A COMPARATIVE ANALYSIS OF THE DIFFERENCES BETWEEN FRONT-ON AND SIDE-ON FAST BOWLING TECHNIQUES AT THE ELITE LEVEL OF CRICKET.

WHAT ARE THE DIFFERENCES IN TERMS OF OVERALL PERFORMANCE INCLUDING LINE AND LENGTH, ECONOMY RATES, BOWLING AVERAGE AND WICKETS PER MATCH BETWEEN INTERNATIONAL BOWLERS USING DIFFERENT BOWLING TECHNIQUES?
TABLE OF CONTENTS

1 INTRODUCTION

1.1 General Introduction 1
1.2 Aim of the Study 7
1.3 Hypothesis 8
1.4 Rationale for the Problem 8
1.5 Limitations 10
1.6 Delimitations 10

2 REVIEW OF LITERATURE

2.1 Introduction to Notational Analysis 11
2.2 An Historical Perspective – Hand and Computer Analysis 13
   2.2.1 Computerised Notation Systems 15
2.3 Notational Analysis and Cricket 16
2.4 Notational Analysis Studies on One Day international Cricket 21
2.5 performance Indicators in Cricket 22

3 METHODOLOGY

3.1 Equipment 27
3.2 The System 27
3.3 The Procedure 28
3.4 Data Definitions 30
3.5 Matches Analysed 37
3.5 The Bowlers being Analysed 38
3.6 Data Collected 39
3.7 Pilot Studies 39
3.8 Reliability 40
3.9 Data Processing 41
3.10 Data Analysis 41

4 RESULTS
4.1 Reliability Testing 42
4.2 Bowling Analysis 43
  4.2.1 Shot Result 43
  4.2.2 Lengths Bowled 44
  4.2.3 Lines Bowled 45
  4.2.4 Shot Type 46
  4.2.5 Shot Type and Runs Scored 48
  4.2.6 Played and Missed 50
  4.2.7 Runs Conceded per Over 51
  4.2.8 Wickets per Game and Bowling Average 52

5 DISCUSSION
5.1 Intra-Observer Reliability Test 54
5.2 Statistics 54
5.3 Discussion of the System 55
5.4 Discussion of the Results 57
  5.4.1 Shot Result 57
4.4.2 Lengths Bowled 57
4.4.3 Lines Bowled 60
4.4.4 Shot Type 60
4.4.5 Shot Type and Runs Scored 60
4.4.6 Played and Missed 61
4.2.7 Runs Conceded per Over 61
4.2.8 Wickets per Game and Bowling Average 62

6 CONCLUSION

6.1 General Conclusions 63
6.2 Future Recommendations 64

REFERENCES 65
List of Appendices

APPENDIX A. Reliability

APPENDIX B. Screens Used Within ‘Feedback Cricket’.

APPENDIX C. Wagon Wheels

APPENDIX D. Statistical Tests
## List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1.</td>
<td>Basic Cricket Terminology</td>
<td>30</td>
</tr>
<tr>
<td>Table 2.</td>
<td>Delivery Length Definitions</td>
<td>32</td>
</tr>
<tr>
<td>Table 3.</td>
<td>Delivery Line definitions</td>
<td>34</td>
</tr>
<tr>
<td>Table 4.</td>
<td>Different types of extras</td>
<td>35</td>
</tr>
<tr>
<td>Table 5.</td>
<td>Definitions of specific strokes.</td>
<td>36</td>
</tr>
<tr>
<td>Table 6.</td>
<td>Percentages of reliability for the different performance indicators</td>
<td>42</td>
</tr>
<tr>
<td>Figure</td>
<td>Description</td>
<td>Page No.</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>1</td>
<td>County Cricket Attendance, 1995-2001</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Computer reproduction of a side-on bowling action: side view (right) and front view (left). From left: back foot strike, mid-delivery stride, front foot strike, ball release.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Computer reproduction of a front-on bowling action: side view (right) and front view (left). From left: back foot strike, mid-delivery stride, front foot strike, ball release.</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Computer reproduction of a mixed bowling action: side view (right) and front view (left). From left: back foot strike, mid-delivery stride, front foot strike, ball release.</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>A schematic diagram representing the coaching process</td>
<td>11</td>
</tr>
<tr>
<td>6</td>
<td>An example of a page from a typical scorebook</td>
<td>17</td>
</tr>
<tr>
<td>7</td>
<td>The Hawkeye system</td>
<td>19</td>
</tr>
<tr>
<td>8</td>
<td>Side On Hawkeye</td>
<td>20</td>
</tr>
<tr>
<td>9</td>
<td>Front On View of Hawkeye</td>
<td>20</td>
</tr>
</tbody>
</table>
Figure. 10. Lengths Bowled

Figure. 11. Delivery Lines bowled to right handed batsmen.

Figure. 12. Percentages of dot balls, single runs and boundaries resulting from side on and front on bowling techniques

Figure. 13. Mean percentage of Lengths Bowled.

Figure. 14. Mean percentage of lines bowled

Figure. 15. Mean percentages of the balls bowled which leads to the various front foot shots the batsmen performed

Figure. 16. Mean percentages of the balls bowled which leads to the various back foot shots the batsmen performed

Figure. 17. Total mean percentage of the balls bowled which leads to the various front and back shots executed by the batsmen.

