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INFLUENCE OF THE “PUSH & FLICK” METHODOLOGY ON THE ACCURACY OF THE INDOOR HOCKEY PENALTY CORNER SHOOTING

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ABSTRACT

The penalty corner (PC) is one of the most important game situations in hockey (both outdoors and indoors), which results in 30 – 40% of all goals.

The aim of this paper is to study the influence of the quasi-experimental methodology on the dynamics in the development of indicators characterizing the accuracy of shooting when performing PC in the potentially effective goal zones. Through the application of InterCriteria Analysis (ICrA), the research team sought to establish relationships and directions of dependencies between indicators reflecting the accuracy of zone shooting.

Four elite female indoor hockey players from the team of the National Sports Academy in Bulgaria, participants in the European Indoor Hockey Clubs Challenge, were involved in the examination sessions. According to the requirements of the quasi-experimental “Push & Flick” methodology, the duration of the specialized training was set to 16 weeks. Each player performed 4,800 shootings, or approximately 300 shootings each week. Tests were carried out at the beginning (the first week) and at the end (the sixteenth week) of the experiment in order to determine the accuracy of the shooting – push/flick from a penalty corner spot (9 meters, central from the goal line). We used InterCriteria Analysis and Variance Analysis to analyze the results.

The results of the study provide valuable information related to the training and specialization of elite hockey players profiled in the execution of a penalty corner.

Key words: *accuracy, flick, influence, indoor hockey, InterCriteria Analysis, penalty corner, push, shooting*

INTRODUCTION

Indoor hockey is a team sports discipline practiced in a hall on a playground (pitch) with handball sizes. The game format was created in the 1950s and 1960s in Germany. In 1966, the International Hockey Federation (FIH) published a book with the first Indoor hockey rules, and in 1968 the World Headquarters of-

officially recognized the discipline as an integral part of hockey. Sports statistics and research have identified the hockey penalty corner (PC) as the main goal-scoring tool (Antonov, Minodov, Igov, 2006; Bari, et al, 2014; Eskiyecsek, et al, 2018; Ibrahim et al, 2017; De Subijana, et al, 2011; De Subijana, et al, 2012; Meulman, et.al, 2012; Palaniappan, Sungar, 2018;

Vinson, et al, 2013). The accuracy of shooting in the execution of a PC is one of the key factors for the high success in goals scored in hockey, both outdoors and indoors. Therefore, the shooting performance is a subject of a number of studies. While in the scientific literature there are a number of studies related to the effectiveness of the outdoor hockey PC, mostly studying the goal performance and the biomechanical structure of the main technique – drag flick (Antonov, Mindov, Chavdarov, 2006; Antonov, Mindov, Igov, 2006; Bari, et al, 2014; Beckmann, et al, 2010; Eskiyecek, et al, 2018; Ibrahim, et al, 2017; De Subijana, et al, 2011; De Subijana, et al, 2012; Laird, et al, 2003; Palaniappan, Sungar, 2018), yet no research to date has investigated this key action within indoor hockey (Vinson, et al, 2013).

In one of the few studies by Vinson, et al, (2013) it is claimed that the success rate of indoor hockey penalty corner varied from 20 to 30%. Specifically, for the England Hockey League Women's Premier Division 'Super Sixes' 2010-2011, it achieved a success rate of 22, 6%.

A statistical survey of individual goal scorers from the last women's Indoor Hockey World Cup, Berlin 2018, found that the penalty corner goal score success was over 40%. In the final matches for the medals – both men's and women's, the percentage of goals scored by the penalty corner exceeded 60%.

The indicators that give us information about the success and effectiveness of the penalty corner, give us reason to study the impact of our developed methodology on the accuracy of flick pushing. The Flick (F) is a basic technique for shooting by pushing the ball, included when performing indoor hockey PC. Unlike the Drag Flick (DF) – a highly effective shooting technique used only during the execution of the outdoor hockey PC, F is also used in any goal situation where lifting the ball is required.

In this regard, any study on the impact of

the “Push & Flick” techniques on the performance of Indoor hockey PC (the accuracy of shooting in effective areas (Figure 1)), as well as the establishment of significant dependencies is of paramount importance for the training process and competitive activity of high performance hockey players.

The aim of this paper is to study the influence of the quasi-experimental methodology on the dynamics in the development of indicators characterizing the accuracy of shooting when performing PC in the potentially effective goal zones. Through the application of different methodologies (correlation analysis and InterCriteria Analysis), the research team sought to establish relationships and directions of dependencies between indicators reflecting the accuracy of zone shooting.

