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NOTATIONAL ANALYSIS OF INTERNATIONAL NETBALL

SHOOTING

CONTENTS

CHAPTER III

CHAPTER IV

CHAPTER V

CHAPTER VI

TABLES

FIGURES

Acknowledgements

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Abstract

The purpose of this study was to establish the amount of variability that exists between attacking patterns of play in comparison to the outcome of goal attempts, in elite international netball. The notation was post event, in conjunction with pre-recorded videotapes. Ten international netball matches were used to collect information, regarding eight international teams. The study was conducted using a hand notation system that consisted of a simple table with eight columns to collect various data for each match. A Mann Whitney U and Kruskal Wallis ANOVA test were used to compare successful goals, attacking rebound shots, defensive rebound shots and shots that went off the back of the court. An inter-operator reliability test was undertaken using the kappa statistic, comparing the author's results against a second observer, which revealed a high strength of agreement.

The results of the current investigation showed significant differences ($p < 0.05$) between the outcome of an international netball shot with respect to each performance indicator that was examined. The area from which a shot was taken, the player that executes the shot and the style of shot used was shown to have a significant effect on the outcome of the shot ($p < 0.05$). Also the pattern of attack, highlighted by the feed player and position, was concluded to have a significant impact on the outcome of the goal attempt ($p< 0.001$). Finally the difference between outcome with respect to whether the shot was marked or not was seen as significant ($p=0.018$).

Chapter I

Introduction

Introduction

Netball was invented in 1981 as an alternative to the popular game of basketball. Dr. James Naismith developed netball as a female version of basketball and forms the basis of the game played today (Steele, 1990). The first official game of netball was played in England in 1892 and within five years had become very popular amongst women (Mullan, 1996). By 1926 netball was rapidly spreading, resulting in the formation of the All England Netball Association (AENA) followed by the Welsh Netball Association (WNA) in approximately 1945. Netball is now a thriving sport played in 28 countries affiliated to the International Federation of Netball (Elliott and Smith, 1983).

However, although netball is expanding worldwide, the performance analysis of this sport is still limited in comparison to sports such as soccer and squash (Hughes and Franks, 2004 p.70). Otago (1983) was one of the first researchers to focus on the activity patterns of the netball players. He analysed typical movement patterns and skills used by each position during a game situation to aid coaches during training. This study was later extended by Steele and Chad (1991, 1992) comparing movement patterns during game play with those during training. The reason behind this research was the lack of information available to both coach and athlete for netball conditioning, despite its importance.

Other researches such as Fuller (1990), (cited in Hughes & Franks, 1997 pp. 21), who analysed world championship games in 1987 looked at the different performance trends between winning, losing and drawing teams. The study carried out by Fuller (1990) and other analysts such as Steele and Chad (1991, 1992) and Palmer et al. (1994), analysed broad aspects of the game and a variety of positions. Embrey (1978) noted that analysis in netball was 'adopted to make the most of each player's potential' (cited in Hughes & Franks, 1997 pp.21.) For each player to reach his/her potential a specific training and coaching practice should be enforced and specific player analysis achieves this.

Elliot and Smith (1983) were more specific with their research, they analysed the technique of shooting in netball and within their research they highlighted the lack of match statistics related to shooting under game conditions. They also noted that with the lack of shooting data, no benchmark could be set for coaches to enable them to analyse the statistics which would indicate what is expected from their shooters during the game, for example, how many shots the coach should expect from each shooter per quarter (Cited in Hughes & Franks, 2004, pp. 71).

Palmer et al. (1994) carried out a study investigating centre pass plays of successful and non-successful international netball teams, and within this study found that the skill level of a team can be differentiated on the basis of 'the ability to create goal scoring opportunities'. They also found that the

winning teams had a significantly more active goal shooter, showing how important it is for the goal shooter to be actively involved in the play as well as being an efficient shooter. Agreeing with Palmer's 1994 study is the result of an analysis performed by Edwards & O'Donoghue (2004). This study looked at the technical effectiveness of shooting and passing, of winning and losing teams in international netball. The results found that successful teams create significantly more scoring opportunities, and use the goal shooters more in passing; relying less on other players such as the Centre. However, the research also found that there as no significant difference between the shooting effectiveness of winning and losing teams, disagreeing with research carried out by Fuller (1990) as mentioned earlier.

1.1 Aim of study

The aim of the study was to devise a hand notation system to analyse a number of performance indicators surrounding the attacking pattern of play, and skill of shooting in International Netball. The following information from the system was recorded:

1. The area where each shot is taken from
2. The player attempting the goal
3. The type of shot used
4. The player that feeds each shot
5. The position where the feed comes from
6. Whether each shot is marked
7. The outcome of each shot

From the results of numerous statistical analysis tests, the aim of the research is to see if any differences lie within the outcome of a shot for each performance indicator.

1.2 Scope and Limitations

Scope

The scope of this investigation is 10 International Netball matches involving 8 International teams. The results of the study are only applicable to teams of International standard.

Limitations

1. The time and word limit of the study are limited, therefore limiting the amount of data that can be collected and the depth of the analysis
2. The quality of some of the video tapes is poor, therefore making player recognition difficult
3. The angle at which the matches are videoed is also a limitation. For example, if the camera is close up to the players then the position on court of the action is difficult to judge. Similarly when the camera is viewing the whole court it is difficult to identify the players and differentiate between areas on court.
4. Observational errors will be a limitation and also errors during data input.

1.3 Null hypothesis:

H_0: There is no significant difference between the outcome of an International netball shot, with respect to the following performance indicators:

1. Position of shot within the shooting circle
2. Player who executes the shot
3. Style of shot used
4. Whether the shot is marked or not
5. The player that feeds the shot
6. The position from where the shot is fed

H_A: There is a significant difference between the outcome of an International netball shot, with respect to the following performance indicators:

7. Position of shot within the shooting circle
8. Player who executes the shot
9. Style of shot used
10. Whether the shot is marked or not
11. The player that feeds the shot
12. The position from where the shot is fed

Chapter III

Methods

3. Methods

Introduction

A hand notation system was designed to analyse the difference between the outcome of a netball shot, with respect to a range of variables. Data was notated post-event with the use of pre-videoed footage of ten International netball matches.

3.1. System Design

The table in which the data was entered consisted of eight columns, each of which recorded a different piece of data for every shot taken, an example is shown below (table 1). Every time a shot was taken the author had to rewind the video and note the relevant information into the table leading up to and concerning the goal attempt. The first three columns concern the shot attempt, the position from where the shot was taken, the player who attempted the goal and the type of shot they executed was noted. Within the forth and fifth columns it is noted the position and player that fed the ball into the shooting player. The final three columns note the outcome of the shot, whether the shot was marked or not and the team that is attempting goal.

Table 1. An example of the data sheet used during notation

Circle Position	Shot Taker	Shot Type	Feed Position	Feed Player	Outcome	Marked	Team

3.1.1 Performance Indicators

Below is a list of the performance indicators that were used for each aspect of the shooting pattern and technique that is notated during the current investigation.

