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Analyzing Differences in Penalty Corner Execution Pattern between Winning and Losing Teams in Women's Hockey

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Abstract Penalty corners are crucial events in hockey games as they provide a big opportunity to score a goal and win the game. However, the execution patterns of penalty corners vary among teams, which can impact their success rates. Therefore, the aim of this study was to investigate the execution patterns of penalty corners between winning and losing teams in the Women's Malaysian Hockey League. The data of the study was collected from the National Women's Hockey League, which included twenty league matches and five knockout matches in the cup competition. A total of 195 penalty corners were analyzed using the computerized software namely Gamebreaker (Hudl, USA). This study focused on the pattern or types of shots namely drag flick, direct hit, deflection and tap. The results through a paired-sample t-test found that only drag flick ($p<.05$) showed a significant difference between winning and losing teams. Conversely, direct hit, deflection, and tap showed no significant differences ($p>.05$). In conclusion, this study proved that drag flick was an effective pattern of shot that provided positive results to the team. Therefore, players and teams must focus on improving their penalty corner execution, especially concerning drag flicks, to achieve better outcomes. These findings have practical implications for hockey coaches, players, and teams, highlighting the importance of paying attention to their penalty corner execution strategies.

Keywords Field Hockey, Drag Flick, Tactical Pattern, Performance Analysis

1. Introduction

Field hockey is one of the most popular sports played worldwide. Men's field hockey made its Olympic debut in the 1908 London Games, while women's field hockey was introduced to the Olympics in 1980 during the Moscow Games. Consequently, over 127 countries around the world play field hockey, making it one of the most successful sports globally [1]. Hockey primarily consists of three types of sports: field hockey, indoor hockey, and ice hockey [2]. In field hockey, [3] indicated that there are two play versions involving distinct surfaces: natural grass, which dates back thousands of years, and synthetic turf, which has been used more recently.

The game has several types, each with unique features and rules. However, game genres are broadly categorized into three groups: net and wall games, invasion games, and ground/floor games. Field hockey is a fast-paced game that involves the use of sticks and a ball, falling under the goal-striking invasion game category, as identified by [4]. In these sports, players or teams must surpass their opponents in terms of skill and strategy to gain an advantage during the game, as noted by [5]. According to [6], a penalty shot is also a crucial factor that determines success in some targeted invasion games like field hockey. Thus, players need to master a range of skills, such as

speed, agility, teamwork, and tactical thinking, to excel in this thrilling and challenging game [7].

The aim of field hockey is to outscore the opposing team by getting the ball into the goal. There are several ways to score goals, including the field goal, penalty stroke, and penalty corner. The field goal is scored during open play and is treated like any other goal [8]. However, the penalty corner is one of the most crucial game scenarios in field hockey, accounting for one-third of all goals scored [9]. This corner, awarded to the attacking team, provides a unique opportunity for goal-scoring by setting up an attacking structure that can involve multiple players, including a specialist drag-flicker. As [6] pointed out, the penalty corner is one of the most significant goal-scoring options in field hockey and can be the difference between winning and losing a match. Similarly, a penalty stroke is awarded to the attacking team for a foul committed by a defender in the penalty circle, offering another excellent opportunity to score a goal. Therefore, field hockey players must have a wide range of skills, including accurate passing, ball control, and strategic thinking, to capitalize on these opportunities and win matches.

The penalty corner is a crucial aspect of field hockey that can significantly influence the outcome of a game. It is awarded to the attacking team as a result of a defending team's foul committed inside the circle between the 23-meter line, or an accidental foul inside the circle, leading to a free shot on goal [10]. The attacking team must use this opportunity wisely and employ a well-planned strategy to convert it into a goal. The ball is moved to the stopper who stops the ball outside the circle, and then the striker either flicks or hits the ball (direct hit or slap hit) into the goal line [10]. The choice of the striker and the method of hitting the ball depend on the specific game situation and the opposing team's defense. The team may also employ various techniques, such as feints or disguised plays, to confuse the defenders and increase the chance of scoring. Therefore, executing the penalty corner accurately and effectively is crucial for the attacking team to gain an advantage in the game.

