Determinants of success in Twenty20 cricket

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Abstract

The purpose of this study was to investigate the determinants of success in Twenty20 cricket. 29 matches for winning teams and 30 matches for losing teams were analysed from the 2010 English domestic Twenty20 competition. Magnitude-based inferences, reported as effect sizes (ES), were used to characterise differences in performance indicators between winning and losing teams. The top 5 indicators of success were losing less wickets in the powerplay overs (ES = -1), losing less wickets between overs 7-10 (ES = -1), 50+ run partnerships (ES = 1), individual batsmen contributing 75+ runs (ES = 1) and 50-74 runs (ES = 1). In addition, winning teams scored a higher percentage of total runs to long-off (ES =0.4) and the off-side (ES = 0.2), and bowled a higher percentage of deliveries at a yorker (ES = 0.4) and short length (ES = 0.58) than losing teams. Collectively, these findings highlight that teams should retain wickets in the first 10 overs of an innings, without necessarily maximising the number of runs scored. In the final 10 overs, teams should outscore the opposition by hitting boundary 4s and avoid scoring a high percentage of runs from 1s. Moreover, from a bowling perspective, a more balanced strategy with regards to bowling length appears to be advantageous, as evidenced by the greater usage of short and yorker length deliveries by winning teams.

***Key words*:** Twenty20, batting, bowling, performance analysis.

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1. Introduction

Since its inception a decade ago, Twenty20 cricket has rapidly become arguably the most popular form of the game among players, supporters, administrators, coaches and owners. In particular, Twenty20 cricket has gained a large following on the back of four successful World Cups and numerous domestic competitions around the world, the richest of which being the franchise-based Indian Premier League, where players can earn as much as 100,000 USD per match. Therefore, with so much money invested in Twenty20, performance analysis could play a pivotal role in delivering performance insights, informing successful game tactics and strategies.

To date, however, much of the scientific research on cricket has focused primarily on: the physiological requirements of the game (e.g., Noakes and Durandt, 2000); the biomechanics and motor control of batting techniques (e.g., Stretch et al., 2000; Glazier *et al.*, 2002; Penn and Spratford, 2012); the biomechanics of fast and spin bowling techniques (e.g., Bartlett *et al.*, 1996; Elliott, 2000; Lloyd, Alderson and Elliott, 2000; Glazier and Wheat, 2013); and the psychology of the game (Bawden and Maynard, 2001; Bull *et al.*, 2005; Gucciardi and Gordon, 2009). There is currently a dearth of research undertaken from the scientific sub-discipline of performance analysis (De Silva and Swartz, 1997; Morley and Thomas, 2005; Damodaran, 2006), which is in stark contrast to other team sports such as football (for a review see Mackenzie and Cushion, 2013) and rugby union (for a review see Prim and van Rooyen, 2013) that have both received substantially more attention. Perhaps this reflects the innate conservatism of cricket (Noakes and Durandt, 2000) or a concentration on the more finite, technical elements of the game (e.g. Glazier *et al.*, 2000). With that said, performance analysis research on cricket is now beginning to diversify, addressing a wider range of research questions and applications. For example, the time-motion characteristics of different playing positions have been a topic of study (Petersen *et al.*, 2009), as well as the use of sophisticated mathematical techniques such as artificial neural networks for prediction of bowling performance (Saikia *et al.*, 2012).

Nonetheless, the vast majority of research addresses the technical and tactical facets of the game. Moreover, from examination of the performance analysis research that has been conducted in cricket, much has focused on the 40-50 overs version of the game (e.g. Clarke, 1988; De Silva and Swartz, 1997; Preston and Thomas, 2000; Morley and Thomas, 2005; Damodaran, 2006; Petersen *et al*., 2008b). For instance, De Silva and Swartz (1997) investigated both the coin toss and home field advantage in limited overs matches, and reported that: (1) winning the toss at the beginning of the match provided no competitive advantage in international one-day cricket, and, (2) teams playing at home had a greater probability of winning, a finding that is commensurate with other studies pertaining to match location effects (e.g. Tucker *et al.*, 2005). Additional support for game location effects comes from the work of Morley and Thomas (2005) who analysed the effects home advantage and other factors, such as team quality and match importance, on outcomes in English one-day cricket. It was found that winning the toss provided a greater advantage to the home team.

Other avenues of scientific enquiry have centred on identifying the key performance indicators that dictate successful performance. For example, Petersen *et al*. (2008b) used magnitude-based inferences, reported as effect sizes (ES), to characterise differences in batting and bowling performance indicators between successful and unsuccessful teams. Magnitude-based inferences allowed the relative importance of different indicators to be compared (Petersen *et al*., 2008a). This consequently provided important information to prioritise key areas, and built upon existing literature relating to limited overs cricket (Clarke, 1988; De Silva and Swartz, 1997; Preston and Thomas, 2000; Morley and Thomas, 2005; Damodaran, 2006). However, the findings from Petersen and co-workers (2008b), such as identifying wickets (ES = 1.79) and run rate (ES = 1.39) are rather general or gross performance measures, and lack any supporting contextual information. As such, these particular key performance indicators may not provide a coach with the required depth and sensitivity of analysis to assist with planning coaching interventions and/or match tactics.