In order to determine the possible relationships and the direction of dependence between the indicators, characterizing the accuracy of shooting, we used variation analysis and the comparatively new approach InterCriteria Analysis (ICrA). ICrA is based on the apparatus of the index matrices (IM) (Atanassov, 1987), and the intuitionistic fuzzy sets (IFS) (Atanassov, 2012) and can be applied to decision making in different areas of knowledge (Atanassov, Vasilev, 2018; Atanassov, et al, 2014; Todinova, et al, 2016).

METHODOLOGY

The overall methodology for training specialized performers of a penalty corner in Bulgaria was developed by Antonio Antonov in the period 1997-2005. It includes 12,000 performances per year – 8,000 outdoors and 4,000 indoors. Quantitative indicators and structure were described in detail and presented at a scientific conference in 2006 (Antonov, Mindov, Chavdarov, 2006). For the purposes of this study, only part of the methodology described in 2006 was applied, de-

signed to improve the implementation of the Penalty Corners indoors. It was named “Push & Flick” Methodology. In 2014, the planned shootings in the winter macrocycle of the methodology were updated from 4,000 to 4,800, taking into account the changes of the increased intensification of the training process and the fact that since 2010, according to the Bulgarian Hockey Federation competition regulation, the indoor season has turned into the first annual macrocycle and has had a longer duration. The main technical means of performing indoor hockey shooting are push & flick, hence the name of the methodology. The specialized training sessions, the pretest and the posttest, were conducted in the period of the winter preparation from 44th calendar week of 2014 to 7th calendar week of 2015. The trainings were held in the handball hall of NSA “Vassil Levski”, and the pretest and the posttest in the hall of SOC Kamchia. Both halls maintain a temperature of 22-24, normal humidity and have identical polyethylene flooring Taraflex® Sport M Plus.

Participants

The subject of this research were four female players from the NSA Hockey Club, at an average age of 23 years, +/- 3, who have been practicing hockey for more than 10 years. The four subjects are female members of the main NSA indoor hockey team playing as left forward (Player 1), right forward (Player 2), right defender (Player 3), and left defender (Player 4). The surveyed players were preparing to participate in a European Indoor Hockey Clubs Challenge I, 20 – 22 February, Ankara 2015 and passed the full course of training in “Push & Flick” methodology.

“Push & Flick” Methodology

The “Push & Flick” methodology includes 32 specialized training sessions, twice a week,

with a duration of 60 minutes each, including warm-up (15 min), main part (40 min) and cool down (5 min). The specialized trainings were individual and were held in 16 weekly microcycles (44th calendar week of 2014 to 7th week of 2015). In the weekly microcycle, two specialized trainings were carried out - the first on Tuesday and the second on Thursday. In the main part of each first week training, 150 shots were performed (15 sets of 10 repetitions) in the left zones 1, 2 and 3 (50 in Zone 1, 50 in Zone 2 and 50 in Zone 3) (Figure 1). Each series of 10 repetitions must be performed within 1 minute. The break between repetitions is passive and lasts 1 minute. The break between sets is active, combined with receiving coaching instructions, incl. and video analysis and lasts 5 minutes. The second weekly training is a repetition of the first, but the planned 150 shots are performed in the right zones in descending order 6, 5 and 4 (50 in Zone 6, 50 in Zone 5 and 50 in Zone 4). Throughout the “Push & Flick” Methodology, each player performed 4,800 shootings, respectively 2,400 to the left and 2,400 to the right zones.

Protocol

Every Tuesday, according to the set plan, each player’s training session included direct execution of 150 shootings from a distance of 9 meters in three predetermined left zones with the outer dimensions of the squares 66 x 66 cm. Every Thursday they performed the same training methodology in the three right zones (Figure 1). During each training session, players worked on improving their shooting skills to the left – zones 1, 2 and 3 or to the right – zones 4, 5 and 6, alternating consecutively (Figure 1). “Push & Flick” methodology, was implemented in order to train “narrow specialists” performing Penalty Corner (PC) indoors. One of the main tasks of the methodology was to improve the accuracy of shooting.



Figure 1. Model of a training hockey goal (300×200 cm)

A quasi-experimental method was used, and more specifically a True Experimental design with Pretest and Posttest. We used a video camera (Sony, model HDR-CH190EB) observation and a radar (sports radar Ra-Vid Pro Sport™ (Accuracy: ± 0.1 km/h, Speed range: 1-480 km/h, Stopwatch within 1/100 second, 10 m sec acquisition time, 12-degree radar beam, 1200 to 38.4K baud, available in mph or km/h, Maximum Range, Sports: 400-500 ft., Autos: 1.75 miles). The accuracy of the shooting and the speed of the ball during PC execution in training conditions were determined at the start (Pretest) and at the end (Post-test) of the experiment. The level of accuracy was established with a technique involving 10 consecutive shootings into a spherical target with a diameter $\Phi - 40$ cm, located symmetrically in each zone (Figure 1). A shot (push/flick) to the target was awarded 2 points, and a shot outside the target, but within the zone, including the goal post – 1 point. The white lines that outline the squares of the zones were part of them.