Outcome of shot:

There are 5 possible outcomes for each goal attempt:

S – Successful shot

A – Attacking rebound (an attacking player re-gains possession of the ball)

D – Defensive rebound (a defensive player gains control of the ball)

OB – Off- Back (The ball goes straight off the back of the court, resulting in a defensive, back line pass)

J – Jumped (either the goal defence or goal keeper jump the ball gaining possession during the flight of the goal attempt)

Shot area:

For the purpose of this investigation the shooting circle is split into 7 regions. These regions have been adapted from those advocated by Elliott and Smith (1983) and were defined as in figure 1.

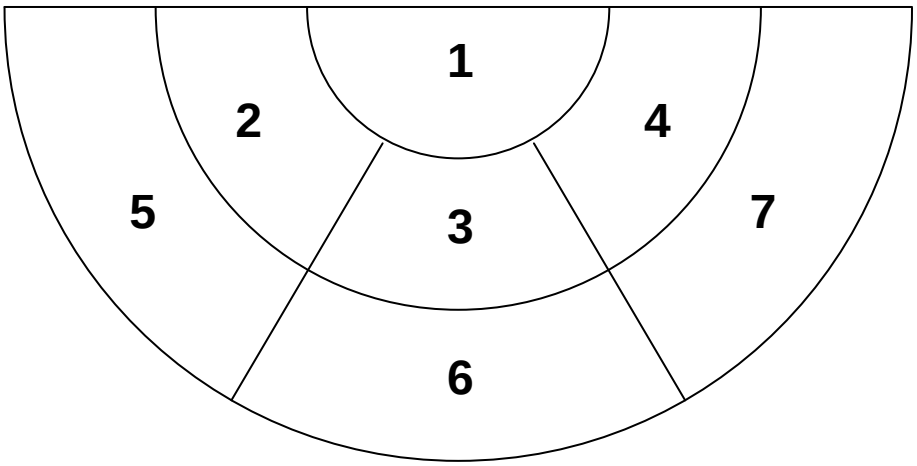


Figure 1. An illustration of the shooting circle as divided by the current investigation

Shot type:

For the purpose of this study there are 6 shot variations, shown below:

A – Standard - two-footed stationary shot.

B - Jump shot – ball release is delayed until reaching the top of the jump, and then the wrist and fingers are used to flick the ball into goal.

C – Back step - step backwards away from the post prior to shot

D – Side step - step to the side either right or left prior to shot

E – Forward step – step towards the post prior to shot

F – Running shot – shot is taken whilst player is in a running motion

(Woodlands, 2006)

Shot taker:

There are two positions that shoot during a game:

A – Goal attack

S – Goal shooter

Feed Player:

As the ball must be fed within the attacking goal third or centre third the goal keeper cannot feed the shot, therefore there are 6 possible feed players:

GD – Goal defence

WD – Wing defence

C – Centre

WA – Wing attack

GA – Goal attack

GS – Goal shooter

Feed Position:

For this investigation the feed area was divided into 10 regions as shown in figure 2. The regions only cover the attacking and centre third as no shot can be fed from the opposing attacking third due to the rule in netball that a ball cannot pass over a third.

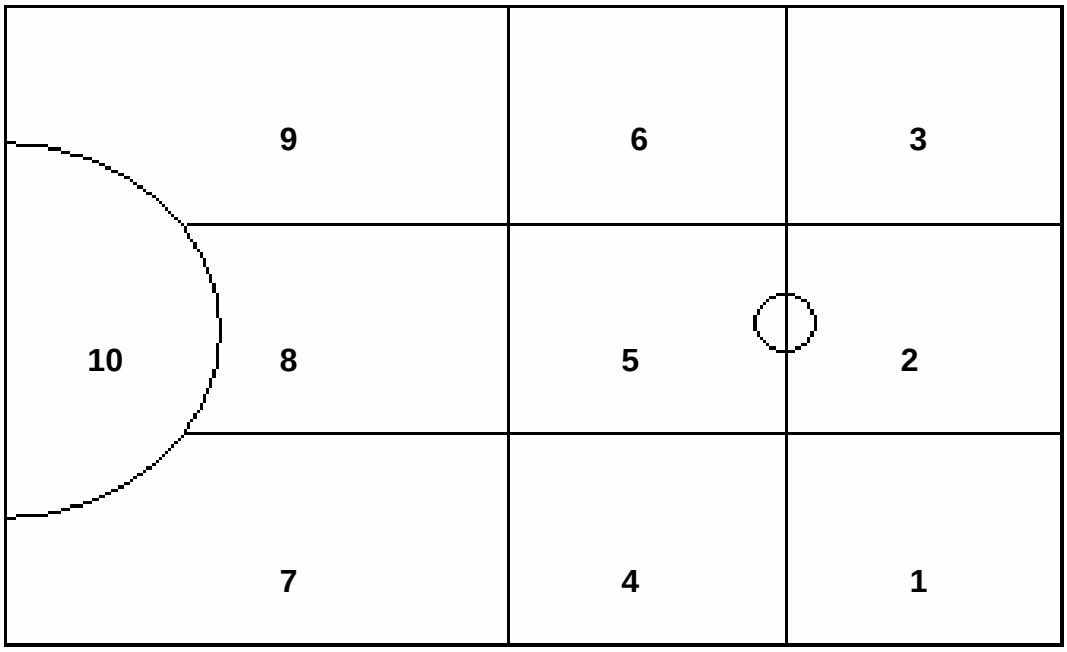


Figure 2. A diagram of the feed areas as specified for this investigation

Alternative performance indicators

During this investigation there are three alternative ‘feed areas’ and ‘feed players’ shown below. These performance indicators are used when a specified feed player and feed area cannot be used due to an alternative pattern of play.

If there is an infringement of the rules within the shooting circle a penalty is given, therefore there is no feed player or position so a penalty shot is noted in its place:

P – Penalty shot

After a shot attempt the attacking team may re-gain possession and take another shot straight away, therefore there is no feed player or position available to notate so a rebound is noted:

R – Rebound

If the defence have possession of the ball and a pass is intercepted by an attacking player within the circle they have the opportunity to shoot. As there is no feed player or position, an interception is noted instead:

IN – Intercepted pass

3.1.2 Data Population

The population for this data was women's International netball teams. The video footage was obtained from 10 international matches, involving 8 separate teams (shown in table 2).

Table 2. Matches analysed during the study

Match	Teams	Event
1	Wales v Jamaica	Commonwealth Games 2005
2	Wales v Singapore	Commonwealth Games 2005
3	Wales v Australia	Commonwealth Games 2005
4	Wales v Barbados	Commonwealth Games 2005
5	Wales v South Africa	Commonwealth Games 2005
6	Wales v Samoa	Commonwealth Games 2005
7	Wales v Jamaica	2005
8	Wales v Glasgow	2003
9	Wales v South Africa	2004
10	Wales v South Africa	2007

3.1.3 Pilot study

A small pilot study was conducted prior to the main analysis to familiarise the author with the system. This consisted of analysing one half of an International netball match. From this study it was concluded that to analyse one half of the match (30 minutes) it would take the author 1 hour to notate all the events, and a further 15 minutes to input the data into excel. Therefore to analyse and input the data from one of the International netball matches it would take the author approximately 1 ½ hours.

3.2 Data Processing

3.2.1 Data Input

All data was collected in Microsoft excel then transferred into SPSS for analysis. Quantitative data gathered for analysis was both nominal and non-parametric in nature, therefore does not carry assumptions regarding the distribution of the data as expected for parametric statistical tests (Vincent, 1999).