Figure. 18. Mean percentages of the runs scored for each of the front foot shots the batsmen performed

Figure. 19. Mean percentages of the runs scored for each of the back foot shots the batsmen performed

Figure. 20: total mean percentages of the runs scored for each of the shot the batsmen performed

Figure. 21: Mean percentage of play and misses
Figure. 22. Runs Conceded per Over

Figure. 23. Average number of wickets

Figure. 24. Bowling Average
Acknowledgments

I would like to pay a special thanks to my Dissertation supervisor Ray Ponting for his help and support over the past few months.

Secondly I would like to thank my friends and family for the support and advice they have given me over the past three years here at UWIC.
ABSTRACT

This research investigated the differences between the front-on and side-on fast bowling techniques at the elite level of the game. The study investigated games played in the 2007, I.C.C. Cricket World Cup held in the West Indies. The games analysed took place in the second stage of the Cricket World called the “Super 8’s”. Fast bowlers from Australia, England, Pakistan, South Africa, Sri Lanka, and New Zealand were analysed.

A specific computerised notation system called, ‘Feedback Cricket’, was used to notate the specific aspects of a bowling performance to determine if there were any differences between front-on and side-on bowlers. To examine the reliability of the study, an intra-observer reliability test was performed. Variables were tested for normality and homogeneity, to ascertain whether data was parametric or non parametric. Independent t-tests were performed on parametric data, while Mann-Whitney-U tests were performed on non-parametric data. These statistical tests enabled the researcher to establish whether the data sets were significantly different.

The bowling analysis showed significant differences to exist, between front-on and side-on bowlers, in terms of delivery lengths bowled, the percentage of shots that were played and missed at and the shot type performed by the batsmen. It was concluded that these differences however, did not contribute to the overall differences in performance of the two bowling techniques, as there were no significant difference between the economy rates, bowling average and the wickets taken per match.
Chapter

I

Introduction
1. Nature of the study

1.1 Introduction

Cricket is a sport that has undergone numerous changes from when the first organised cricket club started at the Hambledon Club in England during the mid eighteenth century (Wynne–Thomas, 1997). The centre of power soon shifted to London, with the establishment of the Marylebone Cricket Club (MCC), which had its headquarters at the Lord's ground. In 1835 the MCC gave cricket its first formal laws, which still stand largely intact today (Andrew, 1986).

During the early twentieth century cricket had strong links with the aristocracy and the upper classes. The majority of those who served on the MCC committee were from the aristocracy of England and controlled not only English cricket but the county set up too. After the First World War cricket had become a key element in the cult of athleticism at public schools, where nearly all public schools boys had to play cricket on most summer afternoons (Williams, 1999).

Cricket is now played at varying levels from school and village clubs to the elite international level. International cricket involves two forms; Test cricket, which involves two innings per side and is played over 5 days and, One Day International Cricket (ODI), which is currently played under a 50 overs per side format.
Cricket at the highest level (test cricket) is played over five days with the competing teams playing a maximum of two innings, therefore making it a long game. Robinson (1997) suggests over a period of decades spectators found this version of the game too long and time consuming to watch and its appeal became limited to enthusiastic cricket fans. This is also backed up by figure 1 stating that attendances at all types of cricket matches have fallen.

Innovations such as “Day/Night” matches have been introduced with the main objective being increasing the crowds after work. Paton and Cooke (2005) found that the timing and location of games have a large impact on attendance levels. In particular evening games held under floodlights, and

Figure 1. County Cricket Attendance, 1995-2001 (Thousands) (Paton and Cooke 2005).
games held at weekends or during school holidays all have significantly higher attendance than others.

Day/Night cricket” has increased attendance at domestic and international one day cricket, and brings new sponsors and makes it possible to watch live cricket twenty four hours a day seven days a week from any corner of the World (Paton and Cooke, 2005).

Another innovation added by the MCC is “Twenty20 Cricket”. It was first played in English domestic cricket in 2003 to popularise first-class cricket and attract more players and fans to the game. Now it has spread too many other countries. A “Twenty20 Game” consists of 20 overs per side, a free-hit after a no-ball is bowled, short boundaries, batting-friendly pitches, designed to attract crowds. However, various members of the MCC did not welcome the idea of “twenty20” cricket, indeed Woodcock (2002) believed that the 20 over game is “hardly more substantial than a game of noughts and crosses or crazy golf on the sea front”.

David Collier (2007) the chief executive of the England and Wales cricket board (ECB) stated that due to the inovations of twenty20 and day night international cricket the total number of spectators watching domestic cricket annually in England & Wales has increased by 21.7 per cent. While aggregate attendance figures for international matches in England and Wales during 2007 was more than 809,000. The increased popularity of cricket in England & Wales combined with the strength of the domestic and international game has enabled ECB to attract and retain a number of high profile commercial
partners such as Vodafone, npower, NatWest, Red Bull, HUGO BOSS, Buxton and Adidas (from 2008).

This rise of ODI, day night cricket and twenty20 is related to the need to find a version of the game that would supplement the traditional five day game and appeal to a mass audience. Robinson (1997) suggested that cricket has to compete with other sources of entertainment and other sports, which have a much smaller time zones.

ODI cricket is a version of the game in which the game is completed in one day and consists of one innings per side of 50 overs. In 1971 the first ODI was played between Australia and England at Melbourne. This occurred as a time filler after a Test Match had been abandoned due to bad weather on the opening days. After tremendous interest and an avid following of the shorter form of the game, the International Cricket Council (ICC) valued the idea of a world cricket tournament.