Data analysis & full description of the InterCriteria Analysis

We used an Intuitionistic Fuzzy Pair (IFP) (Atanassov, 2012; Atanassov, et al, 2013) as an estimation of the degrees of “agreement” and “disagreement” between two criteria applied to different objects. An IFP is an ordered pair of real non-negative numbers $\langle a, b \rangle$ such that: $a + b \leq 1$.

Consider an IM (Atanassov, 1987) whose index sets consist of the criteria (for rows) and objects (for columns). The elements of this IM are further assumed to be real numbers. An IM with index sets consisting of the criteria (for rows and for columns) with elements IFPs corresponding to the degrees of “agreement” and “disagreement” between the respective criteria is then constructed.

Let O denotes the set of all objects O_1, O_2, \dots, O_n being evaluated, and $C(O)$ be the set of values assigned to the objects by a given criterion C , i.e., $O = \{O_1, O_2, \dots, O_n\}$;

$$C(O) \stackrel{\text{def}}{=} \{C(O_1), C(O_2), \dots, C(O_n)\}. \text{ Then, let } C^*(O) \stackrel{\text{def}}{=} \{\langle x, y \rangle \mid x \neq y \ \& \ \langle x, y \rangle \in C(O) \times C(O)\}.$$

In order to find the “agreement” between two criteria, the vector of all internal comparisons of each criteria, which fulfils exactly one of the following three relations: R , \bar{R} and \tilde{R} ,

$$\langle x, y \rangle \in R \Leftrightarrow \langle y, x \rangle \in \bar{R}, \tag{4}$$

$$\langle x, y \rangle \in \tilde{R} \Leftrightarrow \langle x, y \rangle \notin (R \cup \bar{R}), \tag{5}$$

$$R \cup \bar{R} \cup \tilde{R} = C^*(O). \tag{6}$$

Only a subset of $C(O) \times C(O)$ needs to be considered for the effective calculation of the vector of internal comparisons (further denoted by $V(C)$) since from Eqs. (4)-(6) it follows that if the relation between x and y is known, then so is the relation between y and

$$V(C) = \{C_{1,2}, C_{1,3}, \dots, C_{1,n}, C_{2,3}, C_{2,4}, \dots, C_{2,n}, C_{3,4}, \dots, C_{3,n}, \dots, C_{n-1,n}\}.$$

Let $V(C)$ be replaced by $\hat{V}(C)$, where for the k -th component ($1 \leq k \leq n(n-1)/2$):

$$\hat{V}_k(C) = \begin{cases} 1, & \text{iff } V_k(C) \in R \\ -1, & \text{iff } V_k(C) \in \bar{R}. \\ 0, & \text{otherwise} \end{cases}$$

When comparing two criteria, the degree of “agreement” $\mu_{C,C'}$ is determined as the number of matching components of the respective vectors, divided by the length of the vector for normalization purposes. The degree of “disagreement” $\nu_{C,C'}$ is the number of components of opposing signs in the two vectors, again normalized by the length. In most of the obtained pairs, the sum $\mu_{C,C'} + \nu_{C,C'}$ is equal to 1. However, there may be some pairs, for which this sum is less than 1. The difference

is constructed. In other words, it is required that for a fixed criterion C and any ordered pair $\langle x, y \rangle \in C^*(O)$ it is true:

x . Thus, of interest are only the lexicographically ordered pairs $\langle x, y \rangle$. Denote for brevity $C_{i,j} = \langle C(O_i), C(O_j) \rangle$. Then, for a fixed criterion C , the vector with $n(n-1)/2$ elements is obtained:

$\pi_{C,C'} = 1 - \mu_{C,C'} - \nu_{C,C'}$ is considered as a degree of “uncertainty”.

RESULTS AND DISCUSSION

Variation Analysis of the Results

The results from the study of the indicators characterizing the accuracy of each player’s zone shooting at the start and at the end of the experiment are shown in Figures 2-7. Summarized information from the study is presented in Table 1.