During a penalty corner, the attacking team has a crucial opportunity to score a goal, and utilizing the information gained during the particular situation can improve the probability of scoring. This includes factors such as the number of stoppers used by the defending team and the method of play employed by the attacking team [11]. As pointed out by [8], certain well-proven techniques can be used to execute the penalty corner perfectly. These techniques can help coaches and players carefully analyze the offensive and defensive penalty corner strategies of the opposing team and devise an effective approach to counter them, significantly increasing the attacking team's chances of scoring a goal.

When deciding on the style of shooting to use during penalty corner execution, it is important to consider the advantages and disadvantages of both the drag flick and direct hit. The drag flick involves flicking the ball with the stick in a controlled manner to lift the ball into the goal and is a popular technique due to its accuracy and ability to generate high speeds [12]. On the other hand, the direct hit involves hitting the ball directly toward the goal, often at a lower speed, but with greater accuracy and the possibility of generating a rebound or deflection for teammates [12].

Moreover, the placement of the ball is crucial during penalty corner execution [12]. They recommend playing the ball low inside the wooden board at the back of the goal post, at a height of about 46 cm, as this area is often difficult for the goalkeeper to defend. However, with the drag flick, the ball can be raised at any part and position of the goal post, which provides greater flexibility in terms of shot placement. By carefully considering these factors, coaches and players can make informed decisions about which shooting style and placement to employ during penalty corner execution to maximize their chances of scoring.

Other than that, [3] emphasized that deflection is a powerful technique for scoring goals during penalty corners, which is particularly attractive for women's teams, as they use it 27.7 percent of the time due to its effectiveness. The authors suggested that deflection could be an effective way to score, as it involves using the speed of the ball from the push out and deflecting it into the goal, making it more difficult for the goalkeeper to stop it. This finding was in line with the study by [13], who noted that women's teams tend to use deflections or direct hits more frequently than drag-flicks during penalty corners.

As indicated by [14], performance analysis plays a critical role in sports and exercise science, as it provides an objective evaluation of an athlete's actual performance, rather than relying on subjective assessments from participants, coaches, or spectators. This approach involves collecting and analyzing data from various sources, such as video footage, software applications, and specialized devices, to capture detailed information about player behavior, location, timing, and outcomes, including both successes and failures. The use of performance analysis is increasingly common across different sports, enabling coaches to gather accurate and detailed information that can be used to evaluate and improve athlete performance, identify strengths and weaknesses, and develop targeted training programs to optimize performance [15].

Performance analysis is a critical element of modern sports, and coaches and teams heavily rely on its insights to make informed decisions. As noted by [16], performance analysis has evolved significantly in recent years, encompassing a wide range of fields and topics. In particular, there is growing emphasis on the use of sports performance metrics, which provide a standardized way of measuring and comparing performance across different sports and athletes, as well as live movement analysis, which involves real-time tracking of players during matches or training sessions to identify strengths, weaknesses, and areas for improvement.

The use of computer technology has greatly benefited

performance analysis, with analysts able to use software such as Gamebreaker, Sports Code, Nacsports, and System Analysis of Players (SAP) to conduct both post-match and live analysis. This systematic approach uses specialized tools and techniques to collect and analyze data, which can then be used to inform coaching and conditioning strategies. Additionally, the analysis of strategic and tactical factors has become increasingly crucial as coaches and teams seek to gain a competitive edge by understanding and exploiting their opponents' weaknesses.

A key area of interest in performance analysis is the assessment of technical and tactical success during match-play, which can provide valuable insights for coaches and players seeking to improve their performance. Therefore, this study aims to investigate the differences in penalty corner execution patterns between winning and losing teams in the Women's Malaysian Hockey League, using software technology to analyze the data. The study will integrate the results with the coaching process to improve overall team performance, as performance analysis is a critical component of modern sports.

