Cardiff School of Sport

DISSERTATION ASSESSMENT PROFORMA:

Empirical [1]

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Comments	Section
	Title and Abstract (5%) Title to include: A concise indication of the research question/problem. Abstract to include: A concise summary of the empirical study undertaken.
	Introduction and literature review (25%) To include: outline of context (theoretical/conceptual/applied) for the question; analysis of findings of previous related research including gaps in the literature and relevant contributions; logical flow to, and clear presentation of the research problem/ question; an indication of any research expectations, (i.e., hypotheses if applicable).
	Methods and Research Design (15%) To include: details of the research design and justification for the methods applied; participant details; comprehensive replicable protocol.
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	Discussion and Conclusions (30%) [2] To include: collation of information and ideas and evaluation of those ideas relative to the extant literature/concept/theory and research question/problem; adoption of a personal position on the study by linking and combining different elements of the data reported; discussion of the real-life impact of your research findings for coaches and/or practitioners (i.e. practical implications); discussion of the limitations and a critical reflection of the approach/process adopted; and indication of potential improvements and future developments building on the study; and a conclusion which summarises the relationship between the research question and the major findings.
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CARDIFF SCHOOL OF SPORT

DEGREE OF BACHELOR OF SCIENCE (HONOURS)

SPORT AND EXERCISE SCIENCE

2014-5

A Comparison of Seam and Spin Bowling Performance in the 2014 ICC T20 Cricket World Cup

(Dissertation submitted under the Performance Analysis area)

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Certificate of student

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TABLE OF CONTENTS

Chapter Four

4.0 Results

Chapter Five

5.0 Discussion

Chapter Six

6.0 Conclusion

Appendices

Appendix A – Initial Data Collection sheet prior to the Pilot Study

Appendix B – Match Dates, Teams, Venues, Type & Results

Appendix C – Raw Data Values

Appendix D – Dismissals of Cricket

Appendix E – Raw Kappa Tables

LIST OF TABLES

LIST OF FIGURES

Acknowledgements

I would like to thank my parents and close friends for their continued encouragement and support. In particular, a special thank you to Ray Ponting for his guidance and supervision throughout the dissertation process.

Abstract

The study investigated whether there were any differences in performance between seam bowlers and spin bowlers at different stages of a T20 game during the 2014 ICC T20 Cricket World Cup in Bangladesh. The data was gathered from the ESPN Cricinfo website and bowling performance variables from all the men's 35 matches were recorded.

The system was deemed reliable following intra-observer and inter-observer reliability tests using Kappa Analysis. Mann-Whitney U tests were used to test for a significant difference ($p<0.05$) between the performance of seam and spin bowlers.

Seam bowlers were used significantly more than spin bowlers in the first and last six overs of both innings but significantly less in the middle eight overs of both innings. Spin bowlers were found to have a significantly lower economy rate (seam 9.57 ± 3.06, spin 7.80 ± 4.68, $p=0.031$) in the last six overs of the first innings and conceded a significantly lower percentage of runs from boundaries (seam 47.22% ± 24.07, spin 36.61% ± 17.91, $p=0.039$) in the middle eight overs of the first innings. The greatest difference between the tournament average strike rates was established in the first six overs of the first innings (seam 26.41, spin 16.89).

It was suggested that pitch conditions in Asia may favour the performance of spin bowling potentially affecting the above results. Further research is required into different conditions across the world to investigate this.

Chapter One –

Introduction

1.0 Introduction

1.1 Background

The game of cricket has progressively evolved over the centuries culminating in the publication of the Laws of the Game in 1744 (Altham, 1962). These form the basis of today's laws, and are continually updated, altered and added to when circumstances in the modern game dictate for changes to be made (Woolmer and Noakes, 2008). The most traditional form of the game, 5-day Test Match Cricket, continues to flourish to this day with eagerly anticipated international matches being contested around the globe. Modifications to the game such as limited over cricket/ one day international cricket (ODI) were introduced in the 1970s to increase the popularity of the game and bring a more exciting and captivating brand of cricket to the spectators (Douglas and Tam, 2010).

Twenty20 cricket (T20) has emerged as the newest format of the game, following its introduction in the English and Welsh domestic cricket season during 2003 (Sharma *et al*., 2012). The newer shorter format has quickly gained popularity and spectator attendances have quickly exceeded that of domestic limited over cricket (Douglas and Tam, 2010). Since its inception the commercial value of T20 has brought about domestic and international competitions around the globe (Swartz and Perera, 2013). The increasing popularity of the format can be largely based on the cash injection and media publicity surrounding the franchised-based domestic competitions (Petersen *et al*., 2008a). Competitions such as the Indian Premier League make millions of dollars (USD) a year from the sale of TV rights, promotions and franchises, indicating the commercial value of T20 cricket (Petersen *et al*., 2008a). As the rewards and financial incentives within T20 cricket increase, players and coaches will want to utilise available technology to gain a competitive edge over their rivals and give themselves the greatest advantage they can (Moore *et al*., 2012).

Similarly to the other formats of the Sport, T20 Cricket can be split into two distinct phases, the batting phase and the bowling phase. The batting phase provides an

indication of the attacking capabilities of a team as they attempt to score as many runs as possible in their allotted overs. The bowling phase provides an indication of the defensive capabilities of a team as they attempt to restrict the opposition to as little runs as possible (Douglas and Tam, 2010). Each team when batting faces 20 six ball overs in which fielding restrictions (Powerplay overs) apply for the first six overs. Each bowler is permitted a maximum of 4 overs an innings (Petersen *et al*., 2008a). In addition to the capability of the 11 players competing in each team, success can also be significantly affected by the type of pitch, the winning of the toss and sequences of batting or bowling (Sharma, 2013).

Dey *et al*. (2011) indicated that a bowler can be categorised as either a seam bowler or a spin bowler. Different types of seam bowler and spin bowler can be found within these sub-categories, however, the same tactical and technical components are still noticeable between each type. Seam bowlers will predominantly attempt to deceive batsman through pace, seam and swing while spin bowlers will use flight and spin as their key armoury. Similarities can be found between the two as they both regard line and length as important technical and tactical components within bowling (Woolmer and Noakes, 2008). Petersen *et al*. (2008b) identified restricting runs as the key strategy within bowling and highlighted two main methods in which to do so. Firstly, bowlers can bowl tight lines and lengths to restrict batsman's scoring opportunities, while secondly, bowlers may look to bowl more aggressively and look to take wickets in an attempt to bowl the opposition out before their allotted overs end.

1.2 Research Question

What are the differences in performance between seam bowlers and spin bowlers at different stages of a T20 game?

1.3 Rationale for Research Question

Research within cricket is particularly sparse across all formats, in particular that of T20 cricket (Douglas and Tam, 2010). The limited studies to date have thus far merely confirmed the embryonic key performance indicators (KPI's) related to

success across the different disciplines (batting, bowling and fielding) (Moore *et al*., 2012). Previous analyses within bowling have specifically concentrated on strategies adopted by different types of bowlers, performances of bowlers individually, but, not the differences in performance between them collectively. Identifying the differences in performance between seam bowlers and spin bowlers at different stages of a T20 game can provide assistance to players and coaches. Greater knowledge on performances of bowlers will enable an understanding of which type of bowler best meets the desired KPI's related to success during that period of the game.

1.4 Null Hypothesis

H1- There are differences between the seam and spin bowling strategies adopted by teams at different stages of a T20 game.

H2- There are no differences between spin and seam bowling performance in the first six overs of either innings.

H3 - There are no differences between spin and seam bowling performance in the middle eight overs of either innings.

H4 - There are no differences between spin and seam bowling performance in the last six overs of either innings.

1.5 Limitations

1 – Weather conditions caused cancellations and abandonments to some of the fixtures in the tournament.

2 – Some fixtures ended in the second innings before the allotted 20 overs due to the batting team scoring the set target.

1.6 Delimitations

1 – Some of the fixtures involved non-elite cricketers from associate member nations, this may potentially cause variations in the skill level of bowlers.

2 – Matches were competed during the 'dew' season in Bangladesh, thus affecting the performance of bowlers within periods of some day/night games.

1.7 Glossary of Terms

Table 1 – Definition of terms:

Phrase	Definition
Seam Bowler	Bowls the ball at high speeds to induce it to bounce in an erratic fashion or move sideways through the air (Dey *et al*., 2011).
Spin Bowler	Bowls the ball with rapid rotation so when it bounces it will deviate in a certain direction (Dey *et al*., 2011).
Associate Member Nations	Teams competing in the World Cup that are not registered as full members of the International Cricket Council. These include Ireland, Netherlands, Afghanistan, Honk Kong, United Arab Emirates and Nepal (ICC, 2015).
Day/ Night Matches	First innings of the match is contested during the day time, whilst the second innings of the match is contested during the night time.

Innings	The period where a batting team faces all their allotted overs or when all their players are dismissed.
30 yard inner circle	30 yard oval (27.4 m) that surrounds the playing strip (pitch) (Douglas and Tam, 2010).
Pitch	22 yards (20.2 metres) long and is where the bowler delivers the ball to the batsman (Woolmer and Noakes, 2008).
Line	The direction in which the bowler delivers the ball on the pitch (Woolmer and Noakes, 2008).
Length	The distance from the batsman in which the bowler lands the ball on the pitch (Woolmer and Noakes, 2008).
Swing	Deviation of the ball in the air, depends on the wrist of the bowler and which side of the ball has the shine. Environmental factors also affect the swing of a ball (Woolmer and Noakes, 2008).
Pace	The speed at which a bowler delivers a ball.
Flight	The trajectory through the air between being released by the bowler and bouncing on the pitch (Woolmer and Noakes, 2008).
First Six Overs	The 'Power Play' overs at the start of the innings. Ranging from the 1st over until

	the end of the 5th over.
Middle Eight Overs	Overs ranging from the 6th over of the innings until the end of the thirteenth over.
Last Six Overs	The final six overs of the innings ranging from the fourteenth over until the end of over number twenty.
Strike Rate	The amount of balls bowled by a bowler divided by the number of wickets taken (Sankaran, 2014).
Economy Rate	The number of runs conceded by a bowler divided by the number of overs a bowler has bowled (Sankaran, 2014).
Percentage of Balls Bowled	The percentage of balls bowled by a type of bowler compared to the overall amount (Sankaran, 2014).
Percentage of Dot Balls Bowled	The percentage of dot balls bowled compared to that of balls where runs have been scored (Sankaran, 2014).
Percentage of Runs Conceded from Boundaries	The percentage of overall runs conceded by a bowler compared to the amount of runs conceded by a boundary 4 or boundary 6 (Sankaran, 2014).