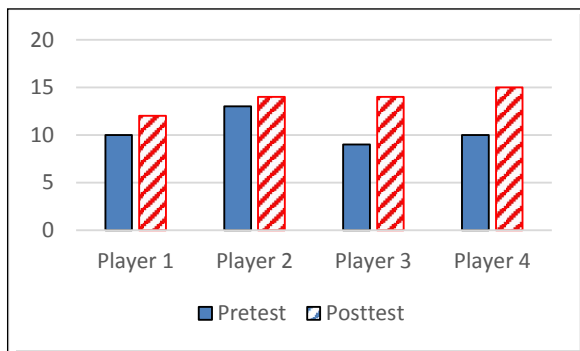


Figure 2. Shooting accuracy in Zone 1

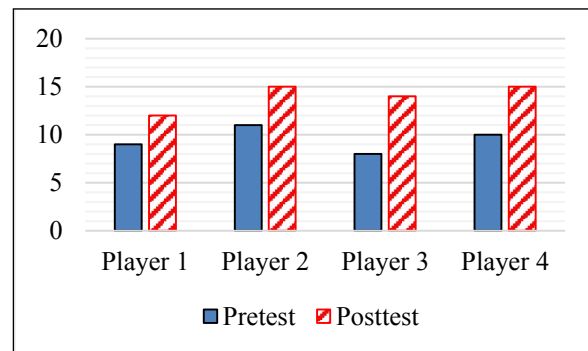


Figure 3. Shooting accuracy in Zone 2

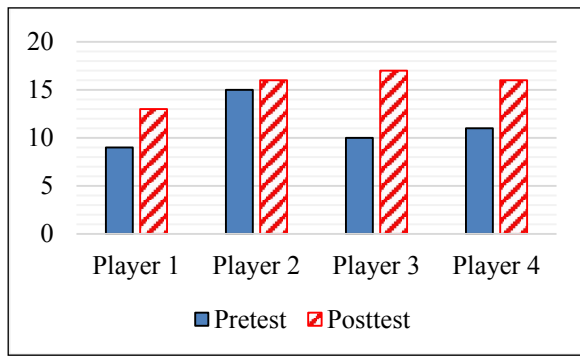


Figure 4. Shooting accuracy in Zone 3

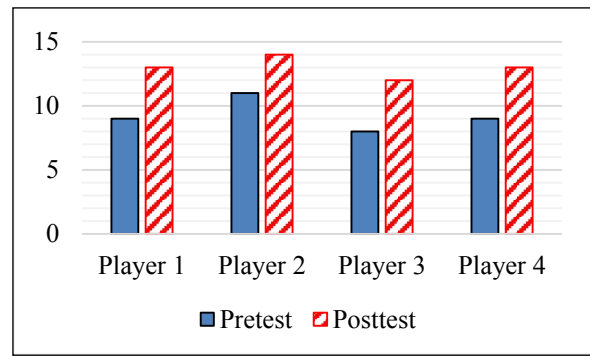


Figure 5. Shooting accuracy in Zone 4

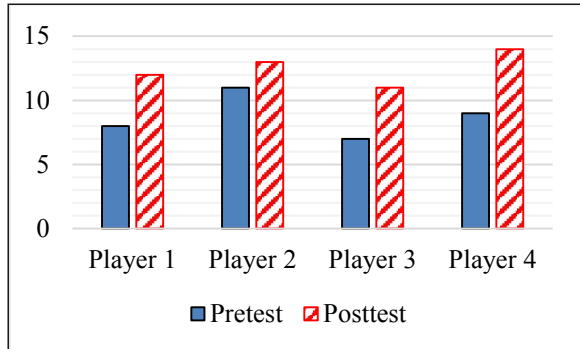


Figure 6. Shooting accuracy in Zone 5

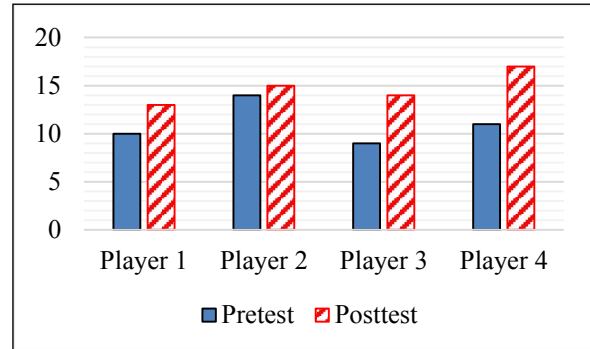


Figure 7. Shooting accuracy in Zone 6

The analysis of the summarized results showed that at the start of the experiment Player 1 achieved the best result in shooting – 10 points (p.) in the low zones – 1 and 6, while the other players scored, respectively: Player 2 – 15 p., Player 3 – 10 p. and Player 4 – 11 p. in the high left area. Player 4 registered the highest level of achievement – 11 p. in the lower right zone. In the first testing (Test 1), Player 2 achieved both the highest score – 15 p. with an effectiveness coefficient (EC) – 75% and the highest total score of 75 p., characterizing

the accuracy of shooting before applying the methodology. The established total of point-awarding indicators showed that, depending on the shooting range in Test 1, players demonstrated the following EC:

1. Zone 3 – 45 p. (EC – 56%);
2. Zone 6 – 44 p. (EC – 55%);
3. Zone 1 – 42 p. (EC – 53%);
4. Zone 2 – 38 p. (EC – 48%);
5. Zone 4 – 37 p. (EC – 46%);
6. Zone 5 – 35 p. (EC – 44%).

Table 1. Summarized results of variance analysis of accuracy indicators

Players	Test stage	Point-awarding indicators by zones						Total points	Min.	Max.	R	X	V, %
		1	2	3	4	5	6						
Player 1	Pretest	10	9	9	9	8	10	55	8	10	2	9.16	9
	Posttest	12	12	13	13	12	13	75	12	13	1	12.5	7
	Difference	2	3	4	4	4	4	3,5	2	4	2	3.5	9
	Increase %	10	15	20	20	20	15	16,7	15	20	5	16.7	10
Player 2	Pretest	13	11	15	11	11	14	75	11	15	4	12.5	11
	Posttest	14	15	16	14	13	15	87	13	16	3	14.5	10
	Difference	1	4	1	3	2	1	2	1	3	2	2	17
	Increase %	5	20	5	15	10	5	10	5	20	15	10	10

Player 3	Pretest	9	8	10	8	7	9	51	7	10	3	8.5	10
	Posttest	14	14	17	12	11	14	82	11	17	6	13.7	15
	Difference	5	6	7	4	4	5	5,2	4	6	2	5.2	9
	Increase %	25	30	35	20	20	25	26	20	35	15	25.8	19
Player 4	Pretest	10	10	11	9	9	11	60	9	11	2	10	7
	Posttest	15	15	16	13	14	17	90	13	17	4	15	11
	Difference	5	5	5	4	5	6	5	4	6	2	5	10
	Increase %	25	25	25	20	25	30	25	20	30	10	25	15
Total p. zones Start (EC-0,5)		42	38	45	37	35	44	241	35	45	10	40.2	12
Total p. zones End (EC-0,7)		55	56	62	52	50	59	334	50	62	12	55.6	12
Difference (Posttest/T2 – Pretest/T1)		13	18	17	15	15	15	93	13	18	5	15.5	11
Total increase in %		16	23	21	19	19	19	19.5	16	23	7	19.5	15

The analysis of the results from the second testing (Test 2) revealed a different picture, reflecting the players' execution skills in the most effective shooting zones. In Player 1 we can see a positive increase of 16.7%, with the highest accuracy of shooting in Zones 3, 4 and 6. There is an evident upgrade of the level of the pushing technique in the high Zones – 3 and 4, where the player registered the best results (13 points). The player maintained a high level of shooting skills in Zone 6, but the highest growth was observed in the average high right Zone 5 – 20%. The results from Test 2 of Player 1 showed a harmonious, positive development of the pushing technique when shooting in the six studied zones.

Player 2, who achieved the highest overall results in the initial test, improved by 10% the overall level of the pushing technique, which was the lowest recorded increase among the four players. The highest accuracy in shooting was achieved by the same player in Zone 3 – 16 points, which, compared to the results from Test 1, showed an increase of only 5%. It can be seen that the player achieved bigger most improvement in the shooting skills in Zone 2 – 20% and Zone 4 – 15%, while in the low Zones 1 and 6 the established increase was only 5%. As a whole, for this player, the methodology had the lowest impact on the in-

crease of the values of the indicators reflecting the accuracy of shooting in case of PC.