To date, the authors are aware of only four studies that have analysed Twenty20 cricket (Lemmer, 2008; Petersen *et al*., 2008a; Douglas and Tam, 2010; Moore *et al*., 2012). Therefore, the key performance indicators underpinning successful performance within this form of the game have yet to be clearly and specifically identified. Further research in the area of Twenty20 is required as the dynamics of the game are very different to the 40-50 over format. This is exemplified by the differences that exist in average scores in 50-over when compared to Twenty20 cricket. The mean winning score in the 2007, 50-over World Cup was 262 ± 90 runs (Petersen *et al*., 2008b), in contrast to 158 ± 26 runs in the 2009, Twenty20 World Cup (Douglas and Tam, 2010). Hence, knowledge of the relative importance of specific Twenty20 performance indicators is needed to objectively develop team strategies and tactics (Petersen *et al*., 2008a).

From the research that has examined Twenty20 cricket, Petersen *et al.* (2008a) examined the performance of teams participating in the 2008 Indian Premier League Twenty20 competition. Petersen *et al.* (2008a) reported the three indicators for success to be: (1) taking more wickets in the game (ES = 1.92), (2) taking more wickets in the last 6 overs (ES = 1.01), and, (3) having a higher run rate when batting (ES = 0.96). Lemmer (2008) investigated individual players' performances in the 2007, Twenty20 World Cup and ranked batsmen and bowlers. Lemmer (2008) concluded the result of a match depends on team effort and not only on individual performances. In support of Petersen *et al.* (2008a), Douglas and Tam (2010) investigated the 2009, Twenty20 World Cup, reporting the top 5 indicators for success in the tournament to be losing less wickets in the game (ES = -1.66), scoring more runs per over (ES = 1.23), losing less wickets in the powerplay overs when batting (ES = -1.22), bowling more dot balls (ES = 1.15) and scoring more runs in the middle 8 overs (ES = 0.86).

Although the research from both Petersen *et al.* (2008a) and Douglas and Tam (2010) provides a suitable starting point for further research on Twenty20 cricket, there is an important limitation that warrants consideration. Despite the useful foundation provided by these studies, they suffer from the same limitation as the work of Petersen *et al.* (2008b) whereby only a general overview of the most effective strategies employed by a Twenty20 team can be provided. Consequently, it could be argued that this level of analysis is insufficient to provide meaningful conclusions to the coach of a Twenty20 team. The key performance indicators identified, such as having a higher run rate when batting, and losing less wickets apply to all limited overs cricket, and ostensibly, it would appear that the main conclusions would be of little value to a cricket coach planning a team's strategy and selection. Therefore, a greater depth of analysis is required for more useful and applicable conclusions to be reached that can subsequently inform practice.

In addition, the studies completed on Twenty20 cricket (Lemmer, 2008; Petersen *et al.*, 2008a; Douglas and Tam, 2010) have investigated international and Indian Premier League competitions, neglecting the English domestic Twenty20 competition, which may exhibit different characteristics. For example, Petersen *et al.* (2008a) found that, on average, winning teams scored 163 runs whereas losing teams scored 150 runs during the 2008 Indian Premier League. However, Douglas and Tam (2010) found the average score for winning and losing teams to be 158 and 133 respectively during the 2009, Twenty20 World Cup. Therefore, there is currently uncertainty as to whether these findings from international cricket (Douglas and Tam, 2010), and a franchise-based competition (Petersen *et al.*, 2008a) can be extrapolated to the English domestic Twenty20 competition.

Finally, to date, little research has been conducted on specific batting and bowling tactics used in a Twenty20 match, such as scoring areas for batsmen and delivery lengths for bowlers. In one such study, Justham *et al.* (2008) compared bowling tactics using only three right arm bowlers (a fast bowler, a medium paced bowler and an off-spin bowler), playing all three forms of cricket (Test match, 50 over cricket and Twenty20). Justham *et al.* (2008) reported the fast bowler's pitching length is at its shortest (furthest away from the batsman) during test matches and its fullest (closest to the batsman) during Twenty20 matches. In comparison to other types of bowler, spin bowlers were also found to bowl the fullest lengths in all forms of the game. However, this study did not relate delivery length to run restriction or wicket-taking. Therefore, a more definitive link between delivery length and run rate needs to be established to ascertain the relative merits of different delivery lengths. In support of this contention, Petersen *et al.* (2008a) highlighted the need to evaluate the type of bowling delivery most associated with wicket taking success and run restriction. On a practical level, this information would be particularly useful to a bowling coach in defining bowling strategies to be used in a Twenty20 match. Scoring areas for winning and losing teams when batting can also be considered of value, but has yet to receive adequate scientific appraisal. This information would assist a player or coach in selecting the areas to score in when batting and defend when bowling and fielding.

Moore and colleagues (2012) addressed gaps in the literature with regards to investigation of bowling length and scoring area, conducting a preliminary analysis of team performance in English domestic Twenty20 cricket. A total of seven matches were analysed from a single cricket ground during the 2010 English domestic Twenty20 campaign. Importantly, in addition to the more general and rudimentary key performance indicators that pervade the performance analysis literature on cricket (e.g. runs scored, run rate, wickets taken etc.), more detailed variables were also included, such as the manner of dismissal, bowling line and length of wicket-taking deliveries, and destination of boundaries as a function of match over. Commensurate with the findings of Petersen *et al.* (2008a) and Douglas and Tam (2010), both run rate and wickets taken in the last 6 overs strongly differentiated winning teams from non-winning teams. Furthermore, winning teams appeared to bowl an off-stump line more frequently within the middle 8 overs, and a fuller length within the last 6 overs. The use of a fuller bowling length corroborates the aforementioned work of Justham *et al.*

(2008). Finally, winning teams took more wickets from leg-before-wicket decisions (10%) when compared to losing teams (2%). One limitation of the study that is worthy of note is that due to the exploratory nature of the work of Moore *et al.* (2012), only 7 matches were analysed. Consequently, although interesting and novel insights were presented that built upon the extant research, the relatively low sample size may limit the validity of the findings, a contention acknowledged by Moore *et al.* (2012) themselves. As such, additional investigation is certainly warranted with a larger data set.