Chapter Two -

Literature Review

2.0 Literature Review

2.1 Notational Analysis in Cricket

Hughes and Bell (1998) stated that cricket is a game of facts and figures and the scorebook itself is a sophisticated notational system of analysing match performance. However, it must be considered that the scorebook only provides a limited analysis of performance and cannot provide feedback on the technical and tactical aspects of match performance. Croucher (1987, cited by Helmich, 2011) created a system called 'Cricket-Stat'. In the same way as the scorebook, Cricket-Stat identifies the number of runs scored by each batsman and the outcome of each delivery by the bowler. However, Croucher's system also identifies the line and length of each delivery and direction of the shot. This allows a detailed technical and tactical evaluation of match performance in which players can gain a greater understanding of the strength and weaknesses of their performance. A clear limitation of the system was the time in which it took to input the data. Roberts (2010) stated that the operator needed to record data on a hand notation sheet and then transfer it to a computerised system which was extremely time consuming.

'Cricket-Stat' has progressively developed over the years and has formed the basis for other notational system's such as Hughes and Bell's (1998) system that establishes an in-depth 'performance profile' of cricketers. These profiles identified the components of performance in terms of selection, execution and result. The line, length and outcome of each ball delivered by the bowler was identified along with the strengths and weaknesses of performance from a tactical and technical perspective. All data was collected post event from video for the elite level cricketers (N=22) involved in the Australia and England ODI series in 1997.

A more recent notational system designed is the Feedback Cricket (2004) system. The system captures ball by ball match coverage, recording both video and data for complete match analysis. Feedback Cricket provides a clear coding template for the system operator which enables performance variables to be collected, modified or deleted creating a detailed and immediate analysis of match performance. The

system has been used by international and domestic cricket teams around the world highlighting its success and usability (Feedback Sport, 2004).

2.2 Tactics and strategies in cricket

Tactics and strategies are important concepts of all sporting performance, especially that of cricket. O'Donoghue (2010) states that prior to a sporting competition, players and coaches will often plan strategies to utilise perceived strengths and restrain any potential weaknesses within performance.

Petersen *et al*. (2008b) stated that the dynamics of T20 cricket are extremely different to that of the other formats of the game, by which they meant different strategies were required. However, a contrasting statement by Justham *et al*., (2008) stated that bowlers do not significantly change or adjust their bowling styles across the different formats of the game. The study indicated that bowlers did not significantly vary their line and length of delivery. This was distinctly different to batsman, where significant changes were found in batting strategies across Test match, ODI and T20 cricket (Justham *et al*., 2008). It was suggested in the study that batsman's playing style became more aggressive in limited over matches, due to the reduced amount of allotted overs per game.

Helmich's (2011) study compared the bowling strategies in ODI and T20 cricket across different playing conditions around the world. He identified that strategies did not vary between formats supporting Justham *et al*. (2008). However, it was suggested that bowling lengths adopted may vary between continents around the world. Woolmer and Noakes (2008) stated that cricket pitches in Asia and the Southern Hemisphere do not offer as much bounce or pace compared to that found in Australasia and England / Wales. This suggests that bowling strategies may be influenced depending on different playing conditions. Helmich (2011) study is extremely valuable as it is the only recognised study to examine the different playing conditions around the world. Tactics and strategies in one country cannot be assumed to be the same in a different country due to the varying climates and playing conditions. Significant differences were not found between the strategies of

the same type of bowler in ODI and T20 cricket, however, it was identified that a significant difference was found between seam and spin bowlers strategies. Seam bowlers were found to bowl a significantly shorter length than spin bowlers. This approach may be a result of spin bowlers attempting to exploit the use of flight and guile, to entice the batsman to the pitch of the ball.

Jones (2010) investigated the different bowling strategies adopted during powerplay overs and non-powerplay overs in the English T20 first-class season. The study found seam bowlers delivered 85% of the balls during the powerplay overs compared to 15% delivered by spinners. This drastically changed during the non-powerplay overs as spinners delivered 55% of deliveries compared to 45% delivered by seam bowlers. The study suggested that seam bowlers performed far better in the powerplay overs than spinners when the tactics adopted were analysed. A limitation of the study was that the results were only collected in England / Wales. Woolmer and Noakes (2008) state that greener and damper conditions can be found in England and Wales which are far more conducive to seam bowling. Spin bowlers, however, are suited to dryer and more abrasive pitches found in Asia.

2.3 Performance Analysis within T20 Cricket

Performance analysis is particularly sparse across the T20 format of cricket (Douglas and Tam, 2010). To date most studies related to T20 cricket have focused on team's performance, key performance indicators (KPI) and tactics or strategies implemented within the format. Sport performance is measured by performance indicators which can be defined as "a selection, or combination, of action variables that aims to define some or all aspects of sports performance" (Hughes and Bartlett, 2002). A key performance indicator (KPI) should relate to a successful performance or outcome and can be used to objectively develop team strategies (Petersen *et al*., 2008a).

Petersen *et al*., (2008a) study analysed team batting and bowling performance variables related to success in the 2008 Indian Premier League (IPL). This was established by comparing the magnitude of differences between winning and losing teams using a standardised (Cohen's) effect size (ES: 0.2) measurement with 90%

confidence limits. The three best indicators of success for winnings teams in the current study were taking more wickets in the game (ES=1.93), taking more wickets in the last six overs (ES=1.01) and having a higher run rate (ES=0.96). Taking more wickets in the first six overs of an innings and restricting runs in the middle eight overs were also important KPI's related to success. Petersen *et al*. (2008a) concluded that specialist bowlers capable of taking wickets should be employed in the first six and last six overs, while more defensively minded bowlers should be employed in the middle eight overs to restrict runs. This highlights the value of understanding which type of bowler will best implement the above KPI's related to successful performance.

Douglas and Tam (2010) conducted a similar study on the 2009 ICC World T20 Cup where they considered batting, bowling and fielding variables related to success using Cohen's effect size (ES) measurement. Findings from the study identified similar KPI's as those found in Petersen *et al*'s. (2008a) study. Losing less wickets in the game (ES=-1.66), losing less wickets in the batting powerplay (ES=-1.22), having a higher run rate (ES=1.23) and scoring more runs in the middle eight overs (ES=0.86) were all related to success. A new finding from Douglas and Tam's (2010) study identified bowling more dot balls than the opposition (ES=1.15) as a new KPI. Douglas and Tam (2010) concluded in agreement with Petersen *et al*. (2008a) that specialist types of bowlers should be utilised at specific stages of an innings to implement desired KPI's. The 2009 World Cup was held in England / Wales which has significantly different playing conditions compared to those found in the subcontinent during Petersen *et al*'s. (2008a) study. This is important as it indicates that KPI's related to success do not vary in different playing conditions. However, more studies are required to strengthen this statement.

Moore *et al*. (2012) investigated batting and bowling indicators related to success in the 2010 English T20 first-class season. Pitch level analysis was also employed to identify successful outcomes in matches such as where the ball pitched when a wicket was taken or when a boundary had been scored. Chi square tests were used to analyse pitch level analysis and found that successful teams have a different grouping of deliveries to non-winning teams. This in turn may have caused a higher

number of dismissals through leg before wicket (LBW) decisions. Similar KPI's to previous studies such as number of wickets taken (ES=1.64), more wickets in the last six overs (ES=0.96) and run rate (ES=0.90) were again found to be related to success. Number of boundaries conceded (ES=1.26) and lower percentage of runs conceded from boundaries in the first six overs (ES=0.96) were also identified as significant batting and bowling variables. Moore *et al*. (2012) stated that different bowling tactics were adopted by winning teams and suggested that mapping of performance indicators across different T20 playing conditions may assist with team preparation and tactics. Again, Moore *et al*. (2012) was found to be in agreement with Petersen *et al*. (2008a) and Douglas and Tam (2010) suggesting that the timing and utilisation of wicket taking or run restricting bowlers is paramount to successful performance.

Few studies have actually investigated the performance of different types of bowlers within T20 cricket. Lemmer (2008) looked at batting and bowling performances in the inaugural T20 World Cup in 2007 held in South Africa. Bowling performances were quantified using Lemmer (2005, cited by Lemmer, 2008) Combined Bowling Rate (CBR). The formula =3R/ (W*+O+W*x R/B). R denoted number of runs conceded, W* the importance of the wickets taken (higher the batting position the more important the wicket), O the overs bowled, B the number of balls bowled. The study identified a spin bowler as the top ranked bowler, although seven seam bowlers occupied most of the top ten places. The study was beneficial when looking at the best individual performances, however, it was limited when seam and spin bowling performance as a whole were considered. It must be recognised that the study took place in 2007 and, with the dynamics of the game ever changing, bowlers' tactics and strategies have developed which potentially will have resulted in changes within performance.

Dey *et al*. (2011) measured the individual performance of seam and spin bowlers over a two year period in the IPL. KPI's such as economy rate, strike rate per wicket and wickets taken were used to evaluate performance. Like Lemmer's (2008) study, performance was looked at from an individual perspective. Results from the two year period identified spin bowlers as the top three ranked bowlers in the competition,

while only three seam bowlers occupied the top ten places. The study highlighted the dominance spin bowlers have when playing in Asian conditions, compared to the dominance seam bowlers experienced in friendlier Australasian conditions during Lemmer's (2008) study. Again, the limitation of the study was that only overall performance of bowlers was considered. Wicket taking capabilities or the capability of restricting runs was not examined individually, making it harder to identify the best type of bowler's to implement these strategies.

Wickramasinghe (2014) looked at bowling performance as a whole, investigating the most important indicators of performance and the effect bowling style/ type has on levels of performance. The study examined the 2013 ODI Champions Trophy in England. Although the competition was an ODI format the results can still be related to the T20 format due to similarities in tactics and strategies adopted by bowlers. Using Lemmer's (2005) CBR formula, economy rate of bowlers was found as the most important indicator towards performance. No significant difference was found between performance and different bowling styles/types. This may be due to the small data set in the study that did not include enough fast bowling, fast-medium bowling and medium bowling to allow the study to have any great depth.

2.4 Summary

It can be identified from Justham *et al.* (2008) and Helmich's (2011) studies that bowling tactics and strategies do not differ between the three formats of cricket. However, it has been suggested by Helmich (2011) that strategies of bowler's length can vary depending on the different playing conditions across the world. His study also highlighted that different strategies are adopted by seam and spin bowlers in ODI and T20 cricket. Important KPI's have been distinguished in Petersen *et al*.'s (2008a), Douglas and Tam's (2010) and Moore *et al*.'s (2012) studies. Having a higher run rate, losing less wickets in the first six overs, scoring more runs in the middle eight overs, taking more wickets in last six overs, bowling more dot balls and scoring more runs from boundaries were all highlighted as KPI's related to success. However, it must be considered that research into KPI's in cricket is still sparse compared to other sports and still requires further research (Key, 2013).