The World Cup is the ultimate prize in international cricket, therefore, this is why the study was based on the World Cup in the West Indies in 2007. The competition is run by the International Cricket Council (ICC). The Cricket World Cup is a One Day International (ODI) cricket competition that is conducted every four years between ICC sanctioned teams. The first attempt at a World Championship of cricket was in 1912, when a three-way series of test matches were held between Australia, England and South Africa. Unfortunately, the competition was spoiled by stormy weather and the concept was not revisited until 1971. Since 1975, however, the ICC Cricket
World Cup has been contested every four years and has been a resounding success. The ten ICC Test-playing nations (West Indies, Australia, Pakistan, India, England, New Zealand, Sri Lanka, South Africa, Bangladesh and Zimbabwe), together with an additional select group of ICC-sanctioned nations currently compete for the title.

The 2007 World Cup was won convincingly by Australia who beat Sri Lanka by 53 runs in the final. (Unfortunately, the tournament will not be remembered for Australia's fourth consecutive World Cup title but for the death of Pakistan's head coach Bob Woolmer). In addition, during the World Cup, Ireland and Bangladesh made it through to the final group stage for the first time in their history and in doing so helping to knock out Pakistan and India respectively.

This study has focused on fast/seam bowling from the World Cup 2007. Rice (1990) suggested that the vital aspects of fast bowling are consistency, accuracy, control and range. A fast bowler is expected to take early wickets and also remove the tail end batsmen. Their most obvious asset is their ability to bowl at a high pace, which many batsmen, especially tail-enders, find difficult to cope with.

In elite fast bowling there are two recognised categories of bowling action, side on and front on. The side-on technique has been advocated as the correct and most effective way to bowl. Until recently, it was the only technique recognized by the MCC in their coaching book (MCC, 1976). It is
typified by a relatively low run-up speed at the start of the delivery stride, a rear foot position which is parallel to the popping crease and a shoulder alignment at rear foot strike that points down the wicket, such that the angle between the wickets and the line joining the shoulders is approximately 180 degrees, as shown in figure 2 (Bartlett et al., 1996).

Figure 2: Computer reproduction of a side-on bowling action: side view (right) and front view (left). From left: back foot strike, mid-delivery stride, front foot strike, ball release (Bartlett et al., 1996).

The front-on technique is typified by a higher run-up speed, a rear foot position that points more towards the direction of ball travel after release, and a more open chested position at rear foot strike and a more open chested position at rear foot strike with the shoulders at an angle which considerably exceeds 180, as shown in figure 3 (Bartlett et al., 1996).
1.2 Aims of the Research

The aim of this study was to analyse elite fast/seam bowlers from the World Cup in 2007 using a specific cricket computerised notational analysis system called Feedback Cricket. The main issue of the investigation was to examine the different types of bowling techniques (Front on and Side on bowling). The study analysed the different technical and tactical performance indicators to
justify if one bowling technique is more successful that the other. For example the line and length of the ball, the economy, the bowling average, wickets per game and where the batsmen scores his runs.

1.3 Hypotheses

Null Hypothesis: There will be no differences in terms of overall performance between front-on and side-on bowlers at the elite level of cricket.

Alternative Hypothesis: There will be differences in terms of overall performance between front-on and side-on bowlers at the elite level of cricket.

1.4 Rationale of the study

Many of the most important aspects of a cricket team’s performance cannot be “teased out” by biomechanics alone. Therefore, this investigation used performance analysis to examine if one bowling technique is more successful than the other.

The practical implications of the study are that when a coach observes a young child using a mixed action, which is characterized by bowlers adopting a front-on foot and shoulder orientation at back foot strike, which is followed by a realignment of the shoulders to a more side-on position during the delivery stride. The coach can then modify the child’s bowling action to which ever technique was the most successful in the study. Bartlett et al. (1996) suggested that a mixed technique (see figure 4) is believed to be more likely
to lead to a high incidence of lower back problems (bony abnormalities such as pedicle sclerosis, spondyloysis and spondylolisthesis; disc degeneration and bulging). This occurs because of the spine adopting a twisted and hyper extended position at a time (front foot strike) when ground reaction forces are high (Foster et al., 1989).

![Computer reproduction of a mixed bowling action: side view (left) and front view (right). From left: back foot strike, mid-delivery stride, front foot strike, ball release.](image)

**Figure 4:** Computer reproduction of a mixed bowling action: side view (left) and front view (right). From left: back foot strike, mid-delivery stride, front foot strike, ball release.

There has been detailed research into the biomechanics of fast bowling, and more specifically the difference between front on and side on bowling eg. Bartlett et al. (1996). However, there is a gap in the research when it comes to analysing the different outcomes of various bowling techniques using notation.
1.5 Limitations

The interaction of the bowler and the batsman is the core of the game, a bowler having an exceptional day can make a world class batter look average and vice versa, therefore this has to be taken into account when analysing the results (Hughes and Bartlett, 2002).

Possible other limitations of the study were environmental changes/weather and selection of analysed players. The World Cup was played in eight different West Indies countries on eight different grounds. Each pitch varied notably and not all grounds were the same size. In addition, certain pitches were more favourable to bowlers than other grounds, which can be attributed to the weather and preparation.

The world's top teams occasionally rested their best players against the weaker nations, which could affect the analysis, in addition, various bowlers from the ICC top ten bowlers were injured during the World Cup most notably Australia’s Brett Lee. (Who was ranked 2nd in the world before the World Cup 2007)

1.6 Delimitations

The matches notated were all international games and so bowling patterns identified may not reflect domestic matches. The matches notated were all World Cup matches, therefore if as said above teams rest players against the weaker nations, bowling patterns may be affected and thus may not be correct for other international matches and county matches.
Chapter

III

Methodology
3 Methodology

Eight games from the Cricket World Cup in 2007 held in the West Indies were notated using a specific cricket computerised notation system called “Feedback Cricket”. The raw data was then quantitatively analysed to see if there were any significant differences between front on and side on bowlers.