Therefore, the purpose of the current study was to investigate objectively the determinants of success in Twenty20 cricket, using magnitude-based inferences to characterise differences in performance indicators between winning and losing teams in the 2010 English domestic Twenty20 competition.

2. Methods

2.1. Participants

A total of 29 matches from winning teams and 30 matches from losing teams were analysed from the 2010 English domestic Twenty20 competition. This sample size was calculated on the basis of the number of matches required for each performance indicator to attain a stable, representative profile of performance (Hughes *et al*., 2001). Written, voluntary informed consent was obtained to film and code matches, and ethical approval was granted by the local institutional research ethics committee.

2.2. Procedure

All matches were coded using Crickstat version 3.0.0.12 (CSIR, South Africa). Prior to a match commencing, the game file was set up and the following information was entered: fixture information, teams competing, date, weather conditions and the umpires adjudicating that particular match. Each ball was then coded using a specific analysis sequence. First, the location the ball landed on the pitch was coded on a visual pitch map. Second, the outcome of that delivery was then coded using the following criteria: extra type, validity, claims, decision, runs and extras code. For example, a ball hit to the boundary for 4 runs would be coded; NE – No Extra, LG – Legitimate ball, NO – Not Out, 4 runs and no extras. Finally, the location of the ball, as a result of the batsman's shot was coded on a visual map of the ground. Before the coding process began, stringent operational definitions for delivery length were established (see Table 1). Specifically, operational definitions were established using Hawk-Eye™ technology (Hawk-Eye Innovations, United Kingdom) and Crickstat (CSIR, South Africa) pitch animation charts, and cross-validated with a qualified performance analyst, with over 10 years' experience in the sport. Moreover, the delivery lengths selected were a compromise between precision and accuracy, adhering to the recommendations of O'Donoghue (2007). Delivery lengths were also contextualised by video to help establish, for example, the difference between a full and good length of delivery on the visual pitch map. Contextualisation helped to alleviate uncertainly in the coding process that could be caused from reliance on operational definitions alone.

Table 1. Operational definitions of the delivery lengths on a 22-yard (20.12m) length pitch.

Delivery Length	**Definition**
Yorker	Ball pitches at under 2 metres from the batsman's centre stump.
Full	Ball pitches at between 2 to 6 metres from the batsman's centre stump.
Good	Ball pitches at 6 to 8 metres from the batsman's centre stump.
Short	Ball pitches at over 8 metres from the batsman's centre stump.

Upon completion of the coding process, all key performance indicators were extracted for further analysis. The general batting and bowling performance indicators analysed in this study are displayed in Tables 2 and 3 respectively. These performance indicators were selected based on previous studies on Twenty20 and limited overs cricket (Petersen *et al*., 2008a; Petersen *et al*., 2008b; Douglas and Tam, 2010), and then cross-validated with a qualified performance analyst, with over 10 years' experience in the sport.

Table 2. General batting performance indicators quantified for winning and losing teams.

Batting performance indicator
Total runs scored
Total wickets lost
Runs scored in powerplay overs (1 to 6), overs 7-10 and overs 11-14
Wickets lost in powerplay overs, overs 7-10, overs 11-14 and overs 15-20
Run rate in last 6 overs (15-20)
Total number of 6's
Total number of 4's
Total number of 3's
Total number of 2's
Total number of 1's
Total number of dot balls
% of runs scored from 6's, 4's and 1's
6's in powerplay overs, overs 7-10, overs 11-14 and overs 15-20
4's in powerplay overs, overs 7-10, overs 11-14 and overs 15-20
1's in powerplay overs, overs 7-10, overs 11-14 and overs 15-20
Dot balls in powerplay overs, overs 7-10, overs 11-14 and overs 15-20
Runs scored by opening partnership
Partnerships of 25 - 49 runs
Partnerships of 50+ runs
Batsmen scoring 25 - 49 runs,
Batsmen scoring 50 - 74 runs
Batsmen scoring 75 + runs

Table 3. General bowling performance indicators quantified for winning and losing teams.

Bowling performance indicator
Total wides
Total no balls
Total overs of spin bowled
Overs of spin bowled in powerplay
Overs of spin bowled in overs 7-10
Overs of spin bowled in overs 11-14
Overs of spin bowled in last 6 overs (15-20)
Overs bowled by a left arm bowler
Bowlers taking 2+ wickets

In addition to the general batting and bowling indicators, the number of balls bowled and the number of wickets taken with respect to each delivery length was calculated. Scoring areas when batting were also analysed for winning and losing teams. For each match, the number of runs scored to third man, the off-side, mid-off/long-off, mid-on/long-on, the leg-side and fine-leg was quantified for winning and losing teams. Once coding of an innings was complete a statistical review was compiled detailing each ball, in the form of a score sheet, score card, pitch animation chart and wagon wheel chart. The data was then exported to Microsoft Excel (Microsoft Corporation, USA) to enable statistical analysis of the performance indicators to be performed.