Few studies have investigated the performance of the different types of bowler's in T20 cricket. Lemmer (2008) and Dey *et al*. (2011) investigated individual's bowling performance in T20 competitions and found contrasting results. Lemmer (2008) identified seven of the top ten bowlers in the 2007 inaugural T20 World Cup as seam bowlers, while Dey *et al*. (2011) identified seven of the top then bowlers in the 2009 and 2010 Indian Premier League as spin bowlers. Playing conditions may have played a pivotal role in the findings in these studies, however, further research is need to support this statement. Limitation of both studies is the failure to compare seam and spin bowling as a whole and the failure to compare different types of bowler's that best meet desired KPI's related to success.

Chapter Three – Method

3.0 Method

3.1 Introduction

The current study aims to investigate the differences in performance between seam and spin bowling at different stages of a T20 game. Outcomes of each delivery were collected and performance indicators were calculated to analyse performance.

3.2 Equipment Used

In order for the data collection procedure to take place successfully and efficiently, the following high quality equipment was used:

- ESPN Cricinfo 2014 Website
- Computer / Laptop
- Microsoft Office 2013
- IMB SPSS Statistics 20
- Notebook
- HP v195b USB drive

3.3 Participants

The data was collected from male participants in the 35 matches held in the 2014 ICC World Twenty20 Cup in Bangladesh. Data were collected for seam and spin bowlers' performances in each match and bowling statistics over the tournament as a whole were analysed. Matches were held in 3 venues (Dhaka, Chittagong and Sylhet) over the course of the tournament. All match dates, locations, day/night games and results are given in Appendix B.

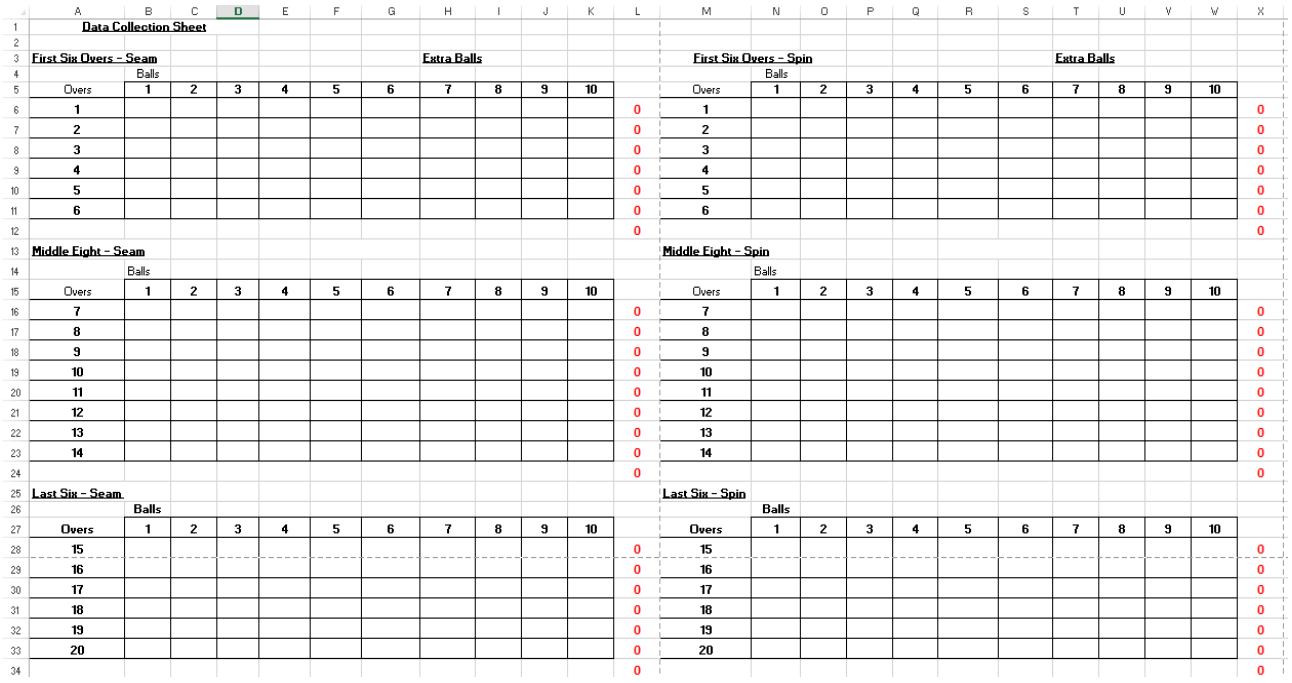
3.4 Pilot Study

A pilot study was carried out prior to the data collection stage of the study. Data was collected from the ESPN Cricinfo website (2014) on the first innings of the England v

India T20 International at Birmingham on the 7th September 2014. Following data collection and analysis of the system a number of issues were identified. It was clearly highlighted that separate tables for seam and spin bowling needed to be created in order to make it easier for the operator to distinguish between the data. Symbols commonly used in the scorebook to notate cricket games were initially proposed to notate the outcomes of each delivery. However, Excel did not recognise these symbols therefore numbers were used in their place to notate the outcome of each delivery. This also allowed the creation of formulas which calculated the number of runs scored against seam and spin bowling enabling a far more accurate and quicker process. These corrections provided a far more efficient and effective system prior to the data being collected. An example of the initial system is given in Appendix A.

3.4.1 Hand Notation System

The final hand notation system was designed on Microsoft Excel 2013 following analysis of data collection during the Pilot Study. Notation sheets collected seam and spin bowling data separately with one used per innings.



Data Collection Sheet

First Six Overs – Seam	Balls										Extra Balls
Overs	1	2	3	4	5	6	7	8	9	10	
1											0
2											0
3											0
4											0
5											0
6											0
											0

Middle Eight – Seam	Balls										
Overs	1	2	3	4	5	6	7	8	9	10	
7											0
8											0
9											0
10											0
11											0
12											0
13											0
14											0

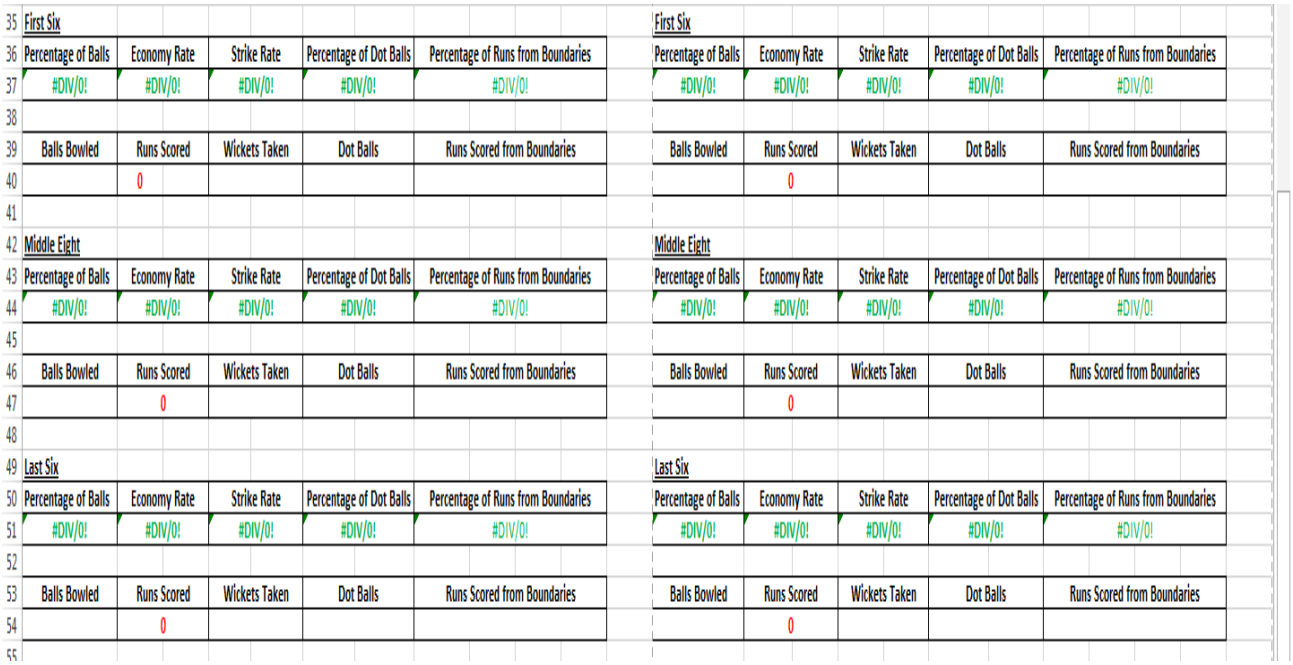
Last Six – Seam	Balls										
Overs	1	2	3	4	5	6	7	8	9	10	
15											0
16											0
17											0
18											0
19											0
20											0
											0

First Six Overs – Spin	Balls										Extra Balls
Overs	1	2	3	4	5	6	7	8	9	10	
1											0
2											0
3											0
4											0
5											0
6											0
											0

Middle Eight – Spin	Balls										
Overs	1	2	3	4	5	6	7	8	9	10	
7											0
8											0
9											0
10											0
11											0
12											0
13											0
14											0

Last Six – Spin	Balls										
Overs	1	2	3	4	5	6	7	8	9	10	
15											0
16											0
17											0
18											0
19											0
20											0
											0

Figure 1a. Hand notation system used during Data Collection



First Six				
Percentage of Balls	Economy Rate	Strike Rate	Percentage of Dot Balls	Percentage of Runs from Boundaries
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Balls Bowled	Runs Scored	Wickets Taken	Dot Balls	Runs Scored from Boundaries
	0			

First Six				
Percentage of Balls	Economy Rate	Strike Rate	Percentage of Dot Balls	Percentage of Runs from Boundaries
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Balls Bowled	Runs Scored	Wickets Taken	Dot Balls	Runs Scored from Boundaries
	0			

Middle Eight				
Percentage of Balls	Economy Rate	Strike Rate	Percentage of Dot Balls	Percentage of Runs from Boundaries
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Balls Bowled	Runs Scored	Wickets Taken	Dot Balls	Runs Scored from Boundaries
	0			

Middle Eight				
Percentage of Balls	Economy Rate	Strike Rate	Percentage of Dot Balls	Percentage of Runs from Boundaries
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Balls Bowled	Runs Scored	Wickets Taken	Dot Balls	Runs Scored from Boundaries
	0			

Last Six				
Percentage of Balls	Economy Rate	Strike Rate	Percentage of Dot Balls	Percentage of Runs from Boundaries
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Balls Bowled	Runs Scored	Wickets Taken	Dot Balls	Runs Scored from Boundaries
	0			

Last Six				
Percentage of Balls	Economy Rate	Strike Rate	Percentage of Dot Balls	Percentage of Runs from Boundaries
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Balls Bowled	Runs Scored	Wickets Taken	Dot Balls	Runs Scored from Boundaries
	0			

Figure 1b. Hand Notation system used during Data Collection

3.5 Operational Procedure

Templates were copied and pasted in Excel creating one sheet for the 1st innings of the game and a separate sheet for the 2nd innings of the game. Match commentary was accessed from the ESPN Cricinfo website to begin data collection. For each over, the bowler type (seam or spin) was identified from the player profiles on the ESPN Cricinfo website. Then for each ball the ESPN description of the outcome was interpreted to and entered into the relevant (seam or spin) bowling table depending on the type of bowler during that period of the innings. Symbols for the outcomes of the different types of deliveries were found in Table 3. Once the 1st over was coded the following process was repeated until all the overs of the innings had been finished. Each over was coded in the correct table (seam or spin) and the correct over the bowler bowled. All balls bowled, dot balls bowled, wickets taken and runs conceded from boundaries in the first six overs were counted and inputted into the first six overs table seen in Figure 1b. This was repeated for the middle eight overs and the last six overs. When all the data had been inputted the pre-existing formulas created in the system design calculated the remaining variables. The procedure was repeated to code the 2nd innings of the game and complete match data collection.

