportionally enhanced as the opponents' attacking system organization will be deteriorated. These relations are corroborated by the data (Table 4) on the average number of goals scored after fastbreaks (5.10) which is larger in comparison with other groups. This may be connected to a larger average number of unsuccessfull shots performed from the backcourt attackers' playing positions (13.30).

In group B the variable *shots taken, but missed from the backcourt attackers' positions* (FS_M) had a statistically significant (p = 0.00) negative influence (BETA = -0.56) and the variable *goals scored from the backcourt attackers' positions* (FS_S) had a statistically significant (p = 0.03) positive influence (BETA = 0.28) on goal difference at the end of the preliminary round matches.

The shot effectiveness of the backcourt attackers in group B primarily defined the performance

of their teams. The selection of shots from the backcourt attacking positions is conditioned by the level of attack organization. The contribution of successfully performed shots from the backcourt attacking positions to the total number of successfully performed shots is accentuated.

Justification for field shots' performance depends on numerous circumstances, factors and elements, among which are: the level of destabilisation of defensive formations and defensive performance, timing of ball passes and receptions, momentary distance between both the goal and the defenders, on the possible contact with a defender at the moment of shooting, on the direction of attacking activities, on the type of approaching the defence (vertical, oblique, semi-circular), etc. Anticipation of defenders' movements at the moment or just before a shot, ball control (safety of a grip, appropriate distance between the ball and the opponent, "hiding" the ball from the goalkeeper), opportunities for the assistant pass (i.e. a pass to an open team-mate in a better scoring position) and cooperation with a pivot (timely set screens and other group tactical solutions) are elements that additionally regulate the shot effectiveness in the context of the applied tactical conception, instructions of the coach, motivation and health status of the locomotor system parts responsible for the performance of various throws at the goal, like ground or support shots, jump shots and/or dive shots (overhead shot, knee- or hip- high shots, the same throwing hand-leg support shots, trunk deviation shots). The synergy of physical abilities, technical-tactical knowledge and skills, as well as of cognitive-conative features of backcourt attackers are emphasized especially in shot selection, which is manifested in the statistical significance of the contribution of field shot/goal variables to the success of teams.

The partial results of the contribution analysis of the set predictor variables to the criterion of success in group C (Table 6) revealed the following: the variable *shots taken, but missed from the backcourt attackers' positions* (FS_M) had a statistically significant ($p = 0.01$) negative influence (BETA = -0.44) on the success defined by the goal difference at the end of the matches. The same can be stated, with a high conclusion certainty ($p = 0.01$), for the variable *technical errors* (ERR) (BETA = -0.42). The variable *goals scored from counter-attacks* (FB_S) had a statistically significant ($p = 0.05$) positive influence (BETA = 0.32) on the goal difference at the end of the matches played in the preliminary round of the competition in group C.

Based on the aforementioned results it is feasible to confirm the existence of the similarities of the successfulness generators in groups C and A. For greater sport achievements these teams should first reduce the number of unwanted, nonefficient shots (shots from semi-chances and other shots performed without a proper setting up of an attack). A too broad definition of the variable *technical errors* (*ERR*) does not allow for a deeper analysis of its contribution to the success of the teams in group C.

A statistically significant ($p = 0.05$) positive contribution of the variable *goals scored from counterattacks* (BETA = 0.32) to the success of the teams in group C is a logical result. Namely, the counter-attack and semi-counter-attack shot effectiveness is mostly a result of errors commited in play by, mainly, the backcourt attackers of the opposing team (they allowed the defenders to intercept their passes, or to perform quickly free throws, etc.), or an unsuccessful shot performance (shot missed, blocked out, or saved). By regaining possession of the ball, in either of the afore described ways, the former defenders meet the basic preconditions for a fastbreak against the unorganized defence of the former attackers. The fewer the number of passes during the realisation of the counter-attack, the better it is. However, the eventual qualification to the main round of the competition was not achieved only by the continuity of attack engagement in counter-attacks and semi-counter-attacks, but mistakes in their realization also contributed negatively to the criterion variable.