2. Methods

2.1. Sampling and Video Selection

In this study, purposive sampling was employed, involving a stratification process to select relevant videos. As a result, a comprehensive analysis was conducted on a dataset comprising 25 videos from the TNB Women Malaysian Hockey League 2016, which included both league and knock-out matches. The dataset specifically consisted of 20 regular league matches and an additional 5 knock-out matches played during the cup games. In total, there were 25 winning teams and 25 losing teams altogether that had been selected in this study. All matches were meticulously analyzed using the Gamebreaker computer software (Hudl, USA) to examine penalty corner execution patterns. A total of 245 penalty corners were evaluated, with 148 penalty corners attributed to the winning teams and 97 to the losing teams. This extensive and detailed examination of the dataset facilitated a deeper understanding of the variations in penalty corner execution strategies, ultimately emphasizing key differences between the winning and losing teams in the Women's Malaysian Hockey League.

2.2. Procedures

The data for this study was collected using a cross-sectional design, which involved analyzing data from a specific population at a particular moment to gain insights into its characteristics [17]. The study's data was collected from various locations, primarily focusing on the regions of Klang Valley, Melaka, and Johore. In the Klang Valley, matches took place at Stadium Hoki KPM, Bangsar, and Stadium Hoki Jalan Duta. Another venue, Stadium Hoki Majlis Bandaraya Melaka Bersejarah (MBMB) in Bukit Serindit, was utilized in Melaka, while Stadium Hoki Sekolah Sukan Tunku Mahkota Ismail (SSTMI) in Bandar Penawar, Johore, also served as a host for games. These stadiums were specifically chosen as the home venues for the participating teams in the league.

To facilitate the subsequent analysis, all matches were recorded using a high-definition video camera with enhanced resolution. Since the analytical software requires MP4 format, all game footage was converted accordingly. The program then analyzed the videos based on the selected output predictors established in the code window. This process involved breaking down the videos into individual frames, each representing a success metric, and displaying them in a timeline window. As [14] noted, a variety of software systems and tools have been developed to aid in performance measurement across different sports. These analytical tools enable coaches to gain valuable insights that can inform their strategies and ultimately improve their teams' performance.

2.3. Types of Shot

In this study, four different types of shots were chosen for analysis, which include drag flicks, hits, deflections, and taps (Table 1). Each of these shot types represents a unique approach to scoring goals during TNB Women Malaysian Hockey League. By examining these four shot types, the study aimed to gain a comprehensive understanding of the various techniques utilized by players during the League to score goals, as well as how these shots contribute to a team's overall performance in field hockey.

Table 1. Types of shot for penalty corner analysis

No	Types of Shot	Details
1	Drag flicks	Swiftly dragging the ball forward with the head of the stick and then flicking it towards the goal with great speed and accuracy.
2	Hits	Striking the ball with a powerful swing of the stick.
3	Deflections	Occur when a player intentionally redirects the trajectory of the ball using their stick, often in mid-air.
4	Taps	Gently taps or nudges the ball into the goal.

2.4. Video Analysis Software

The state-of-the-art computerized software, Game Breaker (Hudl, USA), was employed to analyze the data collected in this study. This particular software was selected due to its capability to effectively categorize performance indicators, thereby streamlining and simplifying the analysis process. Moreover, the software boasts a wide array of features, furnished by the developer, that serve to further enhance and refine the analytical procedures employed in the study.

The performance indicators adopted in this study were grounded in the findings of previous research conducted by esteemed scholars, such as [3], [11], [18], [19]. By leveraging these pre-existing indicators, the study was able to build upon and expand the current body of knowledge, ultimately yielding a more comprehensive understanding of the various performance factors in field hockey. The use of Game Breaker (Hudl, USA) not only facilitated a thorough analysis of the data, but also enabled the researchers to identify patterns and trends in player performance, assess the effectiveness of various techniques, and uncover potential areas for improvement during penalty corner.