3.5.1 Operational Definitions

Operational definitions were created in order for the system operator to fully understand all terms related to the data collection process. Bowler types and action were defined from the players profiles found on the ESPN Cricinfo website. Outcome of each delivery was defined by the match commentary found on the ESPN Cricinfo website.

3.5.2 Bowler Types and Actions

Table 2 – Descriptions of the different types of bowling actions:

Type of Bowler	**Bowling Actions (abbreviation)**	**Description**
Seam	Right- arm fast (RF)	Right- arm bowler who bowls the ball over 90mph.
	Left- arm fast (LF)	Left-arm bowler who bowls the ball over 90mph.
	Right-arm fast medium (RFM)	Right-arm bowler who bowls the ball between 80-90mph.
	Left-arm fast medium (LFM)	Left-arm bowler who bowls the ball between 80-90mph.
	Right-arm medium (RM)	Right-arm bowler who bowls the ball under 80mph.
	Left arm medium (LM)	Left-arm bowler who bowls the ball under 80mph.
Spin	Right-arm off spin (OS)	Right-arm bowler who turns the ball into a right-handed batsman.

	Slow left-arm orthodox (SLA)	Left-arm bowler who turns the ball away from a right-handed batsman.
	Right-arm leg spin bowler (RLS)	Right-arm bowler who turns the ball away from a right handed batsman.
	Left-arm chinaman bowler (LC)	Left-arm bowler who turns the ball into a right-handed batsman.

3.5.3 Outcome of Deliveries

Table 3 – Descriptions of the different outcomes of deliveries:

Outcome of Delivery	Symbols	Description
Runs	1,2,3,5	When the batsmen run to the opposite end of the pitch and both pass the crease line. Number of runs is dependent on the amount of times they do this.
Boundary Four	4	When a ball passes the boundary but is grounded before it is 4.
Boundary Six	6	When the ball passes the boundary but is grounded beyond it is 6.
Dot Balls	0	When the batsman does not score any runs off that delivery.
Leg Byes	0	When the ball hits the batsman's body (not including glove) and they run between the wickets.

Byes	0	When the ball does not come in contact with bat or the batsman's body and they run between the wickets.
Wide	1,2,3,4,5	When the batsman does not hit the ball and it is deemed too wide by the umpire for the batsman to be able to hit it. 1 run is awarded and an extra delivery has to be bowled. Extra runs can be earned if the ball passes the boundary or if the batsmen run between the wickets.
No Balls	1,2,3,4,5,6,7	When the bowler's feet overstep the front line on the crease or a full toss is bowled above the waist. 1 run is awarded and an extra ball has to be bowled. Batsman can still score runs off the bat when a no ball is delivered but cannot be dismissed by the bowler.
Wicket	**0**	When a type of dismissal by the bowler is recorded. Bowler's dismissals do not include 'run out', 'timed out', 'handled ball', 'retired out', 'obstructing the field' and 'hit the ball twice'. See Appendix D for description of all dismissals.

3.6 Reliability

An intra-observer and inter-observer reliability test was conducted on Match 3 between Ireland and Zimbabwe at Sylhet and Match 7 between Netherlands and Zimbabwe at Sylhet. For the intra-observer test the author recoded these two games a month after the initial coding. A second observer, an experienced cricketer also coded the matches once. The author's two observations were compared using Altman's (1991) Kappa Analysis to provide an intra-observer reliability value. The author's first observation was then also compared to the second observer's data using the same analysis to provide an inter-observer reliability value.

3.6.1 Reliability Findings

Table 4 – Altman (1991)'s strength of agreement for Kappa Values:

Kappa Values	Strength of Agreement (Altman, 1991)
0-0.2	**Poor**
0.2-0.4	**Moderate**
0.4-0.6	**Fair**
0.6-0.8	**Good**
0.8-1.0	**Very Good**

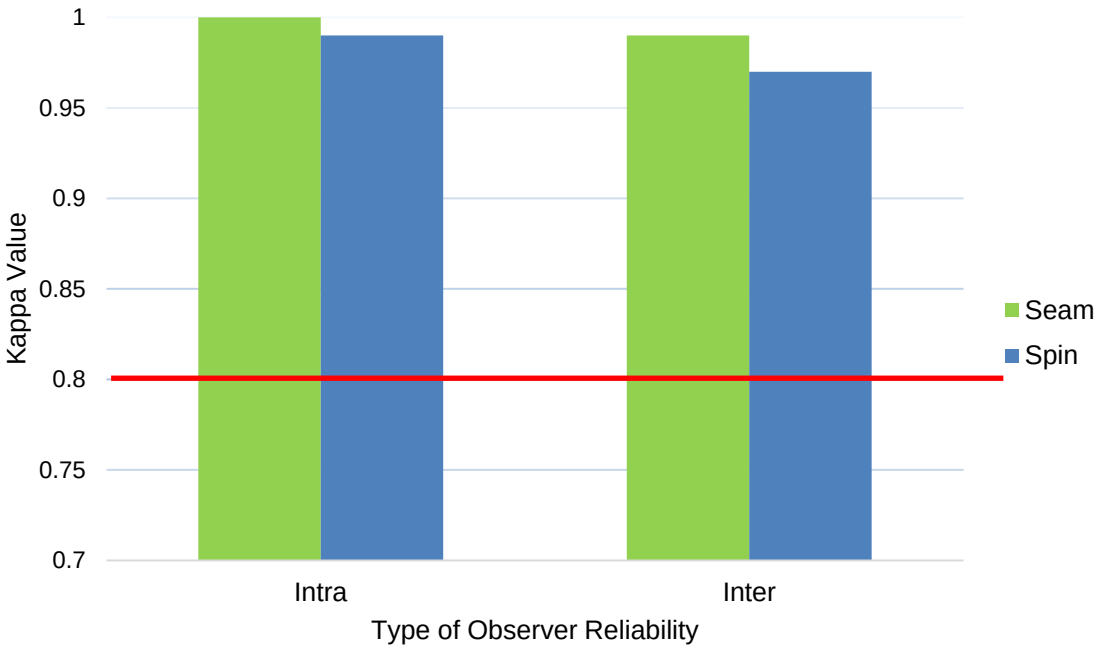


Figure 2. Intra-observer and inter-observer reliability test values for seam and spin bowling delivery outcomes.

The lowest intra-observer Kappa value identified from the above figure is 0.99. While the lowest inter-observer value was 0.97. These provide very good strength of agreement between observations based on Altman (1991) Kappa analysis. Differences between the author and second observer's data can be explained by a coding error in which the second observer identified a run out as a wicket to the bowler. Other marginal differences found between the author's two observations and the second observer data can be explained by lapses in concentration during the coding process. Intra-observer and inter-observer reliability test for determination of bowler type (seam and spin) was of perfect agreement (Kappa=1).

3.7 Data Analysis

Results were organised and exported from Microsoft Excel into SPSS. The data was deemed as non-parametric and seam and spin were compared using a series of unpaired Mann-Whitney U tests. The significance level was set at p=0.05. Mean values for each performance indicator were provided to represent seam and spin bowling. Performance indicators were normalised after every match due to the uneven distribution of balls bowled by seam and spin bowlers over the course of a

T20 innings. Standard deviation was calculated to examine the fluctuations in the individual results gathered compared to that of the mean. Tournament average strike rate was provided for seam and spin bowlers.

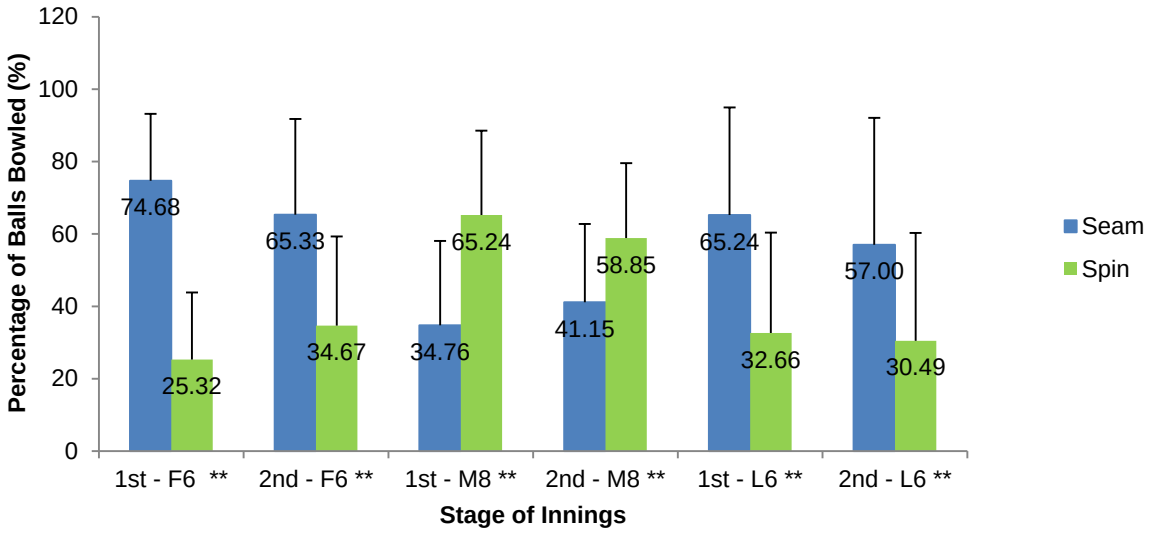
Chapter Four – Results

4.0 Results

4.1 Introduction

The purpose of the study was to investigate the differences in performance between seam bowlers and spin bowlers at different stages of a T20 game. Data was examined in the first six overs, middle eight overs and last six overs of both the first innings and second innings to identify any variations between seam and spin performance. Results for percentage of balls bowled, economy rate, percentage of dot balls bowled and percentage of runs conceded from boundaries are provided as means and standard deviation values have been recorded. A Mann-Whitney U statistical test was performed on each variable to determine if a significant difference existed between seam and spin bowlers ($p<0.05$). Strike rate was analysed by looking at the average strike rate of bowlers over the course of the tournament as a whole.