3.1 Equipment:

- Sky Plus Box,
- Sony DVD recorder (model number RDR – HXD870),
- Toshiba laptop (model number PTM20A - OJT21)
- “Feedback Cricket” designed by Zach Hitchcock
- Microsoft Excel 2003 and,
- SPSS 12.1 for Windows XP

3.2 The System

The specific computerised notational analysis system “Feedback Cricket” was used to notate the specific performance indicators. Data was entered through the score panel and the bowling figures were available through the scoreboard facility. Examples of the score panel, scoreboard and other various screens from “Feedback Cricket” can be found in Appendix B. Before notating the key performance indicators “Feedback Cricket” Requested important match data:

- Team Name;
- Match Type;
- Team Batting First;
• Venue;
• Umpires;
• Team List;
• Player Details (for example if the bowler or batsmen is left or right handed).

When this information has been inputted the following details are then notated every ball:

• Bowler Type;
• Ball Line;
• Ball Length;
• Runs Scored;
• What Shot was Played;
• Direction of the shot, and
• Extras scored.

3.3 Procedure

Matches were recorded from Sky Sports television and subsequently stored on the Sky Box’s hard drive. Matches were then copied from the sky box onto DVD’s using a Sony DVD recorder (model number RDR – HXD870). The DVD’s were played back on a Toshiba (model number PTM20A - OJT21) laptop which had “Feedback Cricket” already installed on its hard-drive.

In “Feedback Cricket” the team sheet was filled out as to the conditions, toss and player details from watching the build up of the game. Once the game had begun each ball was notated the same way by left clicking on the start
ball icon. The video was watched in slow motion to notate the line and length of the ball. The video was then continued so that the batsmen’s stroke, direction of the shot and any runs could be notated. Once the ball ended and all the data had been collected, left clicking on the end ball icon saved the data onto the computer's hard-drive.
### 3.4 Data Definitions

**Table 1: Basic Cricket Terminology**

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over</td>
<td>Consists of 6 balls bowled plus wides and no-balls</td>
</tr>
<tr>
<td>Length</td>
<td>The distance from the batter that the ball pitches</td>
</tr>
<tr>
<td>Line</td>
<td>The line which the ball pitches on across the width of the pitch</td>
</tr>
<tr>
<td>Extra</td>
<td>Runs which are not scored by the batter</td>
</tr>
<tr>
<td>Off-side</td>
<td>The side of the field which is at the front of the batter when he/she is in stance or to the right of the batsman.</td>
</tr>
<tr>
<td>Leg-side</td>
<td>(Also referred to as on-side) when the batter is in their stance the leg side is to the left of the batsman or at the back of the batter when he/she is in stance.</td>
</tr>
<tr>
<td>Runs per over (R.P.O.)</td>
<td>the runs scored off each over bowled</td>
</tr>
<tr>
<td>Hit Square</td>
<td>Describes shots which are hit square of the wicket on either the leg side or off side. The ball which is hit in the direction that either his back or front is facing.</td>
</tr>
<tr>
<td>Hit Straight</td>
<td>Shots which are hit straight are balls which are hit back in a similar direction of the bowlers end.</td>
</tr>
<tr>
<td>Straight batted shots</td>
<td>Describes shots which are played with the bat vertical to the bowler.</td>
</tr>
<tr>
<td>Cross batted shots</td>
<td>Shots which are played with the bat horizontal to the bowler.</td>
</tr>
</tbody>
</table>
**Delivery Length**

The Delivery length identifies the distance that the ball pitches away from the batsmen. The lengths are full toss, Yorker, full, good length, short and bouncer.

![Diagram of Delivery Lengths](image)

**Figure 10**: Lengths Bowled
Table 2: Delivery Length Definitions

<table>
<thead>
<tr>
<th>Length</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Toss</td>
<td>A delivery which does not pitch before reaching the batsman.</td>
</tr>
<tr>
<td>Yorker</td>
<td>A ball that pitches at the batsman’s feet, which is hard for the batsman to score runs from.</td>
</tr>
<tr>
<td>Full</td>
<td>A delivery which pitches fuller than a good length, allowing offensive shots off the front foot to be played.</td>
</tr>
<tr>
<td>Good Length</td>
<td>A ball that pitches around nine feet from the crease, causing uncertainty in the batsman mind whether to go forwards or backwards.</td>
</tr>
<tr>
<td>Short</td>
<td>A ball that pitches short of a good length forcing the batsman to play a shot off the back foot.</td>
</tr>
<tr>
<td>Bouncer</td>
<td>A ball pitching very short aiming at the batsman’s head and chest to intimidate the batsman.</td>
</tr>
</tbody>
</table>
Delivery Line

The delivery line identifies where across the width of the pitch the ball pitches in relation to the stumps. On “Feedback Cricket” there are three options for delivery line. Either middle stump to leg side, middle stump to just outside off stump, and outside the off stump (see appendix B for “Feedback Cricket” screen shots).

![Diagram of delivery lines]

**Figure 11:** Delivery Lines bowled to right handed batsmen
<table>
<thead>
<tr>
<th>Delivery Line</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Describes a ball that has pitched outside off stump</td>
</tr>
<tr>
<td>Line</td>
<td>Describes a ball which pitches between middle stump and just outside off stump.</td>
</tr>
<tr>
<td>Leg</td>
<td>Describes a ball which pitches leg side of middle stump</td>
</tr>
</tbody>
</table>
**Bowling Extras**

Describes the runs that occurred that did not come from the batsmen bat. For example, no balls, wides, leg byes and byes.