3.2.2 Statistical Testing

A Mann Whitney U test is ‘a non-parametric statistical technique for determining the significance of the difference between rankings of two groups of subjects who have been ranked on the same variable’ (Vincent, 1999, p.279). This procedure was used during this study when comparing shot outcome with variables that have only two groups, for example shot taker.

The remaining data was compared to the shot outcome using a Kruskal Wallis ANOVA test. The Kruskal Wallis ANOVA is a nonparametric test to compare three or more samples. It tests the null hypothesis that all populations have identical distribution functions against the alternative hypothesis that at least one of the populations tends to have larger or smaller values than the other (Hinton et al., 2004).

The results that are highlighted as significant by the Kruskal Wallis test have further been individually tested using Mann Whitney Tests to identify where the significance lies within the data. For example, the results showed a significant difference between shot area and outcome. To identify where the difference lay, individual Mann Whitney tests were performed comparing each area individually with every other area.

For a result to be significant the Mann Whitney U or Kruskal Wallis statistical test must have a value of $p \leq 0.05$. This creates a level of significance of 95% or above.

3.3 Reliability

Inter-observer Reliability test

Reliability of study is essential for gathering accurate and consistent data for analysis (Hughes *et al*, 2002). Vincent (1999) described reliability as a measure of the consistency of data, often determined by test- retest methods where a first measure is compared to a second or third. A second observer, who was familiar with notational analysis carried out an inter-reliability test to ensure the results obtained are accurate by estimation of what actually occurred. The first two matches were analysed by the second observer following the same procedure as the author. The reliability was then tested by means of a series of Kappa analysis tests. Altman (1999) proposed that Kappa is the most accurate form of statistical test to use when comparing two sets of data, as it takes the two columns of data and analyses across, thus any discrepancies in a single event would become clear.

Table 3. The results of the reliability test

Performance Indicator	**Kappa Score**
Circle Position	0.96
Feed Player	1.00
Feed Position	0.99
Marked	1.00
Outcome	1.00
Shot Taker	1.00
Shot Type	1.00
Team	1.00

The reliability results have shown a 100% correlation of results for all performance indicators apart from feed position and circle position, however they still have a very high reliability score, therefore shows much agreement between the author and second observer.

Chapter IV

Results

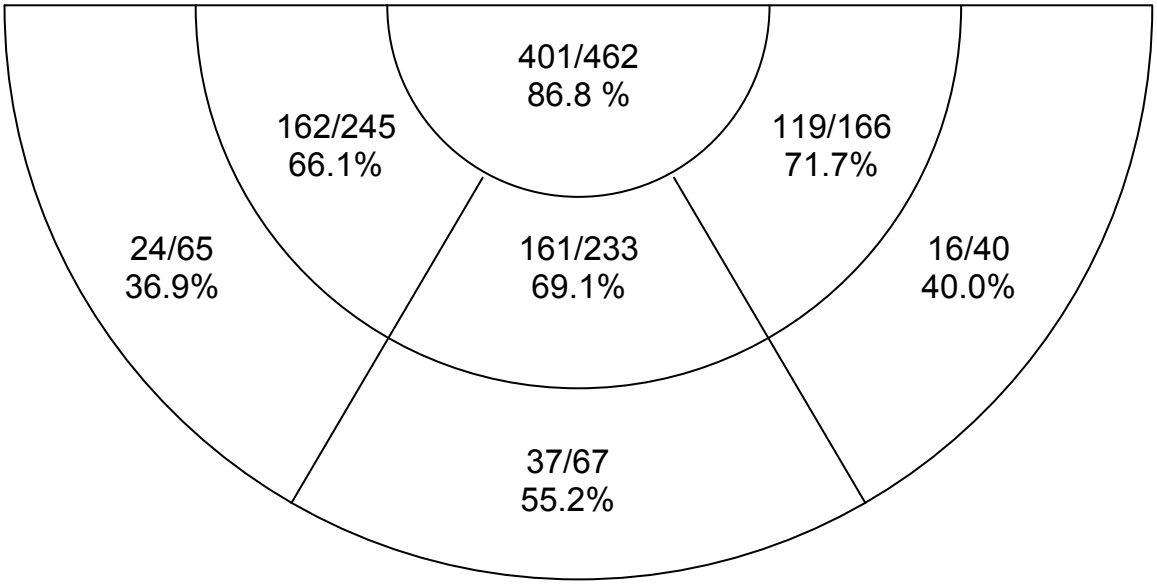
4.0 Results

The results for each performance indicator are noted below, highlighting any significant differences shown during statistical analysis. For the current study there was 5 possible 'outcomes' for each shot. However during data collection the outcome of a 'jumped shot' was not noted once, therefore this outcome was void and has been eliminated from the results.

4.1. Shot area

Results from the analysis of shot area show the most successful area to be area 1, directly under the post with an 86.8% success rate, shown in figure 4. The least successful areas were shown to be area's 5 and 7 with a shot success rate of 36.9% and 40.0% respectively. The Kruskal Wallis analysis revealed a significance score of $p < 0.001$, therefore there is a significant difference between where the shot is taken from and the outcome. The individual Mann Whitney U tests highlighted the significant differences between numerous pairs of data, notably area 1 had significant differences to all other areas, area 5 and 7 also showed significant differences to area's 2, 3 and 4 and area 6 showed a significant difference to areas 1, 3 and 4.

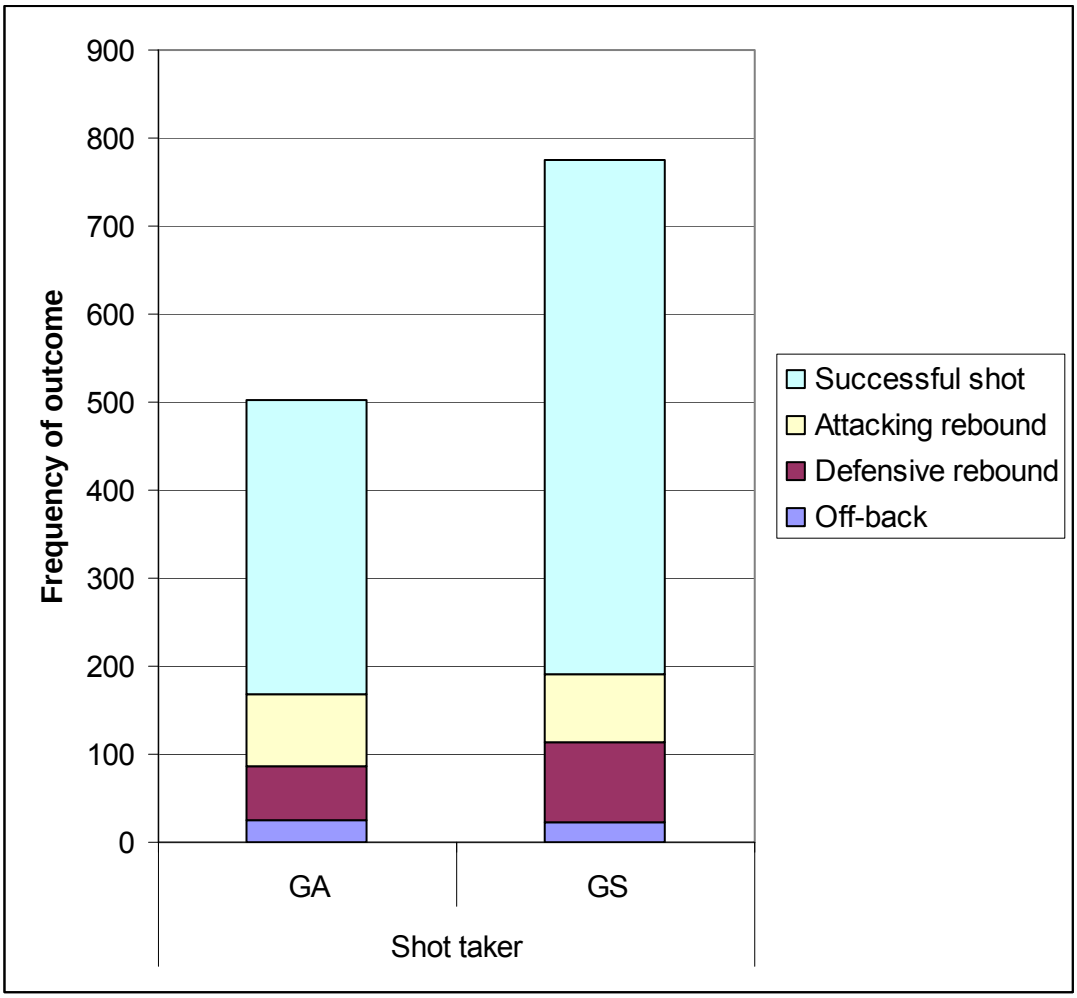
Figure 3. The results and percentage of successful shots in each area of the shooting circle