4.2 Percentage of Balls Bowled

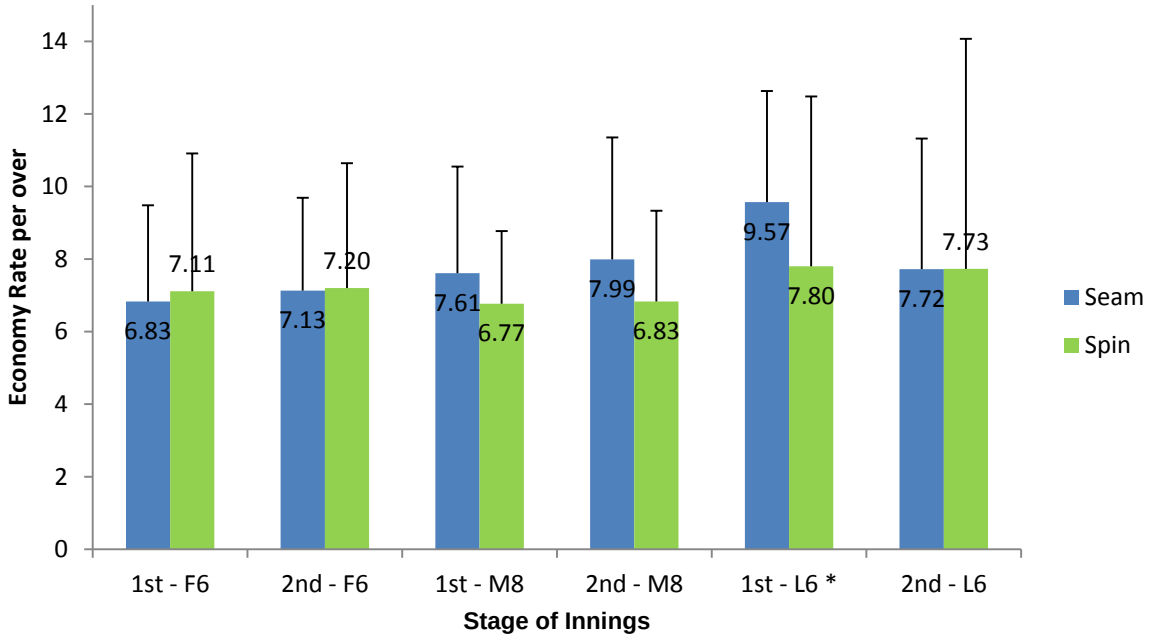


* ($p<0.05$), ** ($p<0.01$)

Figure 3. Percentage of balls bowled by seam and spin bowlers at different stages of a T20 game (mean and standard deviation values)

Significant differences ($p<0.05$) were found at every stage of a T20 game when comparing the percentage of balls bowled by seam and spin bowlers. The most significant difference ($p=0.000$) was found in the first six overs of the first innings where seam bowlers bowled (74.68 ± 18.52) percent of balls compared to (25.32 ± 18.52) percent by spin bowlers.

4.3 Economy Rate



* ($p<0.05$), ** ($p<0.01$)

Figure 4. Economy rates for seam and spin bowlers at different stages of a T20 game (mean and standard deviation values)

A significant difference ($p=0.031$) was found in the last six overs of the first innings where spin bowlers were found to have a significantly lower economy rate (7.80 ± 4.68) compared to that of seam bowlers (9.57 ± 3.06). No other significant differences ($p>0.05$) were found.

4.4 Strike Rate

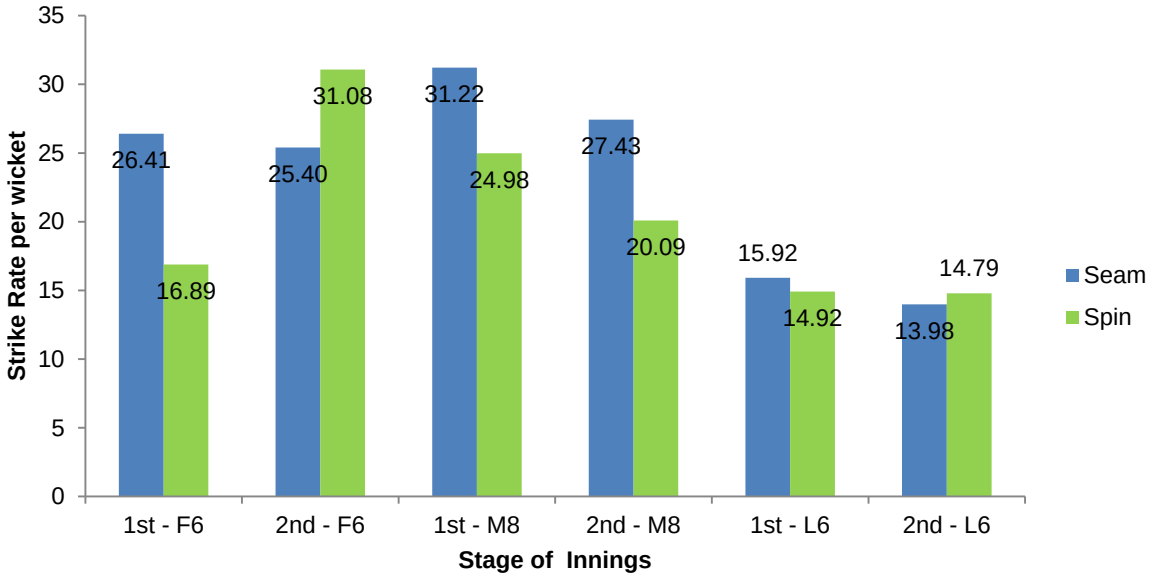
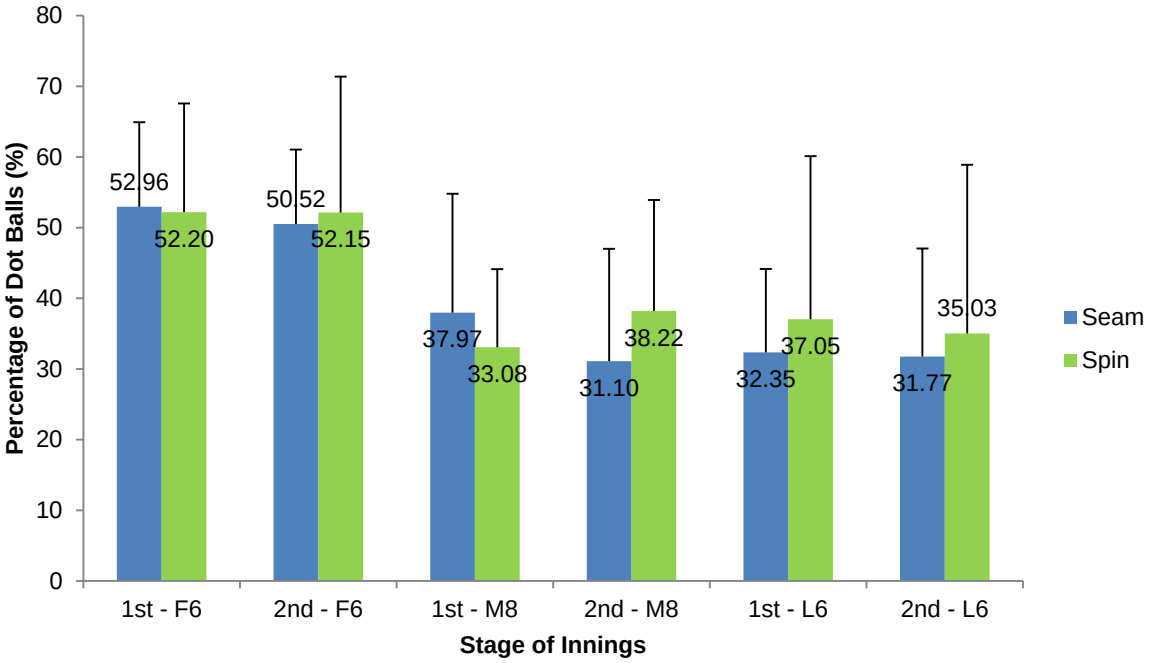


Figure 5. Tournament average strike rates for seam and spin bowlers at different stages of a T20 game.

The greatest difference between seam and spin bowler's tournament average strike rate was found in the first six overs of the first innings. Spin bowlers were found to have a far lower strike rate (16.89) compared to that of seam bowlers (26.41). Strike rate was its lowest in the final six overs in both seam bowlers (13.98) and spin bowlers (14.92).

4.5 Percentage of Dot Balls Bowled

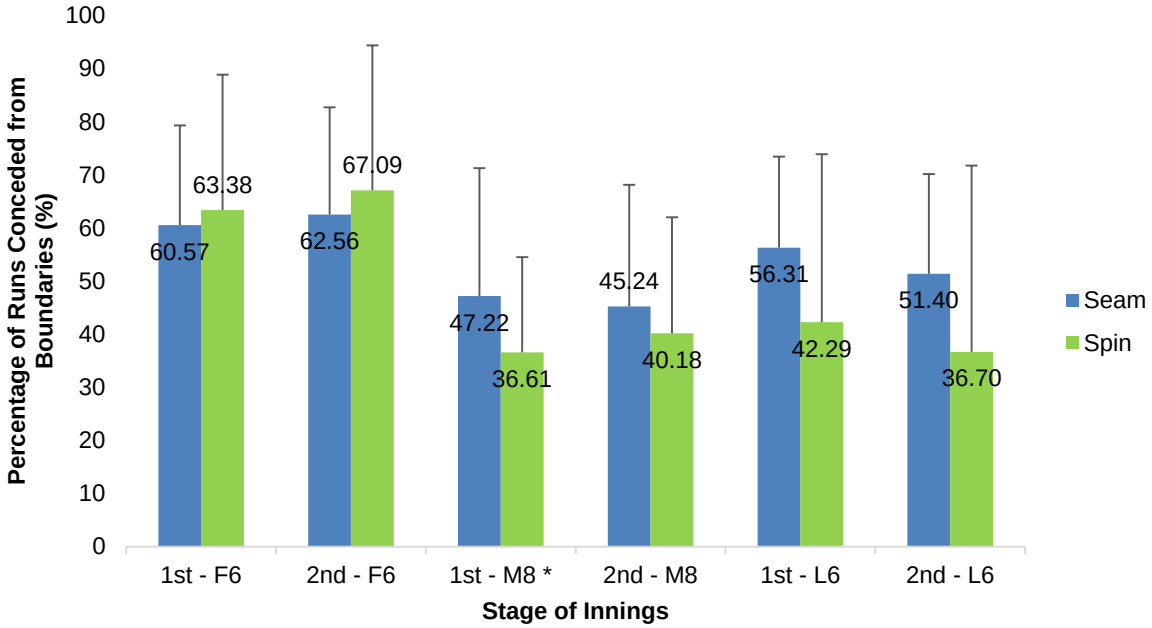


* ($p<0.05$), ** ($p<0.01$)

Figure 6. Percentage of dot balls bowled by seam and spin bowlers at different stages of a T20 game (mean and standard deviation values).