Player 3, who demonstrated the lowest overall results in Test 1 – 51 p., (EC – 43%), achieved the highest overall positive increase of 31 p. The established increment of 26% gives us a reason to believe that for this player the methodology had the most significant impact on improving the level of the pushing technique when shooting. The highest accuracy was achieved by this player also in Zone 3 – 17 points. This result, which also presents the highest value of EC – 85% in shooting in both tests, as well as the recorded increase between the two tests in Zone 3 – 35%, is the highest achievement of the implemented methodology for refining the pushing technique. It is evident that the player achieved higher values of the indicators and improvement in the left zones – 2 (8-14 p. / 6 p. diff. / 30%) and 3 (10-17 p. / 7 p. diff. / 35%) compared to the right ones – 4 (8-12 p. / 4 p. diff. / 20%) and 5 (7-11 p. / 4 p. diff. / 20%). When shooting at the ground, both to the left – Zone 1 (9-14 p. / 5 p. diff. / 25%) and to the right – Zone 6 (9-14 p. / 5 p. diff. / 25%), the indicators and the increase showed absolutely aligned values. Overall, for this contestant the methodology had the greatest impact on the increase in the values of the indicators reflect-

ing the accuracy of the pushing technique in the left Zones 2 and 3. The influence on the indicators of the accuracy of shooting when pushing low flying balls to the left and to the right diagonal was with a positive orientation and consistent strength in both Zones 1 and 6.

Player 4 achieved the second highest overall positive increase of 30 p. The established increase of 25% gives us a reason to believe that this player was also significantly influenced by the methodology in terms of improving the level of the pushing technique when shooting. The highest accuracy was achieved by the player in Zone 6 – 17 p. The result is aligned with that of Player 3 and has the highest value of EC – 85% in shooting in in both tests. It is evident that the athlete achieved a relatively uniform increase in the values of the indicators in all the studied zones with an

average increase rate of 25%. The highest increase was observed in Zone 6 (11-17 p. / 6 p. diff. / 30%), the lowest in Zone 4 (9-13 p. / 4 p. diff. / 20%), in all other zones, an increase of 4 points was registered, and the established increase was aligned with the average – 25%. As a whole, for this contestant the methodology had a uniformly strong positive effect on the increase in the values of the indicators reflecting the accuracy of the pushing technique in all zones.

Table 2 summarizes the information reflecting the results of Test 1 (Start/Pretest), Test 2 (End/Post-test), the total and the difference between the point-awarding indicators from the two tests, the established total increase and EC in shooting in the respective zone.

Table 2. Summarized results of indicators reflecting the accuracy of zone shooting

Zones	Pre-test, points	Post-test, points	Total Σ, points	Difference, points	Increase, %	EC, %
1 – low - left	42	55	97	13	13%	S56% - E69%
2 – medium - left	38	56	94	18	22%	S48% - E70%
3 – high - left	45	62	107	17	22%	S56% - E78%
4 – high - right	37	52	89	15	19%	S46% - E65%
5 – medium - right	35	50	85	15	19%	S44% - E63%
6 – low - right	44	59	103	15	19%	S55% - E74%

It can be seen that in the three left Zones – 1, 2 and 3, and in the lower right Zone 4, the players demonstrated higher accuracy in shooting. This fact is also confirmed by the higher value of the EC in Zones 1 (EC 69%), 2 (EC 70%), 3 (EC 78%) and 6 (EC 74%), compared to Zones 4 (EC 65%) and 5 (EC 63%).

The positive increase in the value of indicators between the first and the second testing and the observed percentage increase showed that the Push & Flick methodology had a greater impact on the accuracy of the pushing technique when shooting a PC in Zones 2 (22%) and 3 (22%), with less impact in Zone

1 – only 13% (Table 2). The determined fact is based on a logical justification – in two thirds of the planned shootings, the focus is on flicking – pushing with lifting (Zones 2, 3, 4 and 5), while in Zones 1 and 6, the focus is on pushing – along the surface or with a slight lift of the ball (Zones 1 and 6).

InterCriteria Analysis of the Results

Two IMs (IM₁ and IM₂) were constructed in order to perform the ICrA of the indicators characterizing the accuracy of shooting in the most effective goal-scoring areas (zones):

		Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10
IM ₁ =	Zone 1	3	2	6	7	3	8	4	4	4	1
	Zone 2	0	3	6	6	2	1	8	3	8	1
	Zone 3	2	3	5	7	7	4	1	7	4	5
	Zone 4	3	5	6	2	0	1	7	5	4	4
	Zone 5	0	3	4	4	4	4	5	8	1	2
	Zone 6	4	3	5	6	4	4	5	7	3	3
		Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10
IM ₂ =	Zone 1	4	6	8	6	4	7	6	6	4	4
	Zone 2	5	6	7	5	8	5	5	5	6	4
	Zone 3	5	8	8	5	7	7	4	7	5	6
	Zone 4	7	4	7	8	5	4	8	5	1	3
	Zone 5	4	6	5	8	5	4	3	4	5	6
	Zone 6	5	5	8	6	6	6	5	7	6	5