4.3. Shot taker

Figure 4 shows the data comparing the amount of shots taken by both shooting positions and the outcomes of the shots. The Mann Whitney U test showed a significant difference between the outcomes (P=0.001.) It can clearly be seen that the goal shooter has more attempts at goal than the Goal Attack. The Goal Shooters had an overall success percentage of 75.5% whereas the Goal Attacks had a success rate of 66.6%. However Goal Attacks did show a higher percentage of goal attempts that resulted in an attacking rebound, which is the most desirable outcome of a missed attempt.

Figure 4. The frequency of each outcome for each shot taker

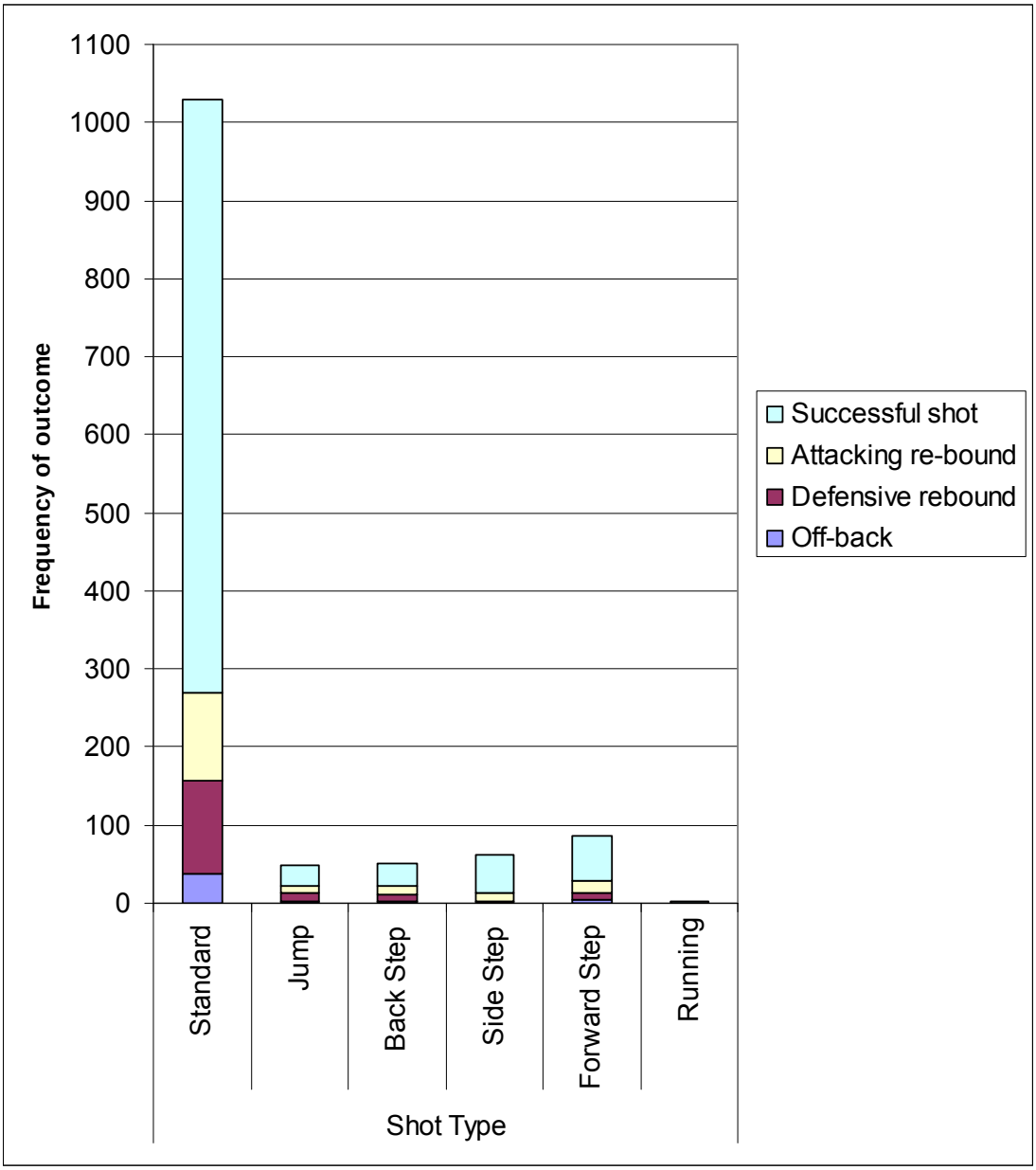


4.2 Shot type

Figure 5 shows the frequency of each outcome of shot attempts when using different shot types. The result from the Kruskal Wallis test show a significant difference between the type of shot used and the outcome of the shot with a result of p= 0.002. The results of the Mann Whitney U test's on this data shown there was a significant difference between the following shot types in comparison to outcome. The data for the standard shot was significantly different to the jump shot and the back step shot. The Jump shot was

significantly different to the side-step shot as well as the standard shot. The back-step shot was also significantly different to the side-step shot. The forward step shot and running shot were not significantly different to any of the other shot types with respect to outcome.