**Table 4: Different types of extras**

<table>
<thead>
<tr>
<th>Extras</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wides</td>
<td>A ball which is deemed illegitimate by the umpire due to being too wide for the batsmen to play at. An extra run and delivery is awarded to the batting side.</td>
</tr>
<tr>
<td>No-Balls</td>
<td>A delivery which is deemed illegitimate by the umpire due to overstepping the front line when bowling, delivering the ball on the full above waist height or breaking the fielding restrictions. An extra run and delivery is awarded to the batting side</td>
</tr>
<tr>
<td>Leg Bye</td>
<td>When runs are scored off the batters body, without touching the bat.</td>
</tr>
<tr>
<td>Bye</td>
<td>When runs are scored without touching the bat or body.</td>
</tr>
</tbody>
</table>
# Type of Shot Played

**Table 5: Definitions of specific strokes**

<table>
<thead>
<tr>
<th>Stroke</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Shot</td>
<td>When a batsman decides to not to play a shot to a delivery, therefore allowing the ball to go through to the wicket keeper for no run.</td>
</tr>
<tr>
<td>Forward Defensive</td>
<td>A defensive shot, where the main purpose is to defend the stumps. Played on the front foot with a straight bat.</td>
</tr>
<tr>
<td>Backward Defensive</td>
<td>A defensive shot, where the main purpose is to defend the stumps. Played on the back foot with a straight bat.</td>
</tr>
<tr>
<td>Off side front foot drive</td>
<td>An offensive shot played off the front foot. The shot is played with a straight bat through the off side.</td>
</tr>
<tr>
<td>Leg side front foot drive</td>
<td>An offensive shot played off the front foot. The shot is played with a straight bat through the leg side.</td>
</tr>
<tr>
<td>Off side back foot drive</td>
<td>An offensive shot played off the back foot. The shot is played with a straight bat through the off side.</td>
</tr>
<tr>
<td>Leg side back foot drive</td>
<td>An offensive shot played off the back foot. The shot is played with a straight bat through the on side.</td>
</tr>
<tr>
<td>Leg Glance</td>
<td>An offensive shot played on the front foot that is deflected through the leg side.</td>
</tr>
<tr>
<td>Front foot cut shot</td>
<td>An offensive cross batted shot played off the front foot hit through the off side.</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Back foot cut shot</td>
<td>An offensive cross batted shot played off the back foot hit through the off side.</td>
</tr>
<tr>
<td>Front Foot pull or hook</td>
<td>An offensive cross batted shot played off the front foot hit through the leg side.</td>
</tr>
<tr>
<td>Back foot pull or hook</td>
<td>An offensive cross batted shot played off the back foot hit through the leg side.</td>
</tr>
<tr>
<td>Sweep Shot</td>
<td>A front foot, offensive, cross-bat shot played towards the square region of the on-side</td>
</tr>
<tr>
<td>Play and Miss</td>
<td>The batsman playing at the ball but missing the ball.</td>
</tr>
</tbody>
</table>

### 3.5 Matches Analysed

The data was gathered from the 2007 Cricket World Cup held in the West Indies. Matches were recorded in the “super eight” section of the World Cup, as this allowed for international elite cricketers to be used as subjects in the study. The permissions of the teams and players were not needed as the games were already in public domain.

The matches being analysed were chosen because these teams were ranked by the International Cricket Council (ICC) in the top eight One Day International (ODI) sides in the world prior to the Cricket World Cup in 2007.

- **28th March, 2007, South Africa vs Sri Lanka**: Providence Stadium, Georgetown, Guyana (South Africa won by 1 wicket).
- **2nd April, 2007, West Indies vs Pakistan**: Sabina Park, Kingston, Jamaica (West Indies won by 54 runs).
- 4th April, 2007, **England vs Sri Lanka**: Sir Vivian Stadium, North Sound, Antigua and Barbuda (Sri Lanka won by two runs).

- 8th April, 2007, **England vs Australia**: Sir Vivian Stadium, North Sound, Antigua and Barbuda (Australia won by 7 wickets).

- 10th April, 2007, **West Indies vs South Africa**: Queens Park, St Georges, Grenada (South Africa won by 67 runs).

- 14th April, 2007, **South Africa vs New Zealand**: Queens Park, St Georges, Grenada (New Zealand won by five wickets).

- 15th April, 2007, **England vs New Zealand**: Beausejour Stadium, Gros Islet, Saint Lucia (New Zealand Won by 6 wickets).

- 16th April, 2007, **Sri Lanka vs Australia**: Queens Park, St Georges, Grenada (Australia won by 7 wickets).

### 3.2.1 The Bowlers Being Analysed

The bowlers being analysed were chosen because they were ranked by the International Cricket Council (ICC) in the top twenty One Day International (ODI) bowlers in the world prior to the Cricket World Cup in 2007.

#### “Side On” Bowlers

- Shane Bond (New Zealand)
- Shaun Pollock (South Africa)
- James Anderson (England)
- Lasith Malinga (Sri Lanka)
• Shaun Tait (Australia)

“Front On” Bowlers

• Andrew Flintoff (England)
• Andre Nel (South Africa)
• Glen McGrath (Australia)
• Umar Gul (Pakistan)
• Makhaya Ntini (South Africa)

3.6 Data Collected

The following key performance indicators were collected:

• Delivery line;
• Delivery length;
• Bowling extras;
• Type of shot played;
• Runs Scored;
• Number of dot balls (balls bowled where the batsmen didn’t score a run and no extras were conceded);
• Number of scoring shots;
• Direction of the shot collected through wagon wheels.