It is well known that technical errors in attack are caused by two reasons: the insufficient level of technical-tactical skills of players in the backcourt attacking line, and the high-quality functioning of defence systems. Tactical adequacy of the utilization of and reliance on all the available attacking systems is not in question here (with one or two pivot players, intensified application of unexpected individual solutions, unexpected switching of playing positions, etc.), but we should direct our attention to the principle of the responsible technical-tactical behaviour in attack. Namely, the teams in group C (the lowest-quality teams of Argentina and Saudi Arabia), which failed to meet the requirement for an optimal, efficient attack building, made many errors and allowed their opponents to perform a lot of successful counter-attacks or easy scores. On the other hand, the matches of more balanced quality teams (the first four in the group: Croatia, France, Russia, and Hungary, which were ultimately placed as the first, third, fifth, and sixth teams, respectively), generated fairly small goal differences, thus accentuating the necessity of responsible tactical behaviour in attack, because only one or two mistakes might make the difference between victory or defeat.

In group D a high statistical significance was registered of positive contribution of the variables *goals scored from the wing positions* (BETA = 0.31; $p<0.03$) and *goals scored from the pivot playing position* (BETA = 0.34; $p<0.01$) to the final match successfulness, defined as the goal difference at the end of the matches. Characteristics of the teams which

played in the preliminary round group D were: to the attack-oriented concept of play, fast ball circulation and an average shot effectiveness of backcourt attackers. Special emphasis was on the generally high and efficient utilization of wings and pivot players against either the organised or unorganised defence formations.

The generators of success in group D differ considerably from the generators of success in other preliminary round groups. The centre of gravity of the game in this group is transferred from the backcourt attackers to the line attacking players, wings and pivot(s). This information is confirmed by the results of the multivariate analysis of variance which detected the parameters of situational efficiency in group D as the main differentiating generators among the competition groups.

The results of the series of regression analyses, as expected, confirmed the statistically significant contribution of the predictor variables to the successfulness of the teams.

Albeit the structure of contributions differred among the groups, the statistical significance of the contribution was defined in all the groups on a respective level of reasoning ($p < 0.01$), with the coefficients of the determination, that is, the amount of the explained variance of the criterion (goal-difference), ranged from 0.73 to 0.84.

The results of multivariate analyses indicated the feasibility of the detection of the standard performance parameters in attack. However, when interpreting the obtained results one must be careful despite their relatively high statistical significance. Namely, the proportion and the structure of the samples of cases and observed variables limit the virtue of the obtained results to a certain extent.

The results obtained by the analysis of particular performance parameters confirm the findings of previous research related to this issue (Rogulj, 2003; Gruić, Vuleta, Milanović, & Ohnjec, 2005; Vuleta, Milanović, Gruić, & Ohnjec, 2005; etc.).

The differences among the variances of the observed standard situational efficiency indicators of the four preliminary round groups are statistically significant, which implied the necessity of separate analyses which gave different projections of the contribution of standard performance parameters to the criterion of successfulness, here defined as *goal difference.*

The contribution of the predictor variables to the final successfulness criterion is statistically significant. The partial effects of regression analyses confirmed the importance of the situational efficiency of backcourt attacking players in the generation of final outcomes of handball matches.

The total variance of the criterion variable is mostly explained by the situational (in)efficiency of the backcourt attackers and by the efficiency of counter-attacks. The results imply the cause-and-effect relationships between these two elements of performance and are indicative for the directives of the game of handball's future development. High-quality and top-trained backcourt attackers were the carriers of successfulness of the teams at the 2003 World Championship in Portugal. This finding means that the top-level results can be achieved solely with top level-backcourt attackers. Line position players (wings and pivots) perfected their skills and abilities to an extreme point, therefore their technical-tactical performance improvement is not a guarantee of a significant improvement in the playing performance of a team in the attacking phase. Certain reserves in technical-tactical performance of backcourt attackers confirm the previous statement.

Previously defined frameworks for statistical analysis of match events, that are standard characteristics of technique and tactics of a handball game compared to each other reveal an inadequate coverage of all the characteristics of a handball game. It particularly refers to the evaluation of certain parameters related to an opponent, of players' engagement time, of defensive and attacking systems against specific teams, etc. (Vuleta, Milanović, Gruić, & Ohnjec, 2005).

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