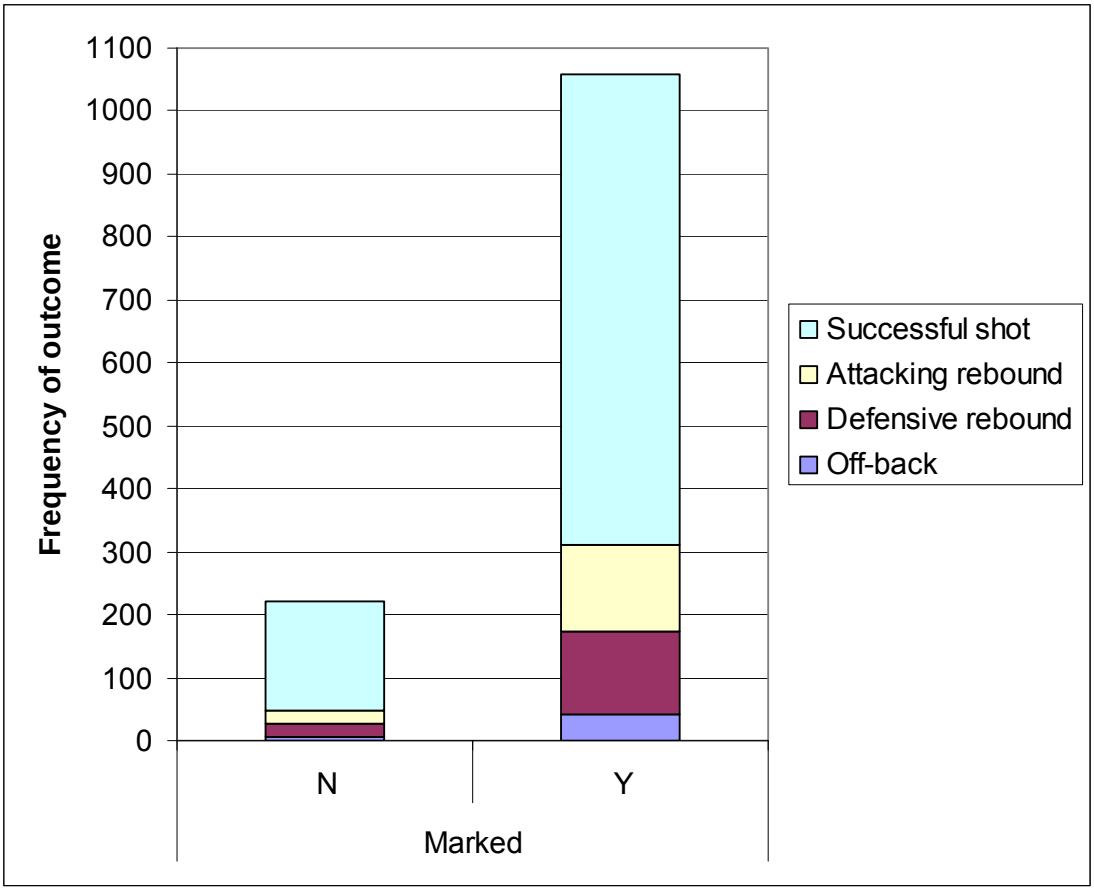
Figure 5. Frequency of each shot outcome compared to shot type



4.4. Defence

Figure 6 shows the frequency of each outcome with respect to whether it was marked or not. The chart shows clearly that the majority of shots were marked (82.8%). Within the marked shots 70.6% of them were successful and 78.6% of the unmarked shots were successful. The Mann Whitney U test showed a significant difference between the outcome of the shot and whether it was marked or not (p= 0.018).

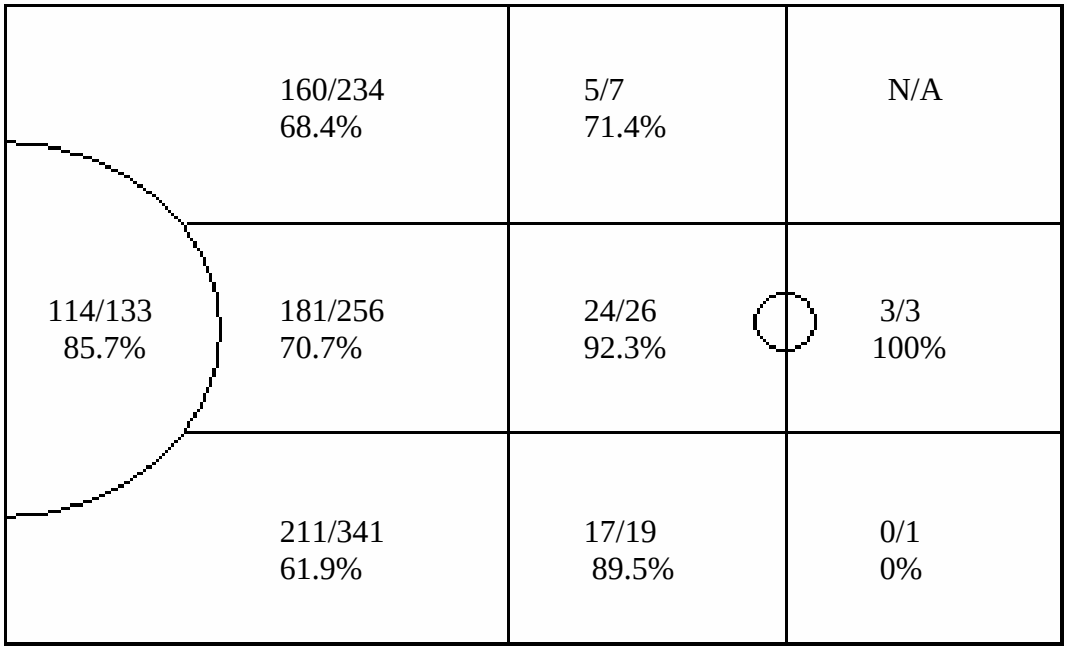
Figure 6. Comparison of shot outcome and defence



4.5. Feed position

The Kruskal Wallis test of significance showed that there is a significant difference between the success rate and the area from which the goal was fed ($p<0.001$). The significant differences mainly lie within the goal third of the court. The individual Mann Whitney U tests showed that area 10 had significant differences with areas 7, 8 and 9. Also area 5 showed significant differences to areas 7, 8 and 9. Another significant difference with outcome was highlighted between areas 4 and 9 during the Mann Whitney U testing. As is shown in figure 8, area 3 was not used to feed the ball; also areas 1 and 2 were only used 1 and 3 times respectively. Area 7 was used to feed most frequently, followed by areas 8 and 9.