No significant differences ($p>0.05$) were found.

4.6 Percentage of Runs Conceded from Boundaries



* (p<0.05), ** (p<0.01)

Figure 7. Percentage of runs conceded from boundaries at different stages of a T20 game (mean and standard deviation values).

No significant differences (p>0.05) were found between the percentages of runs conceded from boundaries by seam and spin bowlers, apart from the middle eight overs of the second innings where seam bowlers were found to concede a significantly lower (p=0.039) percentage of runs conceded from boundaries (62.56% ± 20.18) compared to that of spin bowlers (67.09% ± 27.31).

Chapter Five – Discussion

5.0 Discussion

5.1 Percentage of Balls Bowled

Figure 3 clearly highlights the predominance of the percentage of balls bowled by seam bowlers in the 'Powerplay' overs (74.68% ± 18.52 1st innings, 65.33% ± 26.42 2nd innings). These findings support Jones (2010)'s study who found seam bowlers delivered 85% of balls in the 'Powerplay' overs of a T20 game. Woolmer and Noakes (2008) stated that quicker bowlers are far more likely to produce deviations through the air or from the surface when bowling with a hard and shiny cricket ball at the start of each innings. It was also stated by Woolmer and Noakes (2008) that batsman must take time to play themselves in at the start of their innings to become accustomed to the pace and bounce of the wicket. This may explain the reason why seam bowlers are used more frequently in the first six overs, as teams are attempting to take early wickets while the batsman are most vulnerable.

In the middle eight overs, spin bowlers delivered a significantly higher percentage of balls (65.24% ± 23.29 first innings, 58.85% ± 20.70 second innings). Jones (2010) suggested that slower bowlers do not deliver many balls in the first six overs because of the fielding restrictions and an unprotected boundary. It was also suggested that batsman have an easier job of manipulating the line and length of slower bowlers. Batsmen can do this by turning deliveries into short length balls through the use of their crease or turning deliveries into full pitched balls by using their feet. This in turn makes it far easier to manufacture shots to the boundary. Petersen *et al*. (2008) stated that boundaries and runs are far harder to accumulate in the middle eight overs when the fielding restrictions are relaxed. This stage of the innings gives spin bowlers the opportunity to restrict runs and take wickets by forcing the batsman into taking risks.

In the final six overs, seam bowlers again delivered a significantly higher percentage of balls (65.24% ± 29.73 1st innings, 57.00% ± 35.07 2nd innings). Moore *et al*. (2012) stated that batting teams attempt to accelerate their run rate to the highest achievable rate in the last six overs by hitting as many boundaries as possible.

Woolmer and Noakes (2008) explained that batsmen thrive on rhythm, predictability and familiarity while at the crease and bowlers should mix things up by changing their length. This would provide a good wicket taking strategy, but also an effective means of slowing down the run rate. Deliveries such as yorkers, bouncers and slower balls are far more deceitful and dangerous when delivered by seam bowlers, potentially illustrating the reason why they deliver a higher percentage of balls during this stage.

5.2 Economy Rate

Figure 4 identifies the first six overs as the lowest economy rates found in seam bowlers (6.83 ± 2.65 1st innings, 7.11 ± 3.80 2nd innings). Hinchliffe (2009) stated that batsman do not play as many risky shots at the beginning of their innings due to the increased swing and movement off the seam produced by bowlers using the new ball. This along with the batsman becoming accustomed to the pace and bounce of the wicket may explain the lower mean economy rates found in seam bowlers during the first six overs.

Spin bowlers lowest economy rate was found in the middle eight overs (6.77 ± 2.00 and 6.83 ± 2.50). Lavery (2014) suggested that spin bowlers predominantly bowl in the "safer middle overs" due to the reduced aggression showed by opposing batsman. As previously mentioned (Petersen *et al.* 2008), batsmen attempted to accumulate runs and did not score as many boundaries in the middle eight overs due to the relaxation in fielding restrictions. Finding the gaps in the field without taking risks is substantially harder when the ball is of a slower pace and deviating, potentially explaining the lower economy rates.

Spin bowlers were found to have a significantly lower economy rate in the final six overs of the first innings (7.80 ± 4.68 spin, 9.57 ± 3.06 seam). These findings are surprising as seam bowlers delivered a significantly higher percentage of balls (65.24 ± 29.73) in comparison to spin bowlers. Petersen *et al.* (2008), Douglas and Tam (2010) and Moore *et al.* (2012) all identified restricting the run rate of the opposing team as a KPI related to success. The above economy rate of spin bowling

suggests that teams are not using the types of bowlers that best meet the desired KPI. Garaway (2014) suggested that batsmen have now developed shots to counteract ‘death bowling’ by fast bowlers during the latter stages of an innings. This may explain the reason spin bowlers have a significantly lower economy rate, as batsman are as of yet less accustomed to facing this type of bowling during the last six overs.

Economy rate was not found as significantly different between seam and spin bowlers in the last six overs of the second innings. This may be explained by the different strategies and dynamics adopted by batsman in the first innings and second innings of a limited over game (Preston and Thomas, 2000). Teams batting first are always attempting to increase the run rate when setting a target, however, run rate when batting second may decline over the course of an innings when chasing a small target (Preston and Thomas, 2000). This may cause the bowlers statistics to vary as batsman potentially become less aggressive.

5.3 Strike Rate

Average tournament strike rate was calculated instead of mean strike rate when analysing the performance of seam and spin bowlers. This was done differently to all the other performance variables as a bowler’s strike rate can only be calculated if a wicket has been taken, which for some bowlers did not happen. Figure 5 highlights that the greatest difference between the strike rate of seam bowlers and spin bowlers was found in the first six overs of the first innings (16.89 spin, 26.41 seam). Petersen *et al.* (2008) and Douglas and Tam (2010) identified taking more wickets in the first six overs as a KPI related to success. It was identified that seam bowlers deliver a significantly higher 74.68% of balls during this stage of the game compared to that of spin bowlers. This again suggests that teams may not be utilising the types of bowlers that best meet the required KPI during this stage of the game.

Interestingly, the strike rate of spin bowlers nearly doubled in the first six overs of the second innings (31.08), while the strike rate of the seam bowlers remained similar at (25.40). This again shows how the dynamics of a first innings and second innings

are completely different and that they must be considered separately when looking at the performance of bowlers (Preston and Thomas, 2000). It must be considered that Asian conditions tend to be far drier than other pitches around the world and also have a lack of grass which may limit the seam movement (Woolmer and Noakes, 2008). This may reduce the effectiveness of seam bowlers with the new ball and instead aid spin bowlers as they extract more turn and bounce from a harder cricket ball, potentially increasing their wicket taking capabilities.

Spin bowlers were found to have a lower strike rate in both innings (24.98, 1st innings, 20.09 2nd innings) of the middle eight overs compared to seam bowlers. Although taking more wickets than the opposition in the middle eight overs was not identified as a KPI (Petersen *et al*. 2008, Douglas and Tam, 2010 and Moore *et al.* 2012), it must be considered that bringing a new batsman to the crease following a wicket can benefit the bowling team. As previously mentioned by Woolmer and Noakes (2008), batsmen must become accustomed to the pace and bounce of the pitch when arriving at the crease which may cause a restriction in the run rate.

Petersen *et al.* (2008a) and Moore *et al.* (2012) stated that taking more wickets in the last six overs can be identified as a KPI related to a winning team. This is evident in the current study as strike rate was at its lowest in both seam bowlers (13.98 2nd innings) and spin bowlers (14.92 1st innings) during the last six overs. As previously mentioned, batsman attempt to increase their sides run rate in the last six overs to achieve the highest score they can in their respective innings (Moore *et al.* (2012). This potentially explains why more wickets are taken by the bowling team during this stage of an innings. These findings support Roberts (2010) who indicated that an attempt to increase run rate will cause more high risk shots and increase the loss of wickets. It can be concluded that neither seam nor spin bowlers are more effective than the other one when taking wickets during the last six overs.

It must be considered when analysing bowler's performance the effect the dew factor can have when bowling with a cricket ball. A high percentage of the 2014 T20 World Cup fixtures were played in day/night conditions making them vulnerable of experiencing dew on the playing surface and outfield. Singh (2012) stated that dew

can have adverse effects on a cricket match and can negatively impact the performance of bowlers. Dewy conditions caused the ball to get wet which made it difficult to grip for bowlers. Singh (2012) found that seam bowlers may experience less swing as a result of the dampness and spin bowlers may experience less turn off the wicket, making it far easier for the batsman to score runs.

5.4 Percentage of Dot Balls Bowled

Douglas and Tam (2010) and Carlson (2011) stated the importance of bowling dot balls throughout a game and identified it as a KPI related to success. Figure 6 identifies no significant differences between the percentage of dot balls bowled by seam and spin bowlers. The highest percentage of dot balls bowled in both types of bowler was evident in the first six overs (52.96% ± 11.96 seam 1st innings, (52.15% ± 19.23 spin 2nd innings). These percentages were considerably higher than those found in the middle eight overs and last six overs. This may be explained by a potentially more cautious approach against the new cricket ball or the effect caused by the removal of the fielding restrictions from the seventh over onwards. More fielders in the inner circle make it harder to rotate the strike creating more dot balls in the process. The importance of bowling dot balls in the first six overs was identified as being of greater significance compared to any other stage of an innings by (Douglas and Tam, 2010). Dot balls reduce the run rate and in turn create pressure on the batsman which may cause a mistake leading to a wicket. It can be established from the current study that seam and spin bowlers deliver similar percentages of dot balls throughout the entire course of a T20 game.

5.5 Percentage of Runs Conceded from Boundaries

Carlson (2011) and Moore *et al*. (2012) identified that the number of runs scored from boundaries was an important KPI related to winning teams. A greater percentage of runs conceded from boundaries in the first six overs was highlighted as significantly important in Moore *et al*.'s (2012) study, while a greater percentage of runs conceded from boundaries in the last six overs was identified as significant during Carlson's (2011) study.

No significant differences were identified in Figure 7 between seam and spin bowlers during the first six overs. However, it was identified that both conceded the highest percentage of runs from boundaries (62.56% ± 20.18 seam, 67.09% ± 27.31 spin) during the first six overs of the second innings. As previously mentioned, Jones (2010) stated that boundaries are far easier to come by in the 'Powerplay' overs as a result of the unprotected boundaries and is clearly evident from this study's results.

A significant difference was found in the middle eight overs of the second innings. Spin bowlers conceded a lower percentage of runs from boundaries (36.61% ± 17.91) in comparison to seam bowlers (47.22% ± 24.01). Woolmer and Noakes (2008) stated that Asian cricket pitches are far slower and less bouncy in nature potentially explaining the difficulty to hit runs through boundaries when batting against spin bowling. This coupled with the relaxation in the fielding restrictions may be the cause of the significant difference found between the two types of bowler. It can be established that these findings support the strategies adopted by teams and they should continue to bowl spin bowling at this stage of the innings to implement the desired KPI.