3.7 Pilot Studies

Two pilot studies were conducted for the study. Firstly, an indoor cricket match was analysed to familiarise the analyst with the “Feedback Cricket” system. It was first thought that the system could be used to notate ‘in event’, however, after the first pilot study, due to the complexity and amount of
information needed for analysis, this idea was abandoned. The second pilot study included analysing 15 overs of a One Day International. This was used to improve the analyst’s accuracy and speed of data collection. After the second pilot study it was decided no other alterations to the system were incorporated.

3.8 Reliability

Thomas and Nelson (2005) stated the importance of ensuring that the measurements made as part of research are adequately reliable and valid. To make sure of this 15 overs of the 2007 World Cup match between England and New Zealand on the 15th of April were used to test the reliability of the study. An intra-observer test was performed where the same 15 overs were notated twice by the same person with a week between the two data collection periods. To test for reliability a percentage error was used. Hughes, et al. (2002) suggests that a simple percentage calculation gives the best indicator of reliability.

The equation used for the calculation, adapted from (Hughes and Franks, 2004) is shown below:

\[
\text{Percentage Error} \% = \left( \Sigma (\text{mod}[V1-V2]) / \text{VTOTmean} \right) \times 100 \% ,
\]

In accordance with work by Bland and Altman (1986 cited in Hughes and Frank, 2004) a percentage error of less than 5% was deemed to be acceptable for this study.
3.9 Data Processing
The raw data from “Feedback Cricket” was then transferred to a Microsoft Excel spreadsheet where means of the data were calculated allowing appropriate graphs and tables to be formed for comparison between the different styles of bowlers. In addition, data was then entered into SPSS to allow statistical testing to take place.

3.10 Data Analysis
The raw data was entered into SPSS and was tested to determine whether the data was parametric or non-parametric. The Shapiro-Wilk test was performed to screen for normality of the data and Levene’s test was used to test for the homogeneity of variance. Thomas & Nelson (2002) suggest data which satisfied assumptions for normality of data and homogeneity of variance was deemed to be parametric, while data which did not meet both assumptions was deemed to be non-parametric. Significant difference between front on and side on bowlers were determined using Independent t-tests for parametric data and Mann-Whitney-U tests for non-parametric data. An example of the statistical tests can be found in Appendix D.
Chapter IV

Results
4 Results

4.1 Reliability Study

Table 9 gives the results of the intra reliability study. All of the variables have a percentage error of less than 5%.

**Table 6**: Percentages of reliability for the different performance indicators.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>97.99%</td>
</tr>
<tr>
<td>Line</td>
<td>95.96%</td>
</tr>
<tr>
<td>Direction of Shot</td>
<td>97.99%</td>
</tr>
<tr>
<td>Shot Result</td>
<td>100%</td>
</tr>
<tr>
<td>Shot Type</td>
<td>97.99%</td>
</tr>
<tr>
<td>Extras</td>
<td>100%</td>
</tr>
</tbody>
</table>

The data collected from the intra observer reliability study can be found in Appendix A.
4.2 Bowling Analysis

4.2.1 Shot Result

Figure 12 shows the mean percentage of dot balls, single runs and boundaries resulting from side on and front on bowling techniques. Side On bowlers bowled a greater mean percentage of dot balls (63.6% compared to 58.6%, \( p > 0.05 \)) and boundary balls (8% compared to 6%, \( p > 0.05 \)). While front on bowlers bowled a greater mean percentage of balls that lead to singles (25% compared to 19%, \( p > 0.05 \)). However none of the differences were significantly different. The T bars show the standard deviations away from the mean.

![Graph showing percentages of dot balls, singles, and boundaries](image)

**Figure 12**: Percentages of dot balls, single runs and boundaries resulting from side on and front on bowling techniques.
4.2.2 Lengths Bowled

Figure 13 highlights the mean percentages of the lengths bowled by the different fast bowling techniques. Front on bowlers recorded significant difference of short bowls bowled (20.2% compared to 9%, \( p < 0.05 \)) also, full tosses bowled (4.2% compared to 3%, \( p > 0.05 \)) and finally recorded a higher mean percentages of bouncers bowled (4.8% compared to 4.6%, \( p > 0.05 \)). Side on bowlers recorded a higher mean percentage of length balls (58.2% compared to 57.8%, \( p > 0.05 \)), as well as full deliveries (23.6% Compared to 10%, \( p > 0.05 \)) and yorkers bowled (3.6% compared to 3%, \( p >0.05 \)).

![Figure 13: Mean percentage of lengths bowled.](image)

Significant differences are indicated by (*)
4.2.3 Line’s Bowled

Figure 14 illustrates the mean percentages of the lines bowled by the different techniques of fast bowling. Front on bowlers recorded a higher mean average of balls bowled that pitched outside the off stump (24% compared to 22%, \( p > 0.05 \)) and balls bowled that pitched on middle stump to just outside off stump (66.2% compared to 62.4%, \( p > 0.05 \)). Whilst side on bowlers recorded a higher mean percentage of balls that pitched leg side of middle stump (15.4% compared to 9.8%, \( p > 0.05 \)). However none of the differences were significantly different.