Figure 7. A diagram showing the success rate of feeds from each area



4.6. Feed player

Figure 8. Comparison of feed player and outcome of shot

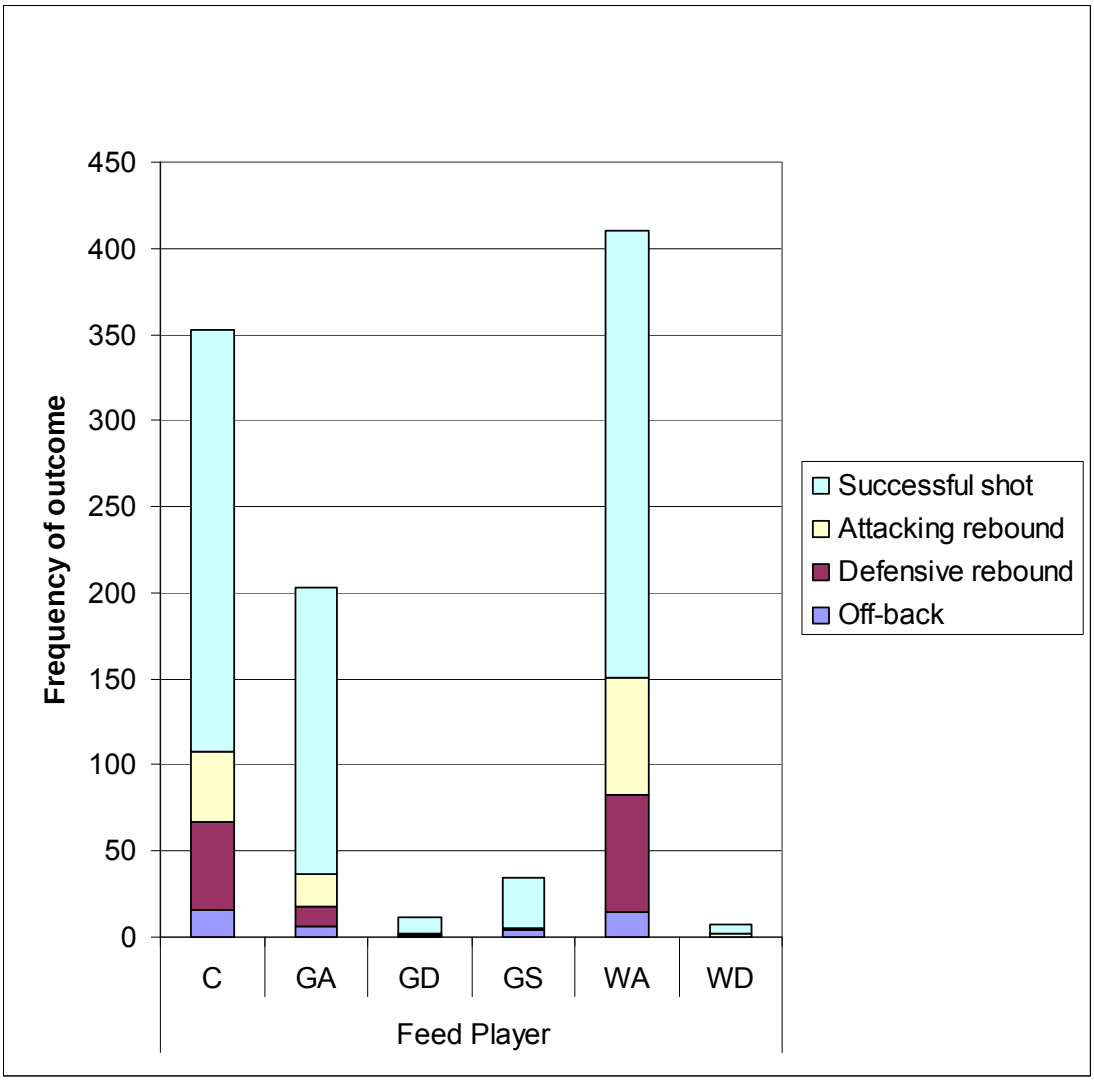


Figure 8 shows the frequency of passes that resulted in a shot being taken, the player that fed the shot and the outcome of that shot. The results from the Kruskal Wallis test show a significant difference within this data ($p<0.001$). The individual Mann Whitney U tests on this data show significant differences within three pairs of data; Centre and Goal Attack; Wing Attack and Goal Attack; Wing Attack and Goal Shooter.

Alternative feed action

As mentioned in the method there were three alternative performance indicators used during the study. The Mann Whitney U test showed no individual significant differences between any of the alternative outcomes and the feed players or positions. Table 4 shows the results of each alternative feed action. The results are not valid within the study therefore have been excluded from the main results and graphs at the authors discretion.

Table 4. The outcome results for the three alternative feed actions

Outcome	Off back	Defensive Rebound	Attacking Rebound	Successful Shot	Total
Interception	0	1	0	1	2
Penalty	5	13	15	125	158
Rebound	2	6	11	77	96

Chapter VI

Conclusion, limitations and future recommendations

6.0. Conclusion

An analysis looking at the impact of different performance indicators on the outcome of netball shots, at an International level, found numerous significant differences within the data. The area from which a shot is taken, the player that executes the shot and the style of shot used was shown to have a significant effect on the outcome of the shot ($p < 0.05$). The defence within the circle was also shown to have a significant impact on the outcome of a shot, with unmarked shots having a higher percentage of defensive rebounds than marked shots. The pattern of attack to feed the ball into the shooting player also showed a significant impact on the outcome of the shot. It was concluded that feeds from within the circle was significantly more efficient than feeds from the other 9 areas. Also agreeing with previous research (Jones and Treadwell, 1988), feeds from the right hand side of the court were slightly more efficient. The outcome of a shot when fed by different players was seen to have significant differences ($p < 0.001$). The differences were highlighted between the four most attacking players (goal shooter, goal attack, wing attack and centre), whereas the remaining two players that were noted held no significance due to the small percentage of shots that were fed by these positions from within the centre third.

6.1. Limitations

A lot of research surrounding the area of netball shooting focuses on the comparison of winning and losing teams (Edwards and O'Donogue, 2004 and Fuller, 1988). Therefore the idea for this study stemmed from a different approach, looking at successful and unsuccessful shots in isolation to the team play. After completing the analysis of the data collected during the current investigation, limitations can be drawn from using a different approach to the comparison of the data. The data collected illustrates many significant differences between the performance indicators surrounding shots with varying outcomes; however more research is needed to specify the data for individual teams. The results that have been gathered are general results for attacking patterns of 8 International teams. The study would need to be repeated to gather a database for specific team play or specific shooting players to be significantly useful to a coach. Another limitation for this study was the fact that the results are only attributable to participants of International standard netball, therefore cannot be used universally. The quality of some of the videos used for the data created difficulties with player recognition, producing a limitation to the study.

6.2. Future recommendations

The results of this study highlight the value of using notational analysis to gain useful information regarding netball shooting at an International level. The research can be used as an aid for coaches to specify training programmes for individual players as well as the team in the form of attacking strategies. The system is simple and transferable therefore could be used to analyse netball of any standard.

There is potential to develop the system into a more specific aid for individual players and teams. The same basic principles can be used however the individual shooter or team could be analysed separately to highlight individual differences between specific shooting players. The results pending a further study such as this would provide coaches with a more detailed and useful database to develop training programmes.

The notation system used for this study could be transferred to a more modern computer notation programme, whereby data may be analysed in a more efficient manner.

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Appendices

Appendices

Appendix A – A.1. Example of data spread sheet from excel

Appendix B - B.1 Reliability results for performance indicators shown as less than 100% accurate.

Appendix C - Tabulated frequency of each performance indicator for all ten International matches, shown as a percentage of total for each outcome.