2.3. Reliability

To ensure objectivity and reliability of the data, inter-operator and intra-operator reliability analyses were conducted. Intra-operator reliability was completed by the lead author coding a randomly selected match on two occasions, separated by a two-week period to negate possible confounding learning effects. To verify inter-operator reliability an experienced analyst, with over 10 years' experience in cricket, coded a randomly selected match and the results were compared to that of the lead author. Both intra-operator and inter-operator reliability analyses were conducted using Cohen's Kappa, performed using Minitab version 16 (Minitab Inc., Coventry, United Kingdom). Interpretation of the kappa values was done in accordance with the criteria proposed by Landis and Koch (1977). Specifically, values of <0.20, 0.21 – 0.40, 0.41 – 0.60, 0.61 – 0.80 and >0.81 equated to poor, fair, moderate, good and very good agreement respectively. For the general performance indicators analysed (see Table 2 and 3), intra-operator and inter-operator reliability values were 0.96 and 0.91, respectively. For scoring areas analysed, intra-operator reliability was 0.84, whereas inter-operator reliability was 0.81. Finally, for the delivery lengths analysed, intra-operator and inter-operator reliability was found to be 0.71 and 0.65 respectively.

2.4. Statistical Analyses

Medians (± inter-quartile ranges) were calculated for all frequency-based performance indicators of interest. In addition, runs scored from 6's, 4's and 1's were normalised to a percentage of the total runs scored. Data for runs scored in the last 6 overs of an innings were also normalised to calculate runs per over in this period due to potential differences in overs bowled between teams i.e. when a team reaches its intended runs target in less than 20 overs. Runs scored in each area and balls bowled at each delivery length were converted to percentages of the total frequencies. Means (± SD) were calculated for all percentage data.

Commensurate with past research, effect sizes were calculated using the approach outlined by Petersen *et al.* (2008b). This allowed the relative importance of different indicators to be directly compared. The criteria for interpreting magnitude of effect size were: < 0.2 trivial, 0.2 – 0.6 small, 0.6 – 1.2 moderate, 1.2 – 2.0 large (Hopkins *et al.*, 2009). Positive values indicated the performance indicator contributed towards the success of the winning team. Conversely, negative effect sizes indicated that the losing team had a better or higher score for that particular performance indicator.

3. Results

The general match performance indicators analysed are summarised in Table 4.

Table 4. General match performance indicators for winning and losing teams.

Performance Indicator	Winning teams	Losing teams
Runs scored	164.0 ± 42.0	153.5 ± 30.5
Balls faced	119.0 ± 8.0	120.0 ± 0.8
Wickets lost	5.0 ± 3.0	8.0 ± 2.8

3.1. Batting performance indicators

The general batting performance indicators for both winning and losing teams are presented in Table 5. The biggest difference identified in batting performance between winning and losing teams is the number of 50+ run partnerships (ES = 1), the number of batsmen scoring 75+ runs (ES = 1) and the number of batsmen scoring 50 - 74 runs (ES = 1). Moreover, losing teams had a greater % of runs scored by 1's and a larger number of 25-49 run partnerships, which are reflected by effect sizes of -0.92 and -1.00 respectively.

Table 5. General batting performance indicators for winning and losing teams.

Performance Indicator	Winning teams	Losing teams	Effect Size	Rating
50+ run partnerships	1.0 ± 1.0	0.0 ± 1.0	1	Moderate
Players scoring 75+ runs	1.0± 1.0	0.0 ± 1.0	1	
Players scoring 50-74 runs	1.0 ± 1.0	0.0 ± 1.0	1	
Total 4's	15.0 ± 4.0	13.0 ± 3.0	0.5	Small
% runs from 4's	38.5 ± 8.3	34.7 ± 6.3	0.5	
Total 3's	1.0 ± 1.0	0.5 ± 1.0	0.5	
% runs from 6's	17.3 ± 8.5	15.0 ± 7.3	0.3	
Total 6's	5.0 ± 4.0	4.0 ± 3.8	0.25	
Total 2's	8.0 ± 6.0	7.0 ± 4.0	0.25	
Runs scored by the opening partnership	25.0 ± 48.0	17.0 ± 29.8	0.25	
% of dot balls	32.6 ± 4.8	34.5 ± 6.1	- 0.34	Small (-)
Total 1's	46.0 ± 10.0	50.5 ± 8.0	- 0.45	
Total dot balls	36.0 ± 5.0	40.0 ± 9.3	- 0.57	
Players scoring 25-49 runs	1.0 ± 1.0	2.0 ± 1.8	- 0.66	Moderate (-)
% of runs from 1's	27.2 ± 5.8	33.1 ± 5.5	- 0.92	
25 – 49 run partnerships	1.0 ± 1.0	2.0 ± 1.0	- 1	

Table 6 displays the batting performance indicators throughout an innings for winning and losing teams. The biggest difference identified in batting performance indicators between winning and losing teams is the number of wickets lost in the powerplay overs (ES = - 1), the number of wickets lost in overs 7 – 10 (ES = -1), boundary 4's scored in the last 6 overs of an innings (ES = 0.8) and the total number of runs scored in overs 11-14 (ES = 0.74). All other indicators had a small or trivial effect (ES < 0.53).