Figure 14: Mean percentage of lines bowled
4.2.4 Shot Type

Figure 15, 16 and 17 exhibit the mean percentages of the balls bowled which leads to the various shots the batsmen performed. Front on bowlers made batsmen use the back defensive shot significantly more than the side on bowlers (14.8% compared to 7.8%, $p < 0.05$). In addition front on bowlers made the batsmen play shots off the back foot more than the side on bowlers (38% compared to 30%, $p > 0.05$). Side on bowlers made the batsmen use more front foot shots (60% compared to 49%, $p > 0.05$). In conclusion figure 14 shows that front on bowlers bowled more balls where shots were played off the back foot compared side on bowlers (40% compared to 33%, $p > 0.05$).

![Figure 15](image-url)

**Figure 15**: Mean percentages of the balls bowled which leads to the various front foot shots the batsmen performed.
Figure 16: mean percentages of the balls bowled which leads to the various back foot shots the batsmen performed

Significant differences are indicated by (*)

Figure 17: Total mean percentage of the balls bowled which leads to the various front and back shots executed by the batsmen.
4.2.5 Shot type and runs scored

Figure 18, 19 and 20 illustrates the mean percentages of the runs scored for each of the shot the batsmen performed. The batsmen scored a higher mean percentage of runs by performing the back foot pull, off the front on bowlers compared to the side on bowlers (17.2% compared to 8.4%, \( p > 0.05 \)), also by executing the front foot off drive (34.8% compared to 26.4%, \( p > 0.05 \)). While batsmen scored a higher mean percentage of runs by performing the leg glance, off the side on bowlers compared to the front on bowlers (25.6% compared to 17.6%, \( p > 0.05 \)). In conclusion front on bowlers conceded more runs when the batsmen played shots off the back foot compared side on bowlers (38% compared to 30%, \( p > 0.05 \)).

![Figure 18: mean percentages of the runs scored for each of the front foot shots the batsmen performed](image-url)
Figure 19: mean percentages of the runs scored for each of the back foot shots the batsmen performed.

Figure 20: total mean percentages of the runs scored for each of the shot the batsmen performed.
4.2.6 Played and Missed

Figure 21 highlights the mean percentage of shots played which where the batsmen missed the ball, broken down by bowler type. Side on bowlers bowled a significantly higher mean percentage of balls that the batsmen played and missed at. (17.6%, compared to 10.8%, $p < 0.05$).

**Figure 21**: Mean percentage of play and misses

Significant differences are indicated by (*)
4.2.7 Runs Conceded per Over (RPO)

Figure 22 shows the mean percentage of runs scored per over, front on bowlers conceded slightly more runs per over than side on, however there was no significant difference (4.3 RPO compared to 4.2 RPO, $p > 0.05$).

![Figure 22: Runs conceded per over](image-url)
4.2.8 Wickets per Game and Bowling Average

Figure 23 shows the mean percentage of wickets per game, side-on bowlers took slightly more wickets a game than front-on bowlers, however there was no significant difference (2.2 wickets per game compared to 1.8 wickets per game, $p > 0.05$). A bowling average is the total number of runs conceded by the bowler divided by the number of wickets taken by the bowler. Front-on bowlers had a slightly higher bowling average than side-on bowlers (23.9 compared to 21.7, $p > 0.05$). However there was no significant difference between the data sets.

![Bar chart showing average number of wickets per game for front and side bowlers.](image)

**Figure 23:** Average number of wickets per game.
Figure 24: Bowling Average
Chapter

IV

Conclusion
6 Conclusions

6.1 General Conclusions
There were significant differences between lengths bowled, more specifically front-on bowlers bowled significantly more short balls than side-on bowlers (20.2% compared to 9%, \( p < 0.05 \)). In addition, front-on bowlers also made the batsmen play the back foot defensive significantly more times than the side-on bowlers (14.8% compared to 7.8%, \( p < 0.05 \)). Whilst the side-on bowlers made the batsmen play and miss at the ball significantly more times than front-on bowlers (17.6%, compared to 10.8%, \( p < 0.05 \)). However, these significant differences did not have an overall affect on the differences in performance between the bowling techniques. This is because there were no significant differences between the economy rates, the average wickets per game and the bowling averages. Therefore, the null hypothesis has to be accepted for this study.

As a result of this study, if a coach observes a young child using a mixed action, a coach should introduce both the front-on and the side-on techniques to the athlete because there was no differences in overall performance between the side-on and front-on bowling techniques. Subsequently, the athlete should choose the technique which feels the most comfortable.

6.3 Limitations
- The computerized notational analysis system gathered frequency data, however, if one accepts the argument that sport performance consists
of a complex series of interrelationships between a wide variety of performance variables, then simple frequency data cannot necessarily capture the full complexity of a performance (Borrie, Jonsson and Magnusson, 2002).

- Environmental changes/weather were not taken into account in the study. The World Cup was played in eight different West Indies countries on eight different grounds. Each pitch varied notably and not all grounds were the same size. In addition, certain pitches were more favourable to bowlers than other grounds.

6.2 Future Recommendations

- The inclusion of bowling variables such as speed of delivery, swing and seam movement are needed to be notated to allow a more in-depth bowling analysis and the notation of fielding variables would also help to provide a more in-depth bowling analysis.

- Notating more matches and using more bowlers will improve reliability because the more resources the data is drawn from the more it is applicable to the findings and to different situations.
References
References


Hawkins, P. (2007). Collingwood LBW Dismissal The Brit Oval, England vs India (online) Available From:


Appendix A
Appendix A

Reliability Data

C1: Reliability study for line bowled.