Appendix D - D.1 – Example of Mann Whitney U test output

D.2 – Example of Kruskal Wallis ANOVA test output

D.3 – Results of statistical tests

Appendix A

Raw data for game 1 (Wales v Jamaica)

Circle Position	Shot Taker	Shot Type	Feed Position	Feed Player	Outcome	Marked	Team
1	S	A	10	GA	S	Y	J
1	S	E	10	GA	S	Y	J
4	S	A	7	WA	D	Y	W
4	A	A	9	WA	S	Y	W
3	S	A	10	GA	A	Y	J
1	A	A	R	R	S	N	J
2	A	A	9	C	S	Y	W
1	S	A	10	GA	S	N	J
1	S	D	9	WA	S	Y	J
1	A	A	8	C	S	N	J
2	S	A	7	GA	S	Y	J
2	S	A	7	WA	A	Y	J
1	A	A	R	R	S	N	J
3	S	D	10	GA	A	Y	J
1	S	A	R	R	S	Y	J
1	S	A	7	GA	S	Y	J
2	S	A	7	WA	S	Y	J
3	S	A	8	GA	A	Y	J
1	A	A	10	GS	S	N	J
1	A	A	7	WA	D	Y	W
2	A	A	7	C	S	Y	J
1	S	A	10	GA	S	Y	J
1	S	E	10	GA	S	N	J
2	S	A	7	GA	S	Y	J
2	S	A	7	C	A	Y	J
1	A	A	R	R	S	Y	J
1	A	A	7	C	S	Y	J
1	S	D	7	C	S	Y	J
4	A	A	9	C	S	Y	J
2	A	A	8	C	D	Y	W
1	S	A	10	GA	S	Y	J
3	S	A	8	WA	A	N	W
3	S	A	R	R	S	Y	W
7	A	A	7	C	A	Y	J
1	S	A	R	R	S	Y	J
4	A	A	8	WA	S	Y	J
1	S	D	10	GA	S	Y	J
1	S	E	10	GA	S	Y	J
2	S	A	7	WA	S	Y	J
4	S	A	10	GA	A	Y	J

1	A	A	R	R	S	Y	J
2	S	A	7	C	S	Y	J
4	A	A	9	C	S	Y	J
1	A	E	9	WA	S	N	J
3	A	A	10	GS	S	Y	J
2	S	A	7	WA	S	Y	J
2	S	A	10	GA	S	N	J
2	S	A	4	WA	S	Y	J
1	S	C	8	WA	S	Y	J
1	A	A	10	GS	OB	Y	J
4	S	A	9	GA	S	Y	J
1	S	A	7	WA	S	Y	W
4	S	A	10	GA	S	Y	J
2	A	A	7	C	A	Y	W
2	S	A	R	R	S	Y	W
1	A	D	10	GS	S	Y	J
1	S	A	8	C	S	Y	J
1	A	D	8	C	S	Y	J
1	S	A	10	GA	S	N	J
2	A	A	9	WA	S	Y	J
3	S	A	9	C	S	Y	W
2	S	A	10	GA	S	Y	J
1	A	D	10	GS	S	Y	J
1	S	A	7	WA	S	Y	J
4	A	A	9	WA	S	N	W
1	A	A	7	C	S	N	J
2	S	D	10	GA	S	Y	J
1	S	A	10	GA	S	Y	J
7	S	C	4	WD	S	Y	W
2	A	A	7	C	S	Y	W
2	S	A	7	C	S	Y	W
2	A	C	7	WA	S	Y	J
6	A	E	7	GA	S	N	J
4	S	A	9	WA	D	Y	W
3	A	A	P	P	A	Y	J
6	A	A	10	GS	S	Y	J
3	S	A	5	GA	S	Y	J
4	S	A	9	WA	S	Y	J
1	S	A	10	GA	S	Y	J
2	S	A	7	WA	S	Y	J
1	S	E	4	WD	S	Y	J
5	A	D	7	C	S	Y	W
3	S	A	8	WA	S	N	W
3	S	A	10	GA	S	Y	J
2	S	E	7	WA	S	Y	W
3	S	A	10	GA	A	Y	J
1	S	D	R	R	S	Y	J
4	S	A	8	WA	D	Y	W
1	S	A	7	WA	S	Y	J
3	S	A	10	GA	S	Y	W

1	S	E	5	GA	S	Y	J
4	S	A	9	WA	S	Y	W
1	A	D	10	GS	S	Y	J
2	S	A	7	C	A	Y	J
4	S	D	10	GA	S	Y	W
4	S	A	9	GA	S	Y	J
6	S	A	P	P	A	Y	W
1	A	B	R	R	S	N	W
1	S	D	9	WA	S	Y	W
7	A	A	9	GS	OB	Y	W
2	S	A	7	GA	S	Y	W
1	A	D	8	WA	S	N	J
4	S	E	9	WA	D	Y	W
4	A	E	9	WA	A	Y	J
1	A	A	R	R	S	N	J
2	A	A	7	WA	S	Y	J
3	S	A	8	C	S	Y	J
2	S	A	9	C	S	Y	W
2	S	D	7	C	A	N	W
6	S	A	R	R	D	Y	W
1	S	E	9	C	S	Y	J
1	S	D	10	GA	S	Y	J
2	S	A	7	WA	S	Y	J
1	S	A	7	C	A	Y	J
1	A	A	R	R	S	Y	J
1	A	E	P	P	S	N	W
1	A	C	8	WA	S	Y	J
3	S	A	8	C	S	Y	W
3	A	A	7	WA	S	Y	J
4	A	A	9	WA	S	Y	J
3	S	A	8	WA	A	Y	J
1	S	A	R	R	S	Y	J
6	S	A	7	WA	D	Y	W
2	S	A	7	GA	D	Y	J

Appendix B

B. 1.1 – The Kappa analysis for reliability between observer 1 and observer 2 for circle position

Count of Circle Position	Circle Position										
Circle Position	1	2	3	4	5	6	7	(blank)	Grand Total	Grand Total	Expected
1	79		2	1					82	79	26.120968
2		62			1				63	62	15.75
3			31			1			32	33	4.2580645
4				41			1		42	43	7.2822581
5					10				10	11	0.4435484
6						14			14	15	0.8467742
7				1			4		5	5	0.1008065
(blank)											
Grand Total	79	62	33	43	11	15	5		248	248	54.802419

P0	0.9718
PC	0.221
kappa	0.9638

B. 1.2 – The Kappa analysis for reliability between observer 1 and observer 2 for feed position

Count of Feed Position	Feed Position												
Feed Position	2	4	5	7	8	9	10	P	R	(blank)	Grand Total	Grand Total	Expected
2	1										1	1	0.0040323
4		5									5	5	0.1008065
5			2								2	2	0.016129
7				73	1						74	73	21.782258
8					41						41	43	7.108871
9					1	48					49	48	9.483871
10							37				37	37	5.5201613
P								11			11	11	0.4879032
R									28		28	28	3.1612903
(blank)													
Grand Total	1	5	2	73	43	48	37	11	28		248	248	47.665323

P0	0.99
PC	0.19
kappa	0.99

Appendix C

Tabulated frequency of each performance indicator for all ten International matches, shown as a percentage of total for each outcome.