Table 6. Batting performance indicators throughout an innings for winning and losing teams.

Performance Indicator	Winning teams	Losing teams	Effect Size	Rating
4's in last 6 overs	5.0 ± 3.0	3.0 ± 2.0	0.8	Moderate
Runs scored in overs 11-14	36.0 ± 13.0	26.0 ± 9.8	0.74	
Run rate in last 6 overs	10.3 ± 2.6	9.0 ± 1.9	0.53	Small
6's in overs 7-10	1.0 ± 1.0	0.5 ± 1.0	0.5	
6's in overs 11-14	1.0 ± 2.0	0.5 ± 1.0	0.5	
4's in powerplay Overs	7.0 ± 2.0	6.0 ± 2.8	0.5	
4's in overs 7-10	3.0 ± 2.0	2.0 ± 2.0	0.5	
1's in overs 7-10	13.0 ± 3.0	11.0 ± 3.8	0.5	
6's in last 6 overs	2.0 ± 2.0	1.0 ± 3.0	0.4	
4's in overs 11-14	3.0 ± 2.0	2.0 ± 2.0	0.4	
Runs scored in overs 7-10	30.0 ± 11.0	26.0 ± 12.5	0.32	
Runs scored in powerplay overs	48.0 ± 7.0	45.0 ± 11.5	0.27	
6's in powerplay overs	1.0 ± 2.0	0.5 ± 2.0	0.25	
Dot balls in powerplay overs	17.0 ± 4.0	17.0 ± 3.0	0	No Effect
Wickets lost in overs 11-14	1.0 ± 0.0	1.0 ± 1.0	0	
Dot balls in overs 11-14	7.0 ± 4.0	7.5 ± 5.0	- 0.1	Trivial
1's in overs 11-14	11.0 ± 3.0	12.0 ± 2.0	- 0.25	Small (-)
Dot balls in overs 7-10	7.0 ± 5.0	8.0 ± 3.0	- 0.25	
Dot balls in last 6 overs	8.0 ± 4.0	9.0 ± 3.5	- 0.3	
1's in powerplay overs	9.0 ± 4.0	10.5 ± 3.8	- 0.38	
1's in last 6 overs	14.0 ± 6.0	17.0 ± 4.0	- 0.6	Moderate (-)
Wickets lost in last 6 overs	2.0 ± 3.0	3.0 ± 2.0	- 0.66	
Wickets lost in powerplay	1.0 ± 2.0	2.0 ± 2.0	- 1	
Wickets lost in overs 7-10	0.0 ± 1.0	2.0 ± 1.0	- 1	

3.2. Batting scoring areas

Table 7 displays the percentage of total runs scored in each area by winning and losing teams when batting. The biggest difference identified in scoring areas between winning and losing teams is the percentage of runs scored to the long-off and mid-off area (ES = 0.4). However, it is important to note that this still only equated to a small effect. Winning teams were found to score 14.3% of total runs in this area, compared to losing teams scoring 11.9%.

Table 7. Scoring areas when batting for winning and losing teams.

Scoring area	Winning teams	Losing teams	Effect Size	Rating
% of runs to third-man	18.3 ± 7.3	18.6 ± 7.3	- 0.04	Trivial
% of runs on the off-side	20.8 ± 7.1	19.3 ± 9.1	0.2	Small
% of runs to long-off/mid-off	14.3 ± 6.5	11.9 ± 4.7	0.4	Small
% of runs to long-on/mid-on	13.7 ± 6	14.2 ± 5.9	- 0.01	Trivial
% of runs on the leg-side	17.4 ± 7.1	19.6 ± 5.8	- 0.3	Small (-)
% of runs to fine-leg	15.5 ± 6.6	16.4 ± 4.4	- 0.1	Small (-)

3.3. Bowling performance indicators

Table 8 displays the bowling performance indicators for winning and losing teams. The biggest difference identified in bowling performance indicators between winning and losing teams is the number of bowlers taking 2+ wickets (2 to 1; ES = 1). With regards to the use of spin bowler, the strategy between winning and losing teams was largely homogeneous.

Table 8. Bowling performance indicators for winning and losing teams.

Performance Indicator	Winning teams	Losing teams	Effect Size	Rating
Bowlers taking 2+ wickets	2.0 ± 2.0	1.0 ± 2.0	1	Moderate
Overs from left-arm bowlers	4.0 ± 4.0	2.0 ± 4.0	0.4	Small
Wides	3.0 ± 3.0	3.0 ± 2.0	0	No effect
Overs of spin in powerplay	0.0 ± 1.0	0.0 ± 1.0	0	
Overs of spin in overs 7-10	2.0 ± 0.0	2.0 ± 1.8	0	
Overs of spin in overs 11-14	2.0 ± 1.0	2.0 ± 1.0	0	
Total overs of spin	5.0 ± 3.0	6.0 ± 3.0	- 0.28	Small (-)
Overs of spin in last 6 overs	1.0 ± 1.0	2.0 ± 1.0	- 0.5	
No balls	0.0 ± 1.0	0.5 ± 1.0	- 0.5	

3.4. Bowling delivery lengths

Table 9 displays the percentages of balls bowled at each delivery length by winning and losing teams. The biggest difference identified in delivery lengths between winning and losing teams is the percentage of balls bowled at a good length (ES = - 0.62). Losing teams bowled 32.5% of total deliveries at a good length compared to 28.4% by winning teams. Furthermore, losing teams bowled a higher percentage of balls at a full length (ES = - 0.29), whereas winning teams seemed to bowl more often at a Yorker length (ES = 0.4). Finally, from visual inspection of the spread of values between winning and losing teams, there is also tentative evidence to suggest that winning teams vary the delivery length more then losing teams, adopting a slightly more balanced bowling strategy, one that places less emphasis on full and good length deliveries.