Although no significant differences were found between the two types of bowler, spin bowlers were found to concede a lower percentage of runs in boundaries in the middle eight overs of the second innings and the last six overs of both innings. Only (42.29%) of runs were scored from boundaries against spin bowlers compared to (56.31%) against seam bowlers in the last six overs of the first innings. This may explain the cause of a significantly lower economy rate found in spin bowlers at the same stage of the innings as economy rate can be directly affected by the number of dot balls bowled and boundaries conceded. These findings also suggest that batsman prefer to have pace on the ball when attempting to score boundaries supporting the previous statement regarding the slow nature of Asian pitches.

It can be concluded that the findings from the current study supports Dey et al. (2011) who identified seven of the top ten bowlers during the 2009 and 2010 IPL as spin bowlers. Similarly, spin bowlers were found to perform significantly better throughout the majority of a T20 game during the current study. Further research is

required in different playing conditions to confirm whether or not these results were caused by the spinner friendly Asian conditions or not.

Chapter Six –

Conclusion

6.0 Conclusion

6.1 Main Findings

The current study investigated the differences in performance between seam and spin bowlers at different stages of a T20 game. Previous studies have compared seam and spin bowling performance individually across T20 competitions, however these have not compared the two with each other.

Seam bowlers were found to deliver a significantly higher ($p<0.05$) percentage of balls in the first six overs and last six overs of both innings, while spin bowlers delivered a significantly higher ($p<0.05$) percentage of balls during the middle eight overs of both innings.

There were no significant differences in economy rates between seam and spin bowling in any period except the last six overs of the first innings (seam 9.57 ± 3.06, spin 7.80 ± 4.68, $p=0.031$). The greatest difference between tournament average strike rates was found in the first six overs of the first innings where spin bowlers (16.89) achieved a far lower strike rate than seam bowlers (26.41). These findings suggest that teams would perform better by increasing their use of spinners at this stage of a game.

No significant differences ($p>0.05$) were found between the percentage of dot balls bowled by seam and spin bowlers. There were also no significant difference found in percentage of runs conceded from boundaries except in the middle eight overs of the first innings (seam 47.22% ± 24.07, spin 36.61% ± 17.91, $p=0.039$). This finding supports the strategies adopted by teams at the same stage of a T20 game. It must be considered that the spinner favoured results may have been caused by the slower, dryer more abrasive conditions found in some Asian cricket pitches (Woolmer and Noakes, 2008).

Overall the findings of the study suggest that spin bowlers perform better than seam bowlers over the course of a T20 game and are best suited to meet more KPI’s related to success.

6.2 Recommendations for Future Research

1. A similar study should be undertaken on continents with different playing conditions. This will help to identify whether the differences in performance between seam and spin bowlers could be caused by more favourable playing conditions. For example spinners favour dryer pitches in Asia, while seamers favour greener pitches in England / Wales.

2. The different types of actions should be investigated. For example left arm against right arm, fast against medium or off-spin against leg-spin. Data collection may be required across a range of T20 competitions to gather sufficient data for such a study.

3. The effect match situation had on performance of bowlers should be studied and how different types of bowlers performed during these situations.

References

Altman, D.G (1991). Practical Studies for Medical Research. London: Chapman & Hall.

Altman, H.S. (1962). A History of Cricket. London: George Allen & Unwin Ltd.

Carlson, R. (2011). Analysis of team performance at the Friends Life Twenty20 Cup. BSc Dissertation. Cardiff, UK: UWIC.

Dey, P.K, Ghosh, D.N, Mondal, A.C. (2011). 'A MCDM Approach for Evaluating Bowlers Performance in IPL'. *Journal of Emerging Trends in Computing and Information Sciences*, 2 (11), pp.563-573.

Douglas, J, Tam, N. (2010). 'Analysis of team performances at the ICC World Twenty20 Cup 2009'. *International Journal of Performance Analysis in Sport*, 10 (1), pp.47-53.

ESPN Cricinfo. (2014). *World T20.* Available: http://www.espncricinfo.com/world-t20/content/current/series/628368.html. (Accessed: 10th February 2015).

Feedback Sport. (2004). *Feedback Cricket Introduction.* Available: http://www.feedbacksport.com/cricket_intro.html. (Accessed 28th November 2014).

Garaway, M. (2014) *How the Best Death Batsmen Score from the Best Death Bowling.* Available: http://www.pitchvision.com/how-the-best-death-batsmen-score-from-the-best-death-bowling. (Accessed 18th February 2015).

Helmich,S. (2011). Bowling strategies in ODI and T20 cricket. BSc Dissertation. Cardiff, UK; UWIC.

Hinchliffe, D. (2009) *How to bowl in Twenty20 cricket: Pace bowling.* Available: http://www.pitchvision.com/how-to-bowl-in-twenty20-cricket-pace-bowling. (Accessed 18th February 2015).

ICC. (2015). *ICC Members.* Available: http://www.icc-cricket.com/about/58/icc-members/full-members/australia. (Accessed 18th March 2015).

Hughes, M, Bell, K. (1998) ‘Performance profiling in cricket’, in Hughes, M, Tavares, F. (ed) *Notational Analysis of Sport IV*. Porto, Portugal: Centre for Team Sports Studies, pp.176-178.

Hughes, M., and Bartlett, R. (2002). ‘The use of performance indicators in performance analysis’. *Journal of Sports Sciences.* 20 (1) pp.739-754.

Jones, A. (2010). A comparison of Twenty20 bowling strategies between Powerplay and non-powerplay overs. BSc dissertation. Cardiff, UK; UWIC. Pp.50

Justham, L., West, A. and Cork, A. (2008). ‘An analysis of the differences in bowling technique for elite players during international matches’, in ‘*The Impact of technology in Sport II*’, Fuss. F, Subic. A, Ujihashi. (ed) London: Taylor & Francis, pp. 331-336.

Key, S. (2013). A preliminary analysis of team performances in English List A cricket. Unpublished master’s thesis. University of Chester, United Kingdom.

Lavery, S. (2014). What’s the Perfect Number of Spinners for Twenty20?. Available: http://www.pitchvision.com/whats-the-perfect-number-of-spinners-for-twenty20. (Accessed 18th February 2015).

Lemmer, H.H. (2008). ‘An analysis of players’ performances in the first cricket Twenty20 World Cup series’. *South African Journal for Research in Sport*. 30 (2), pp.71-77.

Moore, A, Turner, D.J, Johnstone, J.A. (2012). ‘A preliminary analysis of team performance in English first-class Twenty (T20) cricket’. *International Journal of Performance Analysis in Sport*, 12 (1), pp.188-207.

O’Donoghue, P. (2010). Research methods for sports performance analysis. London: Routledge

Petersen, C, Pyne, D.B, Portus, M.R, Cordy, J, Dawson, B. (2008b). ‘Analysis of performance at the 2007 Cricket World Cup’. *International Journal of Performance Analysis in Sport*, 8 (1), pp.1-8.

Petersen, C, Pyne, D.B, Portus, M.R, Dawson, B. (2008a). 'Analysis of Twenty/20 Cricket performance during the 2008 Indian Premier League'. *International Journal of Performance Analysis in Sport*, 8 (3), pp.63-69

Preston, I. & Thomas, J. (2000). 'Batting strategy in limited overs cricket'. *The Statistician*, 49 (1), pp.95-106.

Roberts, C. (2010). A comparison of risk taking by Twenty 20 World Cup batsman between successful and unsuccessful teams. BSc Dissertation. Cardiff, UK: UWIC.

Sankaran, S. (2014). 'Comparing Pay versus Performance of IPL Bowlers: An Application of Cluster Analysis'. *International Journal of Performance Analysis in Sport*. 14 (1), pp.174-187.

Singh, S.B. (2012). 'Dew – The Little Monster; A Boon or Bane for the Day and Night Cricket Matches'. *International Journal of Science and Research*. 3 (8), pp.395-400.

Sharma, S, Amin, G, Gattoufi, S. (2012). 'Choosing the best Twenty20 cricket batsmen using ordered weighted averaging'. *International Journal of Performance Analysis in Sport*, 12 (1), pp.614-628.

Sharma, S.J. (2013). 'A factor analysis approach in performance analysis in t20-cricket'. *Journal of Reliability and Statistical Studies*, 6 (1), pp.69-76.

Smith, T.E. (2004). Tom Smith's new cricket umpiring and scoring. London: Weidenfield & Nicholson.

Swartz, T, Perera, H. (2013). 'Resource estimation in T20 cricket'. *MA Journal of Management Mathematics*, 23 (4), pp.337-347.

Wickramasinghe, R.I.P. (2014). 'Bowlers' Performances in 2013 Champions Trophy'. *Annals of Applied Sport Science*, 2 (1), pp.1-10.

Woolmer, B, Noakes, T. (2008). The Art and Science of Cricket. New Holland Publishers, pp.10-322.

Appendices

Appendix A –

Initial Data Collection sheet prior to the Pilot Study

Data Collection Sheet

First Six Overs — Extra Balls

Overs	Balls 1	2	3	4	5	6	7	8	9	10
1										
2										
3										
4										
5										
6										

Middle Eight – Seam

Overs	Balls 1	2	3	4	5	6	7	8	9	10
7										
8										
9										
10										
11										
12										
13										
14										

Last Six – Seam

Overs	Balls 1	2	3	4	5	6	7	8	9	10
15										
16										
17										
18										
19										
20										

Data collection sheet.

First Six

Percentage of Balls	Economy Rate	Strike Rate	Percentage of Dot Balls	Percentage of Runs from Boundaries
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Balls Bowled	Runs Scored	Wickets Taken	Dot Balls	Runs Scored from Boundaries

Middle Eight

Percentage of Balls	Economy Rate	Strike Rate	Percentage of Dot Balls	Percentage of Runs from Boundaries
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Balls Bowled	Runs Scored	Wickets Taken	Dot Balls	Runs Scored from Boundaries

Last Six

Percentage of Balls	Economy Rate	Strike Rate	Percentage of Dot Balls	Percentage of Runs from Boundaries
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Balls Bowled	Runs Scored	Wickets Taken	Dot Balls	Runs Scored from Boundaries

First Six

Percentage of Balls	Economy Rate	Strike Rate	Percentage of Dot Balls	Percentage of Runs from Boundaries
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Balls Bowled	Runs Scored	Wickets Taken	Dot Balls	Runs Scored from Boundaries

Middle Eight

Percentage of Balls	Economy Rate	Strike Rate	Percentage of Dot Balls	Percentage of Runs from Boundaries
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Balls Bowled	Runs Scored	Wickets Taken	Dot Balls	Runs Scored from Boundaries

Last Six

Percentage of Balls	Economy Rate	Strike Rate	Percentage of Dot Balls	Percentage of Runs from Boundaries
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Balls Bowled	Runs Scored	Wickets Taken	Dot Balls	Runs Scored from Boundaries

Sheet of formulas.