IM₁ corresponds to the results of all tested players from the first testing, IM₂ – from the second testing. A cross-platform software implementing ICrA, called ICrAData (Ikonomov, et.al 2018), was used. The obtained results are presented in the next IM:

First testing

Degree of agreement $\mu_{c,c'}$ and disagreement $\nu_{c,c'}$, based on IM₁

$\mu_{c,c'}$	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Zone 1	1	0.6316	0.5556	0.4615	0.6857	0.7714
Zone 2	0.6316	1	0.5	0.725	0.6667	0.5882
Zone 3	0.5556	0.5	1	0.3421	0.6857	0.6667
Zone 4	0.4615	0.725	0.3421	1	0.6216	0.5405
Zone 5	0.6857	0.6667	0.6857	0.6216	1	0.8788
Zone 6	0.7714	0.5882	0.6667	0.5405	0.8788	1
$\nu_{c,c'}$	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Zone 1	0	0.3684	0.4444	0.5385	0.3143	0.2286
Zone 2	0.3684	0	0.5	0.275	0.3333	0.4118
Zone 3	0.4444	0.5	0	0.6579	0.3143	0.3333
Zone 4	0.5385	0.275	0.6579	0	0.3784	0.4595
Zone 5	0.3143	0.3333	0.3143	0.3784	0	0.1212
Zone 6	0.2286	0.4118	0.3333	0.4595	0.1212	0

Graphical representation of the obtained results is presented in Figure 8. In the analyses of the resulting estimates the scale proposed in (Atanasov, et al, 2015) was used.

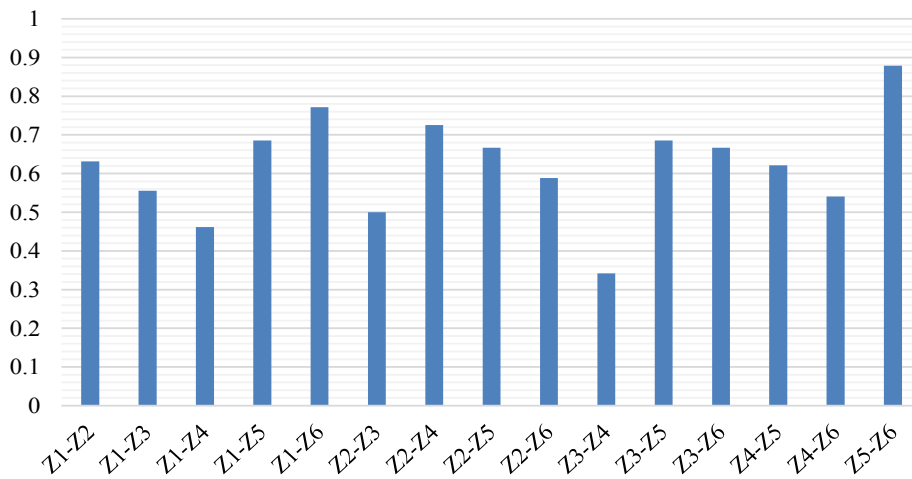


Figure 8. Degree of agreement – ICrA results - first testing

As it can be seen from numerical and graphical results, the obtained ICrA estimates showed the following correlations during the first testing of the players:

- The greatest correlation was found between the achievements of the players in Zones 5 and 6: $\langle \mu_{C,C'}, \nu_{C,C'} \rangle = \langle 0.88, 0.12 \rangle$ with degree of “uncertainty” $\pi_{C,C'} = 0$. This means that those players who show good (or bad

results in Zone 5 in most cases show the same results in Zone 6.

- The next two zones of high correlation were Zone 1 and Zone 6: $\langle \mu_{C,C'}, \nu_{C,C'} \rangle = \langle 0.77, 0.23 \rangle$, again with degree of “uncertainty” $\pi_{C,C'} = 0$.
- The results for the rest of the zones showed that there was no correlation. The obtained results for $\mu_{C,C'}$ were in dissonance.