Table 9. Percentage of balls bowled at each delivery length by winning and losing teams.

Delivery length	Winning teams	Losing teams	Effect Size	Rating
Yorker length	16.7 ± 8.5	13.7 ± 6.8	0.4	Small
Full length	39.8 ± 6.9	41.7 ± 5.7	- 0.29	Small (-)
Good length	28.4 ± 6.5	32.5 ± 6.6	- 0.62	Moderate (-)
Short length	15.1 ± 5.7	12.1 ± 4.2	0.58	Small

Table 10 displays the number of wickets taken from balls bowled at each delivery length by winning and losing teams. The highest numbers of wickets were taken from balls bowled at a full length for both winning (3 ± 2) and losing teams (2 ± 2.75). Balls of a short length were least likely to lead to wickets for winning (0 ± 1) and losing teams (0 ± 1).

Table 10. The number of wickets taken from balls bowled at each delivery length by winning and losing teams.

Delivery length	Winning teams	Losing teams	Effect Size	Rating
Yorker length	1.0 ± 2.0	0.5 ± 1.0	0.5	Small
Full length	3.0 ± 2.0	2.0 ± 2.8	0.5	Small
Good length	1.0 ± 2.0	1.0 ± 0.8	0	No effect
Short length	0.0 ± 1.0	0.0 ± 1.0	0	No effect

Table 11 displays the number of balls per wicket at each delivery length by winning and losing teams. Although the number of balls per wicket for yorker length and short length deliveries is similar regardless of match outcome, the apparent strike rate for full length and good length deliveries is better for winning teams when compared to losing teams. Specifically, winning teams had a strike rate of 13 and 25 balls per wicket for full length and good length deliveries respectively, which is in comparison to 18 and 35 balls per wicket for losing teams.

Table 11. The number of balls per wicket at each delivery length by winning and losing teams.

Delivery length	Winning teams	Losing teams
Yorker length	23	21
Full length	13	18
Good length	25	35
Short length	30	27

4. Discussion

The aim of this study was to investigate objectively the determinants of success in Twenty20 cricket. This was achieved by analysing 29 matches for winning teams and 30 matches for losing teams from the 2010, English domestic Twenty20 competition. The first objective of the study was to compare batting performance indicators for winning and losing teams. From a batting perspective, the main findings of the study suggest the difference between winning and losing teams is the number of wickets lost in the powerplay overs (ES = - 1) and between overs 7-10 (ES = - 1). Winning teams accumulated runs in partnerships of 50 or above (ES = 1), and had individual batsmen contributing between 50-74 runs (ES =1) and 75+ runs (ES = 1). This is in agreement with Petersen *et al*. (2008a) and Douglas and Tam (2010), who both reported wickets lost in the powerplay overs and more substantial partnerships to be key determinants of success in Twenty20 cricket. However, by splitting the middle overs into two groups of 4 overs, this study found retaining wickets between overs 7-10 was equally key to success as retaining wickets during the powerplay overs. In contrast to previous studies, losing wickets in the last 6 overs of an innings was found to be less important (ES = - 0.66). This disparity could be due to the strategic and tactical differences in the samples analysed, such as international and Indian Premier League teams utilising wicket taking bowlers in this period, or the fact that performance indicators in the current study were based on medians, rather than means. The mean is sensitive to extreme scores, while the median represents the middle or typical value, and therefore best represents all other scores (Taylor *et al*., 2005).

From a run scoring perspective, little difference was found between the runs scored by winning and losing teams in the first 10 overs of an innings. Winning teams scored on average 48 run in the powerplay overs, compared to losing teams scoring 45 (ES = 0.27). During overs 7-10 winning teams scored on average 30 runs, compared to losing teams scoring 26 (ES = 0.32). However, differences were evident in the number of runs scored between overs 11-14 (ES = 0.74) and run rate in the last 6 overs of an innings (ES = 0.53). Winning teams scored on average 36 runs in overs 11-14 compared to losing teams scoring 26. In the last 6 overs of an innings winnings teams scored on average 10.3 runs per over compared to losing teams scoring 9 runs per over. Previous research has suggested the middle 8 overs of an innings is the most important period to outscore the opposition (Petersen *et al*., 2008a). However, the current study highlights the importance of outscoring the opposition in the final 10 overs of an innings.