2.5. Data Analysis

Descriptive statistics, particularly mean and standard deviation, were employed to concisely summarize and present the data in a readily understandable format. In addition, the paired-samples t-test was applied to assess the differences in the types of shots executed by winning and losing teams during penalty corners, shedding light on their distinct strategies and effectiveness. All statistical analyses were conducted using the Statistical Package for Social Science version 26 (SPSS ver. 26.0), with a significance level established at $p \leq 0.05$, ensuring the accuracy and reliability of the study's results.

3. Results

Table 2 presents the descriptive statistics for the types of shots executed during penalty corners by both winning and losing teams. As displayed, drag flicks were the most frequent shot type for winning teams when executing penalty corners, accounting for 41.52% with mean 1.960 ± 0.889 of their attempts. Winning teams also performed nearly similar percentages of direct hits and deflections when executing penalty corners with 25.43% and 27.97%, respectively. Tap shots were the least favorable method for winning teams when executing penalty corners, constituting only 5.08% with mean 0.240 ± 0.436 of their attempts.

Conversely, the table also demonstrates that losing teams performed more direct hits than other type of shots, accounting for 40.26% with mean 1.240 ± 0.779 of their attempts. Deflections were the second choice for losing teams, with 35.06% of their attempts. In contrast to winning teams, drag flicks were not a favored shot type for losing teams during penalty corner execution, as they comprised just 22.08% with mean 0.680 ± 0.690 of their attempts. Tap shots were the least preferred method for both winning and losing teams, making up a mere 2.60% of the attempts by losing teams. Furthermore, Fig. 1 presents a line chart illustrating the comparison of shot types in penalty corners between the winning and losing teams.

Table 2. Descriptive Statistics Comparing Shot Types in Penalty Corners for Winning and Losing Team

Type of Shots	Winning Team			Losing Team		
	Score (%)	Mean	SD	Score (%)	Mean	SD
Drag Flick	41.52	1.96	0.89	22.08	0.68	0.69
Direct Hit	25.43	1.20	0.77	40.26	1.24	0.78
Deflection	27.97	1.32	0.80	35.06	1.08	0.57
Tap	5.08	0.24	0.44	2.60	0.08	0.28