Appendix B –

Match Dates, Teams, Venues, Type & Results

Match No.	Stage	Date	Teams	Venue	Time	Result
1	First Round: Group A	Sun 16th March 2014	Bangladesh v Afghanistan	Dhaka	Day / Night	Bangladesh won by 9 wickets
2	First Round: Group A	Sun 16th March 2014	Hong Kong v Nepal	Chittagong	Day / Night	Nepal won by 80 runs
3	First Round: Group B	Mon 17th March 2014	Ireland v Zimbabwe	Sylhet	Day / Night	Ireland won by 3 wickets
4	First Round: Group B	Mon 17th March 2014	Netherlands v United Arab Emirates	Sylhet	Day / Night	Netherlands won by 6 wickets
5	First Round: Group A	Mon 17th March 2014	Afghanistan v Hong Kong	Chittagong	Day / Night	Afghanistan won by 7 wickets
6	First Round: Group A	Tues 18th March 2014	Bangladesh v Nepal	Chittagong	Day / Night	Bangladesh won by 8 wickets
7	First Round: Group B	Wed 19th March 2014	Netherlands v Zimbabwe	Sylhet	Day / Night	Zimbabwe won by 5 wickets
8	First Round: Group B	Wed 19th March 2014	Ireland v United Arab Emirates	Sylhet	Day / Night	Ireland won by 21 runs (D/L method)

9	First Round: Group A	Thurs 20th March 2014	Afghanistan v Nepal	Chittagong	Day / Night	Nepal won by 9 runs
10	First Round: Group A	Thurs 20th March 2014	Bangladesh v Hong Kong	Chittagong	Day / Night	Hong Kong won by 2 wickets
11	First Round: Group B	Fri 21st March 2014	United Arab Emirates v Zimbabwe	Sylhet	Day / Night	Zimbabwe won by 5 wickets
12	First Round: Group B	Fri 21st March 2014	Ireland v Netherlands	Sylhet	Day/ Night	Netherlands won by 6 wickets
13	Group 2	Fri 21st March 2014	India v Pakistan	Dhaka	Day / Night	India won by 7 wickets
14	Group 1	Sat 22nd March 2014	South Africa v Sri Lanka	Chittagong	Day / Night	Sri Lanka won by 5 runs
15	Group 1	Sat 22nd March 2014	England v New Zealand	Chittagong	Day / Night	New Zealand won by 9 runs (D/L Method)
16	Group 2	Sun March 23rd 2014	Australia v Pakistan	Dhaka	Day / Night	Pakistan won by 16 runs
17	Group 2	Sun March 23rd 2014	India v West Indies	Dhaka	Day / Night	India won by 7 wickets
18	Group 1	Mon March 24th 2014	New Zealand v South Africa	Chittagong	Day / Night	South Africa won by 2 runs
19	Group 1	Mon March 24th	Netherlands v Sri Lanka	Chittagong	Day / Night	Sri Lanka won by 9

		2014				wickets
20	Group 2	Tues March 25th 2014	Bangladesh v West Indies	Dhaka	Day / Night	West Indies won by 73 runs
21	Group 1	Thurs March 27th 2014	Netherlands v South Africa	Chittagong	Day / Night	South Africa won by 6 runs
22	Group 1	Thurs March 27th 2014	England v Sri Lanka	Chittagong	Day / Night	England won by 6 wickets
23	Group 2	Fri March 28th 2014	Australia v West Indies	Dhaka	Day / Night	West Indies won by 6 wickets
24	Group 2	Fri March 28th 2014	Bangladesh v India	Dhaka	Day / Night	India won by 8 wickets
25	Group 1	Sat March 29th 2014	Netherland v New Zealand	Chittagong	Day / Night	New Zealand won by 6 wickets
26	Group 1	Sat March 29th 2014	England v South Africa	Chittagong	Day / Night	South Africa won by 3 runs
27	Group 2	Sun March 30th 2014	Bangladesh v Pakistan	Dhaka	Day / Night	Pakistan won by 50 runs
28	Group 2	Sun March 30th 2014	Australia v India	Dhaka	Day / Night	India won by 73 runs
29	Group 1	Mon March 31st 2014	England v Netherlands	Chittagong	Day / Night	Netherlands won by 45 runs

30	Group 1	Mon March 31st 2014	New Zealand v Sri Lanka	Chittagong	Day / Night	Sri Lanka won by 59 runs
31	Group 2	Tues April 1st 2014	Bangladesh v Australia	Dhaka	Day / Night	Australia won by 7 wickets
32	Group 2	Tues April 1st 2014	Pakistan v West Indies	Dhaka	Day / Night	West Indies won by 84 runs
33	1st Semi Final	Thurs 3rd April 2014	Sri Lanka v West Indies	Dhaka	Day / Night	Sri Lanka won by 27 runs (D/L Method)
34	2nd Semi Final	Fri 4th April 2014	India v South Africa	Dhaka	Day / Night	India won by 6 wickets
35	Final	Sun 6th April 2014	India v Sri Lanka	Dhaka	Day / Night	Sri Lanka won by 6 wickets

Appendix C –

Raw Data Values

First Six Overs - 1st innings	**Seam**	**Spin**
Overs Bowled	138	48
Runs Conceded	921	321
Wickets Taken	34	18
Dot Balls Bowled	463	160
Runs Conceded from Boundaries	558	204
First Six Overs - 2nd innings	**Seam**	**Spin**
Overs Bowled	119	66
Runs Conceded	852	463
Wickets Taken	30	13
Dot Balls Bowled	375	205
Runs Conceded from Boundaries	534	310
Middle Eight Overs - 1st innings	**Seam**	**Spin**
Overs Bowled	87	165.5
Runs Conceded	640	1114
Wickets Taken	18	42
Dot Balls Bowled	194	349
Runs Conceded from Boundaries	302	408
Middle Eight Overs - 2nd innings	**Seam**	**Spin**
Overs Bowled	100.3	145
Runs Conceded	771	967
Wickets Taken	23	45
Dot Balls Bowled	188	342
Runs Conceded from Boundaries	348	388
Final Six Overs - 1st innings	**Seam**	**Spin**
Overs Bowled	123.2	334

Runs Conceded	1168	415
Wickets Taken	52	24
Dot Balls Bowled	250	135
Runs Conceded from Boundaries	658	176
Final Six Overs - 2nd innings	**Seam**	**Spin**
Overs Bowled	89.5	45.3
Runs Conceded	752	368
Wickets Taken	41	19
Dot Balls Bowled	179	106
Runs Conceded from Boundaries	386	130

Appendix D –

Dismissals in Cricket

Dismissals in Cricket:

Law 2.9(b): Retired

"If any batsman leaves the field of play without the Umpire's consent for any reason other than injury or incapacity, he may resume the innings only with the consent of the opposing captain. If he fails to resume his innings, he is recorded as being retired – out" (Smith, 2004).

Law 3.0: Bowled

"If a bowler's delivery hits the stumps and a bail is completely removed from the top of the stumps, the batsman is out. The ball can either have struck the stumps directly, or have been deflected off the bat or body of the batsman" (Smith, 2004).

Law 3.1: Timed Out

"If a new player takes more than three minutes to be ready to face or be ready for his partner to face the next delivery after the previous batsman was ruled out, then the new player is out" (Smith, 2004).

Law 3.2: Caught

"If the batsman hits the ball with the bat (or with the glove when the glove is in contact with the bat) and the ball is caught by the bowler or a fielder before it hits the ground, then the batsman is out" (Smith, 2004).

Law 3.3: Handled Ball

"If the batsman touches the ball with his hand for any purpose other than, with the approval of the fielder(s), to return the ball to the bowler, he is out on appeal" (Smith, 2004).

Law 3.4: Hit the Ball Twice

“If the batsman "hits" the ball twice, he is out. The first hit is considered to be if the ball has struck the batsman or his bat, whilst the second "hit" has to be an intentional and separate contact with the ball - not necessarily using the bat” (Smith, 2004)

Law 3.5: Hit Wicket

“If the batsman dislodges his own stumps with his body or bat, while in the process of taking a shot or beginning his first run, then he is out” (Smith, 2004)

Law 3.6: Leg Before Wicket (LBW)

“If the ball strikes any part of the batsman's person, and, in the umpire's judgement, the ball would have hit the batsman's stumps but for this interception, then the batsman is out. The point of impact must be within line with the batsman's stumps and the bowler's stumps if the batsman is playing a stroke. The ball must not pitch outside the line of leg stump. Also, the ball cannot have made contact with the bat or glove before hitting the batsman. If the ball hits the batsman either on the full or immediately after bouncing, the umpire assumes that the ball is travelling straight on” (Smith, 2004).

Law 3.7: Obstructing the Field

“If the batsman, by action or by words, obstructs a fielder, then he is out. Also, a player may be given out if they deliberately hit a ball being thrown back to the keeper whilst being out of their crease” (Smith, 2004).

Law 3.8: Run Out

“If a fielder uses the ball to remove the bails from either set of stumps whilst the batsmen are running between the wickets and have not passed the front crease, then the batsman (strike or non-striker) is out. The batsman nearest the set of stumps from which the bails were removed, is given out” (Smith, 2004).

Law 3.9: Stumped

"If the striker steps in front of the crease to play the ball, leaving no part of his body or the bat on the ground behind the crease, and the wicket keeper is able to remove the bails from the wicket with the ball, then the batsman is out" (Smith, 2004).

Appendix E –

Raw Kappa Tables

Balls Bowled	A	B	C	D	E	F	G	Total
Dot Balls	76							76
1		113						113
2			23					23
3				0				0
4					38			38
6						7		7
Wicket							9	9
Total	76	113	23	0	38	7	9	266

P0	1.00
PC	0.29
Kappa	1.00

Intra-observer data for seam bowling.

Balls Bowled	A	B	C	D	E	F	G	Total
Dot Balls	70							70
1		111						111
2		1	15					16
3				0				0
4					16			16
6						6		6
Wicket							9	9
Total	70	112	15	0	16	6	9	228

P0	1.00
PC	0.35
Kappa	0.99

Intra-observer data for spin bowling.

Balls Bowled	A	B	C	D	E	F	G	Total
Dot Balls	76							76
1	1	112						113
2			23					23
3				0				0
4					38			38
6						7		7
Wicket							9	9
Total	77	112	23	0	38	7	9	266

P0	1.00
PC	0.29
Kappa	0.99

Inter-observer data for seam bowling.

Balls Bowled	A	B	C	D	E	F	G	Total
Dot Balls	69						1	70
1	2	109						111
2		1	15					16
3				0				0
4					16			16
6						6		6
Wicket							9	9
Total	71	110	15	0	16	6	10	228

P0	0.98
PC	0.34
Kappa	0.97

Inter-observer data for spin bowling.