Examination of batting performance indicators also revealed hitting boundary 4's (ES = 0.5) to be of greater importance than boundary 6's (ES = 0.25). Scoring boundary 4's was found to be particularly important in the last 6 overs of an innings (ES = 0.8). Interestingly, losing teams scored 50.5 runs in singles, 33.1% of the total, compared to winning teams scoring 46 runs in singles, 27.2% of the total. Scoring 1's throughout an innings was found to have a small detrimental effect on success (ES = - 0.45), which is in agreement with previous studies (Petersen *et al*., 2008a; Douglas and Tam, 2010). However, by analysing 1's scored in each period of the innings, the results suggest it is important to score 1's and rotate the strike between overs 7-10 (ES = 0.5). This is likely to be a consequence of the higher number of fielders being allowed outside the 30 yard circle after the powerplay overs. Therefore, with boundaries less likely, 1's become more important during this period. Conversely, scoring 1's in the last 6 overs of an innings was a moderate disadvantage (ES = - 0.6). This finding highlights the importance of hitting boundary 4's and 6's rather than looking for singles, particularly at the end of an innings. As expected, the results suggest facing dot balls when batting was a small disadvantage (ES = - 0.57). However, during the powerplay overs dot balls were found to have no effect, with winning teams amassing, on average, 17 dot balls, the same number as losing teams. This is in contrast to previous studies, with Douglas and Tam (2010) reporting facing a higher number of dot balls in the powerplay overs to be a small disadvantage (ES = - 0.45). This disparity once again highlights the importance of hitting boundary 4's and retaining wickets in the powerplay overs of an English domestic match, rather than avoiding dot balls looking for 1's.

The second objective of the current investigation was to examine the scoring areas for winning and losing teams when batting. Little research has been conducted to objectively identify scoring areas in Twenty20 matches (e.g. Moore *et al.*, 2012). However, Moore *et al.* (2012) collapsed the data for destinations of boundaries in the first 6 overs, middle 8 overs, and last 6 overs, and failed to differentiate scoring destination between winning and losing teams. The current study suggests winning teams, in contrast to losing teams, score a higher percentage of total runs to long-off (ES = 0.4), with 14.3% of total runs coming in this area, while losing teams scored 11.9% of total runs in this area. Winning teams also scored a higher percentage of runs to the off-side (ES = 0.2), with 20.8% of total runs coming in this area, whilst losing teams scored 19.3% of total runs in this area. This finding may be due to losing teams bowling a wider line of delivery or winning teams looking to score a higher percentage of runs around the wicket, rather than concentrating on hitting to the leg-side. The results suggest losing teams focused on scoring runs through the leg-side (ES = - 0.3). Losing teams scored 19.6% of runs in this area, compared to winning teams scoring 17.4%. This finding may be due to winning teams bowling a straighter line of delivery or an intention by losing teams to score the majority of runs through the leg-side. However, these contentions warrant further investigation.

Based on these results, the batting side should look to retain wickets in the first 10 overs of an innings, without necessarily maximising the number of runs scored in this period. Subsequently, the batting side should look to outscore the opposition in the final 10 overs of an innings. Team selection should look at utilising specialist batsmen in the first 10 overs of an innings, capable of scoring boundary 4's while not taking significant risks looking to score boundary 6's. Previous research has suggested utilising specialist batsmen in the powerplay overs of an innings (Petersen *et al.*, 2008a; Douglas and Tam, 2010). However, the current study suggests a longer period of retaining wickets, without necessarily outscoring the opposition. This disparity may relate to the current study analysing wickets lost in overs 7-10 and 11-14, rather than just investigating wickets lost in the middle 8 overs of an innings. For the final 10 overs of an innings, batsmen with the highest strike rates, most likely to hit boundary 4's and 6's, and score a low percentage of runs from singles should be utilised. Throughout an innings, teams should focus on at least one batsman contributing a score of 50 or above, which greatly increases the chances of Twenty20 success. The evidence from the current study is also that batsmen from winning teams focus on scoring a high percentage of runs to long-off and the off-side, rather than focusing on hitting to the leg-side. Batting coaches should develop techniques that enable batsmen to score runs and hit boundaries in these areas. An approach of looking to score a high percentage of runs through the leg-side may increase the chances of losing a wicket and will provide technical challenges to a batsman performing the stroke. However, it is acknowledged that this recommendation is obviously dependant upon field placement, which may evolve in light of the context of the match.

A further aim of the study was to investigate bowling performance indicators for winning and losing teams. Wickets lost, particularly in the first 10 overs of an innings was found to be a key performance indicator when batting. Therefore, taking early wickets when bowling is key to restricting opposition run scoring. Bowling wides was found to have no effect on success in Twenty20 cricket. However, bowling no balls was found to be a small disadvantage (ES = - 0.5). This finding is in agreement with Douglas and Tam (2010), who also found bowling no-balls to have small negative effect in the 2009 Twenty20 World Cup (ES = - 0.45). This is likely to be a consequence of a ‘free-hit’ being granted to the batting side after the bowler oversteps the line in a Twenty20 match. The batsman is then able to play a risk free shot without the fear of getting out to the ball after a no-ball is bowled. Therefore, bowling coaches should focus on the prevention of no balls being bowled, with less concern about the number of wides bowled. Interestingly, winning teams were found to utilise a higher number of overs from left-arm bowlers than losing teams (ES = 0.4). However, an effect size of 0.4 may not be large enough to influence team selection. Further research in this area is required, as the initial findings suggest the tactic of a right-arm bowler bowling around the wicket, thus creating the angle of a left-arm bowler, may require consideration. Therefore, future research should examine the frequency by which winning and losing teams bowl over and around the wicket to left and right handed batsmen. In addition, analysis revealed bowling more overs of spin in the last 6 overs of an innings to be a small disadvantage (ES = - 0.5). This finding suggests utilising spin bowlers in the middle overs of an innings, rather than at the end, with batsmen looking to hit a high number of boundaries in the last 6 overs of an innings.