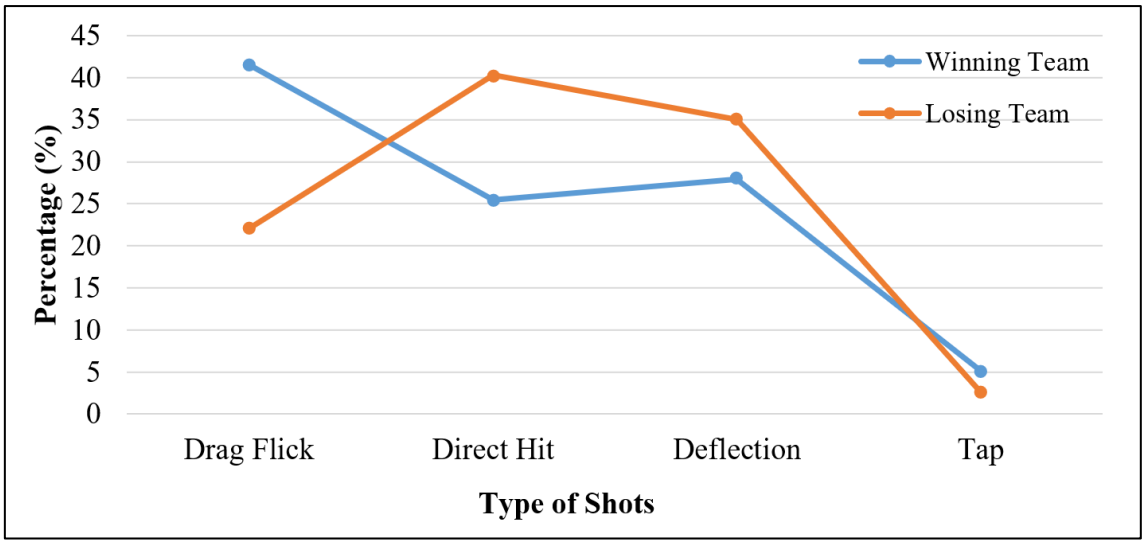

Figure 1. The comparison of type of shots in penalty corners between winning and losing teams

Table 3. A paired-sample t-test of type of shot in penalty corner between winning and losing team

Type of Shot	Mean	SD	t	df	Sig. (2-tailed)
Drag Flick	1.28	1.28	5.02	24	.00
Direct Hit	-0.04	1.06	-0.19	24	.85
Deflection	0.24	1.01	1.19	24	.25
Tap	0.16	0.55	1.45	24	.16

T-test Analysis

A paired-sample t-test was conducted to analyse the type of shots used by the winning and losing teams. The results presented in Table 3 displayed the t-test values for the drag flick [t (24) = 5.02, p (.00) < .05], direct hit [t (24) = -0.19, p (.85) > .05], deflection [t (24) = 1.19, p (.25) > .05], and tap [t (24) = 1.45, p (.16) > .05]. These findings revealed that only the drag flick exhibited a statistically significant difference (p < .05) between the two groups. In contrast, the direct hit, deflection, and tap did not demonstrate any significant differences (p > .05). Consequently, this finding suggests that the drag flick played a crucial role in distinguishing the performance of the two groups, thereby contributing to the divergence in their outcomes.

4. Discussion

The aim of this study was to analyze the differences in penalty corner execution between the winning and losing teams in the TNB Women's Malaysian Hockey League 2016. Penalty corners are widely recognized as one of the most successful ways to score goals and gain an edge over the opposing team, as evidenced by the fact that one-third of goals in field hockey games are scored from penalty corners [9]. Vasiljev et al [20] stated that for the penalty corner to succeed, the last phase of the penalty corner which is the striking phase should be emphasized since it can be played in a large number of variations either from striker's direct to goal or play a set-piece. This study provides significant insights into the execution patterns and shot types used during penalty corners in hockey matches.

Throughout this research, it was observed that both the winning and losing teams predominantly employed the drag flick technique during penalty corners. The findings revealed that the winning teams performed the drag flick more frequently compared to the losing teams. These results demonstrate that winning teams possess superior drag flickers in executing penalty corners. These findings align with the study conducted by [11], which discovered that women's hockey shooters on winning teams predominantly utilized the drag flick technique, particularly targeting the bottom-left area of the corner to achieve their desired outcomes. Eskiyecek [21] also supported these findings by stating that the drag flick is significantly more effective than hits or pushes during penalty corners, thus serving as a valuable tool in altering match outcomes. A study by Lord [22] further emphasized that many teams prioritize improving their drag flick skills due to the technique's high success rate in goal scoring compared to other methods during penalty corners. Indeed, the successful conversion of penalty corner required optimum precision, speed, and correct technique [23]

Researchers [24] indicated that the drag flick is recognized as an efficient tool for penalty corner execution,

as it poses a greater threat and increases the probability of scoring. The researchers also discovered that field hockey laws allow the shooter to pull the shot together with the head of the stick and then flip it, providing more control and power compared to simply touching the ball, similar to a closed chain action seen in cricket batting or badminton smashing. These findings support the present study's conclusion that the drag flick is the most favorable method for executing penalty corners among winning teams.