Second testing

Degree of agreement $\mu_{C,C'}$ and disagreement $\nu_{C,C'}$, based on IM_2

$\mu_{C,C'}$	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Zone 1	1	0.56	0.7407	0.6667	0.4444	0.7917
Zone 2	0.56	1	0.7241	0.4839	0.5667	0.75
Zone 3	0.7407	0.7241	1	0.4	0.625	0.75
Zone 4	0.6667	0.4839	0.4	1	0.3824	0.5517
Zone 5	0.4444	0.5667	0.625	0.3824	1	0.5
Zone 6	0.7917	0.75	0.75	0.5517	0.5	1
$\nu_{C,C'}$	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Zone 1	0	0.44	0.2593	0.3333	0.5556	0.2083
Zone 2	0.44	0	0.2759	0.5161	0.4333	0.25
Zone 3	0.2593	0.2759	0	0.6	0.375	0.25
Zone 4	0.3333	0.5161	0.6	0	0.6176	0.4483
Zone 5	0.5556	0.4333	0.375	0.6176	0	0.5
Zone 6	0.2083	0.25	0.25	0.4483	0.5	0

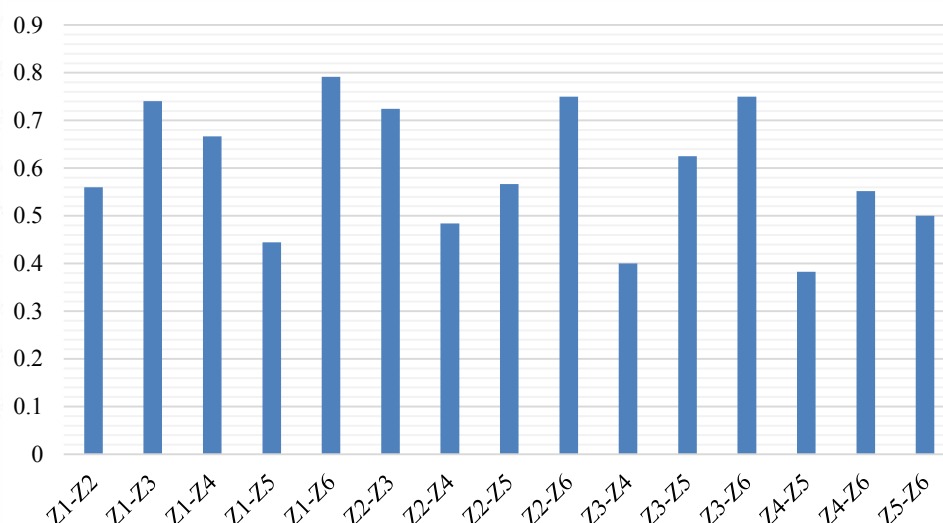


Figure 9. Degree of agreement – ICrA results - second testing

Based on the results (obtained IFP $\langle \mu_{C,C'}, \nu_{C,C'} \rangle$ -values and Figure 9) during the second testing of the players, the following conclusions were made.

Here the correlation between the achievements of the players in Zones 5 and 6 was in dissonance: $\langle \mu_{C,C'}, \nu_{C,C'} \rangle = \langle 0.50, 0.50 \rangle$. This means that the players who show good (or bad) results in Zone 5 or Zone 6 in most cases do not repeat the same results in Zone 6 or Zone 5. This may mean that some of the players significantly improved their performance in one of the two zones.

- The observed correlation between Zone 1 and Zone 6 was higher: $\langle \mu_{C,C'}, \nu_{C,C'} \rangle = \langle 0.79, 0.21 \rangle$, $\pi_{C,C'} = 0$. After training the players showed better accuracy of the shooting both in Zone 1 and in Zone 6.
- The results for the rest of zones showed that there was no correlation. The obtained results for $\mu_{C,C'}$ were in dissonance.
- ICrA analysis showed that there was no correlation between the rest of the zones.

CONCLUSION

The observed dynamics in the increase in the values of indicators reflecting the accuracy of shooting when performing a PC were gen-

erally positive, i.e., the applied methodology had a positive impact on the pushing technique in the six effective zones we determined. In the left areas, we observed a higher increase in Zone 2 (22%) and Zone 3 (22%) and a lower increase in Zone 1 (13%), while in all right zones the increase in the percentage was exactly the same – 19%.

The established different ICrA dependencies between the indicators in the first and in the second testing, especially regarding the increase in Zones 1 and 6, showed that refinement of the pushing technique in the low left Zone 1 will also significantly affect the shooting in the right low Zone 6. The ICrA dependencies determined after the second testing as a whole and the positive dynamics in the increment by zones give a reason to believe that refinement of the pushing when shooting a PC should have a strict specialization and purposefulness, i.e., the focus should be on improving the accuracy of shooting to the left or to the right zones, to the medium or to the high ones, etc.

Based on the results obtained from the analysis, we recommend that the Push & Flick method should be used to improve zone shooting only during the training period. In the pre-competition or early competition phases of

the weekly cycle, the emphasis should be on the variable execution of 80-100 shootings in a minimum of four zones. In the competition period, the amount of specialized training to improve the pushing/flicking, should be reduced progressively to 40-60 shootings, at the expense of greater variability, including in game conditions.

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