C.1 Data for observed circle position

Circle Position	Outcome								Total
	OB	% of total	D	% of total	A	% of total	S	% of total	
1	9	1.95	21	4.55	31	6.71	401	86.80	462
2	6	2.45	35	14.29	42	17.14	162	66.12	245
3	10	4.29	34	14.59	28	12.02	161	69.10	233
4	4	2.41	23	13.86	20	12.05	119	71.69	166
5	8	12.31	16	24.62	17	26.15	24	36.92	65
6	5	7.46	13	19.40	12	17.91	37	55.22	67
7	6	15.00	10	25.00	8	20.00	16	40.00	40
Total	48	3.76	152	11.89	158	12.36	920	71.99	1278

C.2 Data for observed shot taker

Shot taker	Outcome								Total
	OB	% of total	D	% of total	A	% of total	S	% of total	
GA	25	4.97	62	12.33	81	16.10	335	66.60	503
GS	23	2.97	90	11.61	77	9.94	585	75.48	775
Total	48	3.76	152	11.89	158	12.36	920	71.99	1278

C.3 Data for observed shot type

Shot Type	Outcome								Total
	OB	% of total	D	% of total	A	% of total	S	% of total	
Standard (A)	37	3.60	120	11.66	113	10.98	759	73.76	1029
Jump (B)	3	6.12	11	22.45	8	16.33	27	55.10	49
Back Step (C)	3	5.88	9	17.65	11	21.57	28	54.90	51
Side Step (D)	1	1.64	2	3.28	10	16.39	48	78.69	61
Forward Step (E)	4	4.65	9	10.47	16	18.60	57	66.28	86
Running (F)	0	0.00	1	50.00	0	0.00	1	50.00	2
Total	48	3.76	152	11.89	158	12.36	920	71.99	1278

C.4 Data for observed feed position

Feed Position	Outcome								Total
	OB	% of total	D	% of total	A	% of total	S	% of total	
1	0	0.00	0	0.00	1	100.00	0	0.00	1
2	0	0.00	0	0.00	0	0.00	3	100.00	3
3		0.00		0.00		0.00		0.00	0
4	0	0.00	0	0.00	2	10.53	17	89.47	19
5	0	0.00	0	0.00	2	7.69	24	92.31	26
6	0	0.00	1	14.29	1	14.29	5	71.43	7
7	14	4.11	60	17.60	56	16.42	211	61.88	341
8	11	4.30	38	14.84	26	10.16	181	70.70	256
9	13	5.56	27	11.54	34	14.53	160	68.38	234
10	3	2.26	6	4.51	10	7.52	114	85.71	133
11	5	3.14	13	8.18	15	9.43	126	79.25	159
12	2	2.06	6	6.19	11	11.34	78	80.41	97
13	0	0.00	1	50.00	0	0.00	1	50.00	2
Total	48	3.76	152	11.89	158	12.36	920	71.99	1278

C.5 Data for observed feed player

Feed Player	Outcome								Total
	OB	% of total	D	% of total	A	% of total	S	% of total	
C	16	4.53	51	14.45	41	11.61	245	69.41	353
GA	6	2.96	12	5.91	19	9.36	166	81.77	203
GD	0	0.00	1	8.33	1	8.33	10	83.33	12
GS	4	11.43	0	0.00	1	2.86	30	85.71	35
WA	15	3.66	68	16.59	68	16.59	259	63.17	410
WD	0	0.00	0	0.00	2	28.57	5	71.43	7
Total	48	3.76	152	11.89	158	12.36	920	71.99	1278

C.6 Data for observed defence

Marked	Outcome								Total
	OB	% of total	D	% of total	A	% of total	S	% of total	
N	7	3.18	19	8.64	21	9.55	173	78.64	220
Y	41	3.88	133	12.57	137	12.95	747	70.60	1058
Total	48	3.76	152	11.89	158	12.36	920	71.99	1278

Appendix D

D.1 Example of Mann Whitney U test output

NPar Tests
Mann-Whitney Test

Ranks

	Shot Taker	N	Mean Rank	Sum of Ranks
Outcome	GA	503	606.70	305168.50
	GS	775	660.79	512112.50
	Total	1278		

Test Statistics[a]

	Outcome
Mann-Whitney U	178412.5
Wilcoxon W	305168.5
Z	-3.242
Asymp. Sig. (2-tailed)	.001

a. Grouping Variable: Shot Taker

D.2 – Example of Kruskal Wallis ANOVA test output

NPar Tests
Kruskal-Wallis Test

Ranks

	Shot Type	N	Mean Rank
Outcome	A	1029	649.83
	B	49	526.09
	C	51	533.07
	D	61	694.37
	E	86	608.66
	F	2	471.50
	Total	1278	

Test Statistics[a,b]

	Outcome
Chi-Square	19.310
df	5
Asymp. Sig.	.002

a. Kruskal Wallis Test

b. Grouping Variable: Shot Type

D.3- Results of statistical tests

D.3.1 Significance results for comparison of 'outcome' with each performance indicator

Outcome data compared to:	**Kruskal Wallis Test result**
Circle position	p< 0.001
Shot type	p= 0.002
Feed position	p< 0.001
Feed player	p< 0.001

Outcome data compared to:	**Mann Whitney Test result**
Shot taker	p=0.001
Marked	p=0.018

D.3.2 Significance results for comparison within each performance indicator's data

D.3.2.1

Circle Position comparison	Mann Whitney Test result
1 & 2	p< 0.001
1 & 3	p< 0.001
1 & 4	p< 0.001
1 & 5	p< 0.001
1 & 6	p< 0.001
1 & 7	p< 0.001
2 & 3	p> 0.050
2 & 4	p> 0.050
2 & 5	p< 0.001
2 & 6	p> 0.050
2 & 7	p< 0.001
3 & 4	p> 0.050
3 & 5	p< 0.001
3 & 6	p = 0.038
3 & 7	p< 0.001
4 & 5	p< 0.001
4 & 6	p= 0.013
4 & 7	p< 0.001
5 & 6	p> 0.050
5 & 7	p> 0.050
6 & 7	p> 0.050

D.3.2.2

Shot Type comparison	Mann Whitney Test result
A & B	p= 0.004
A & C	p= 0.005
A & D	p> 0.050
A & E	p> 0.050
A & F	p> 0.050
B & C	p> 0.050
B & D	p=0.003
B & E	p> 0.050
B & F	p> 0.050
C & D	p=0.004
C & E	p> 0.050
C & F	p> 0.050
D & E	p> 0.050
D & F	p> 0.050
E & F	p> 0.050

D.3.2.3

Feed Position comparison	Mann Whitney test result
2 & 1	p> 0.050
4 & 1	p> 0.050
5 & 1	p> 0.050
6 & 1	p> 0.050
7 & 1	p> 0.050
8 & 1	p> 0.050
9 & 1	p> 0.050
10 & 1	p> 0.050
4 & 2	p> 0.050
5 & 2	p> 0.050
6 & 2	p> 0.050
7 & 2	p> 0.050
8 & 2	p> 0.050
9 & 2	p> 0.050
10 & 2	p> 0.050
5 & 4	p> 0.050
6 & 4	p> 0.050
7 & 4	p=0.011
8 & 4	p> 0.050
9 & 4	p=0.040
10 & 4	p> 0.050
6 & 5	p> 0.050
7 & 5	p=0.001
8 & 5	p=0.013
9 & 5	p=0.008
10 & 5	p> 0.050
7 & 6	p> 0.050
8 & 6	p> 0.050
9 & 6	p> 0.050
10 & 6	p> 0.050
8 & 7	p> 0.050
9 & 7	p> 0.050
10 & 7	p< 0.001
9 & 8	p> 0.050
10 & 8	p=0.001
10 & 9	p< 0.001

D.3.2.4

Feed Player comparison	Mann Whitney Test result
C & GA	p=0.001
C & GD	p> 0.050
C & GS	p> 0.050
C & WA	p> 0.050
C & WD	p> 0.050
GA & GD	p> 0.050
GA & GS	p> 0.050
GA & WA	p< 0.001
GA & WD	p> 0.050
GD & GS	p> 0.050
GD & WA	p> 0.050
GD & WD	p> 0.050
GS & WA	p=0.025
GS & WD	p> 0.050
WA & WD	p> 0.050