During a drag flick, the flicker performs a run-up followed by a strong "drag" of the ball, maintaining contact between the ball and the stick, before releasing the ball with a flicking motion toward the goal [24]. As the objective is to take a shot with maximum power and accuracy toward the opponent's goalpost, the drag flick is recognized as an effective technique [24]. As strongly suggested by [9] the drag flick should be performed with pace and accuracy when shooting at the target. Therefore, this shot type is likely to be utilized by most hockey teams. On average, penalty corners occurred 2.97 times per game, or 1.48 times per team. As discovered by Mosquera [3], the drag flick has become the most effective method for scoring goals from penalty corners due to its requirement of striking the ball directly toward the goalpost without any height limitations. Furthermore, according to Klatt et al [25], drag flicker has more time to have better gaze direction on defender’s movement to execute a better angle towards the goal.

In addition to the drag flick, both winning and losing teams also employed hit shots during penalty corners. The winning team had a 25.43% direct hit rate, while the losing team had a 40.26% rate throughout the tournament (Table 2). The paired-sample t-test results revealed no significant difference in the application of direct hits within penalty corner executions between the winning and losing teams.

Hit shot typically requires power and generates momentum at the speed of the ball, creating uncertainty for the target keeper in their efforts to save the shot [19]. Furthermore, de Subijana [9] claimed that the velocity of the ball can be optimized when executing the drag flick, provided that the player has received proper training using the required techniques. However, the velocity of the ball cannot reach the same level when performing a direct hit.

Another aspect to consider within the penalty corner set-piece is the athletic qualities and shooting skills of the players involved. This means that selecting players with excellent abilities in executing both the hit and drag flick within the penalty corner is of utmost importance. As suggested by Mosquera [3], the skill of the drag flick and the hit in penalty corner shooting should be acquired by multiple players. However, players who can efficiently master both the drag flick and direct hit are still valuable assets to the team.

A direct hit involves a rapid stick movement to accelerate the shot, with the hands closed at the top of the stick to increase acceleration [8]. According to [12], teams tend to favor the drag flick over the direct hit when executing penalty corners. Unlike the drag flick, which allows the player to lift the ball at any part of the opponent's target post, a direct hit is restricted to the wooden region of the target post, approximately 46 centimeters in height.

However, aside from these two direct shots, the present study illustrated that deflection is a productive method to hit the target, particularly for women's teams, despite no significant differences being found in the present study. As discovered by Moon [11], women in penalty corner situations, deflection had a higher success rate than direct shooting. Although the present study did not identify significant differences between winning and losing teams in executing deflections, it is evident that this technique remains an appealing option for women's teams during penalty corners.

5. Conclusions

In conclusion, the findings of this study provide strong evidence that the drag flick is an effective and successful pattern of shot during penalty corner execution. The analysis demonstrated that the winning teams utilized the drag flick more frequently compared to the losing teams, indicating that this technique played a significant role in their success. The implications of these findings are highly relevant for hockey coaches, players, and teams. It is crucial for players to develop and refine their drag flick skills, as this technique has proven to be a distinguishing factor in the performance of winning teams. Coaches and match analysts should prioritize training sessions that focus on improving drag flick execution, incorporating specific drills and exercises that enhance speed, accuracy, and power in this particular shot. By dedicating attention to penalty corner strategies and ensuring proficiency in the drag flick, teams can significantly improve their chances of success and secure more goals during critical moments of the game. For future study, it may explore additional factors that influence the success of penalty corner execution. For example, investigating the impact of player positioning, team coordination, and defensive strategies employed by the opposing teams could provide valuable insights into optimizing penalty corner strategies. Moreover, incorporating advanced statistical analysis techniques, such as machine learning algorithms, could help identify patterns and tendencies that lead to successful penalty corner execution. By delving deeper into these aspects, researchers can further enhance our understanding of the intricate dynamics of penalty corner play and provide even more comprehensive recommendations for players and coaches.

Conflicts of Interest

The authors declare have no conflict of interest.

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