<table>
<thead>
<tr>
<th></th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>21</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Line</td>
<td>62</td>
<td>63</td>
<td>1</td>
</tr>
<tr>
<td>Leg</td>
<td>16</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>99</td>
<td>2</td>
</tr>
</tbody>
</table>

C2: Reliability testing for length bowled.

<table>
<thead>
<tr>
<th></th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bouncer</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Short</td>
<td>16</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>Length</td>
<td>56</td>
<td>55</td>
<td>1</td>
</tr>
<tr>
<td>Full</td>
<td>21</td>
<td>19</td>
<td>2</td>
</tr>
<tr>
<td>Yorker</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Full Toss</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>99</td>
<td>4</td>
</tr>
</tbody>
</table>

C3: Reliability testing for shot result.

<table>
<thead>
<tr>
<th></th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dot Ball</td>
<td>64</td>
<td>64</td>
<td>0</td>
</tr>
<tr>
<td>Single</td>
<td>25</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>Boundary</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>99</td>
<td>0</td>
</tr>
</tbody>
</table>

C4: Reliability testing for shot type.

<table>
<thead>
<tr>
<th></th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offensive</td>
<td>60</td>
<td>59</td>
<td>1</td>
</tr>
<tr>
<td>Defensive</td>
<td>39</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>99</td>
<td>2</td>
</tr>
</tbody>
</table>

C5: Reliability testing for extras.

<table>
<thead>
<tr>
<th></th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-Balls</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Wides</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>9</td>
<td>0</td>
</tr>
</tbody>
</table>
C6: Reliability testing for direction of shot.

<table>
<thead>
<tr>
<th>Direction</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behind Square – Off Side.</td>
<td>17</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>Behind Square – On Side.</td>
<td>8</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>In Front of Square – Off Side.</td>
<td>44</td>
<td>43</td>
<td>1</td>
</tr>
<tr>
<td>In Front of Square – On Side.</td>
<td>30</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>99</td>
<td>2</td>
</tr>
</tbody>
</table>
Appendix B
Appendix B

Screens Used Within ‘Feedback Cricket’

B 1: Example of the scorecard facility within feedback cricket.
B 2: Example of the score panel facility within feedback cricket.
B 3: Example of the batting analysis within feedback cricket.
B 4: Example of the bowling analysis facility within feedback cricket.
B 5: Example of the Key Performance Indicators facility within feedback cricket.
Appendix C
Wagon Wheels:

C.1 Side – On Bowlers

C.1.1: S. Pollock’s Wagon Wheel

C.1.2: L.Malinga’s Wagon Wheel
C.1.3: J. Anderson’s Wagon Wheel

- Runs: 38
- Balls: 61
- RPO: 3.80
- Dot Balls: 38 (62%)
- 1's: 10 (16%)
- 2's: 8

C.1.4: S. Bond’s Wagon Wheel

- Runs: 26
- Balls: 62
- RPO: 2.60
- Dot Balls: 46 (74%)
- 1's: 8 (13%)
- 2's: 2
C.1.5: S. Tait's Wagon Wheel

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runs</td>
<td>68</td>
<td>3's:</td>
</tr>
<tr>
<td>Balls</td>
<td>66</td>
<td>4's:</td>
</tr>
<tr>
<td>RPO</td>
<td>8.80</td>
<td>5's:</td>
</tr>
<tr>
<td>Dot Balls</td>
<td>28</td>
<td>Boundaries:</td>
</tr>
<tr>
<td>1's:</td>
<td>18</td>
<td>4's:</td>
</tr>
<tr>
<td>2's:</td>
<td>6</td>
<td>6's:</td>
</tr>
</tbody>
</table>
C.2: Front – On Bowlers

C.2.1: M. Ntini’s Wagon Wheel.

C.2.2: G. McGrath’s Wagon Wheel
C.2.3: A. Flintoff’s Wagon Wheel

C.2.4: U. Gul’ Wagon Wheel
C.2.5: A. Nel’s Wagon Wheel

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Runs:</td>
<td>38</td>
<td>3's:</td>
<td>0</td>
</tr>
<tr>
<td>Balls:</td>
<td>61</td>
<td>4's:</td>
<td>0</td>
</tr>
<tr>
<td>RPO:</td>
<td>3.80</td>
<td>5's:</td>
<td>0</td>
</tr>
<tr>
<td>Dot Balls:</td>
<td>38 62%</td>
<td>Boundaries:</td>
<td>32%</td>
</tr>
<tr>
<td>1's:</td>
<td>10 16%</td>
<td>4's:</td>
<td>3</td>
</tr>
<tr>
<td>2's:</td>
<td>8</td>
<td>6's:</td>
<td>0</td>
</tr>
</tbody>
</table>
Appendix D
### D.1 Test for Normality

Tests of Normality

<table>
<thead>
<tr>
<th></th>
<th>Kolmogorov-Smirnov(a)</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistic</td>
<td>df</td>
<td>Sig.</td>
</tr>
<tr>
<td>VAR00002</td>
<td>.151</td>
<td>10</td>
</tr>
</tbody>
</table>

* This is a lower bound of the true significance.
a  Lilliefors Significance Correction

### D.2 Independent T Test

Independent Samples Test

<table>
<thead>
<tr>
<th></th>
<th>Levene's Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
<th>95% Confidence Interval of the Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>Sig.</td>
<td>t</td>
</tr>
<tr>
<td></td>
<td>Equal variances not assumed</td>
<td>1.262</td>
<td>5.329</td>
</tr>
</tbody>
</table>