The final objective of the current investigation was to examine the delivery lengths bowlers’ use on winning and losing teams. The results suggest winning teams bowled more balls at a yorker (ES = 0.4) and short length (ES = 0.58) than losing teams. Losing teams bowled a higher percentage of balls at full (ES = - 0.29) and good lengths (ES = - 0.62) than winning teams. On a practical level, this suggests winning teams vary length more than losing teams with the aim of remaining unpredictable to batsmen. This is tentatively supported by Table 9, which presents the percentage of balls bowled at each delivery length. There appeared to be slightly lower variability across the bowling delivery lengths for winning teams when compared to losing teams, with standard deviations of 11.5% and 14.5% respectively. Furthermore, the results highlight the importance of the yorker and short length ball. The more frequent use of a yorker length by winning teams corroborates the work of Justham *et al.* (2008) and Moore *et al.* (2012). Specifically, Justham *et al.* (2008) acknowledged that delivery length was at its fullest during Twenty20 cricket, whereas Moore *et al.* (2012) observed that winning teams favoured a fuller delivery during the latter stages of a match. Examination of delivery lengths also revealed the highest number of wickets were taken from balls bowled at a full length by winning and losing teams. On average, winning teams took 3 wickets per innings from balls at a full length, with losing teams taking 2 wickets per innings from balls at this length. Importantly, this finding is further supported when normalising the data and calculating the number of balls per wicket for each delivery length (see Table 11). Specifically, the largest difference in balls per wicket between winning and losing teams was for full length and good length deliveries, whereby winning teams had a strike rate of 13 and 25 balls per wicket for full length and good length deliveries respectively, which is in comparison to 18 and 35 balls per wicket for losing teams. Wickets were also taken from balls bowled at a yorker and good length. Bowling balls at a short length was found to be the least effective wicket taking strategy.

Based on these results, the team bowling strategy should look to take wickets in the first 10 overs of an innings by selecting and utilising attacking bowlers with the best strike rate in this period. Bowlers should look to bowl the majority of deliveries at a good and full length, yet recognise the importance of deliveries at a yorker and short length. Ensuring an appropriate balance and variety between delivery lengths could potentially alleviate predictability, allowing bowlers to gain the competitive advantage. A positive approach should be adopted, with attacking field settings to capitalise on any opportunities created. Thereafter, bowlers who are less likely to concede runs, particularly boundaries, should be used for the remaining 10 overs of an innings. Spin bowlers most likely to take wickets should be employed in the earlier middle overs, with more defensive spinners, less likely to concede boundaries being utilised between overs 11-14. Spin bowlers should rarely be utilised in the last 6 overs of an innings. The findings highlight the need for unpredictability when bowling in a Twenty20 match. Therefore, from a coaching perspective, it is important to coach a range of deliveries, such as slower balls, and focus on bowlers being able to bowl a high percentage of balls accurately across the full spectrum of delivery lengths. Team selection should look to include bowlers capable of bowling a high percentage of balls at these lengths, with sufficient variations in pace to remain unpredictable to the batsman.

Although the current study has provided a more detailed analysis of the determinants of success in Twenty20 cricket there are several limitations to consider. The first limitation concerns the subjectivity of the delivery length results. Although the system was operated by trained analysts, with extensive experience in the sport, calculating the length of a delivery on a 22 yard pitch is subjective. This is evident in the reliability results for delivery lengths, with kappa values of 0.71 and 0.65 for intra-observer and inter-observer reliability respectively. Therefore, although it can be assumed the quality of observational agreement is still good, this was the least objective area of the study. In future studies it is recommended that Hawk-Eye™ technology is used to provide a more objective analysis of the delivery lengths used in a Twenty20 match. Currently, the delivery length findings may be too subjective to determine team bowling strategy, and the results should somewhat be viewed with caution. The second limitation concerns the lengths bowled by fast bowlers, medium-paced bowlers and spin bowlers on winning and losing teams. This study analysed the delivery lengths bowled by a team and did not differentiate between the different styles of bowlers utilised. Justham *et al*. (2008) found fast, medium-paced and spin bowlers bowl different lengths. Therefore, the results may currently reflect the types of bowlers winning and losing teams used, rather than the successful lengths to bowl at. This could also be examined in conjunction with the handedness of batters.

Several areas for future research are recommended. First, different styles of bowlers should be analysed to determine the successful lengths for a spinner or fast bowler to bowl, rather than investigating delivery lengths used by a bowling team. Moreover, the sequencing of delivery length across an over would be a fruitful line of enquiry to quantify the variability of length within an over and observe how this changes as the match progresses. Second, the current investigation analysed performance indicators for winning and losing teams. However, no differentiation has been made between a team batting first and second. Future research should investigate this area, studying for example, the most successful strategy to adopt when batting second and striving to reach an opposition target, rather than setting a total batting first. To further enhance the profiles of winning and losing teams, future research should investigate performance against a particular type of opposition utilising a matrix of comparisons. For example, his could include comparisons of top 4 versus top 4 placed teams and top 4 versus bottom 4 placed teams. This type of analysis would allow the refinement of team tactics for a particular opposition.

5. Conclusion

The current investigation has identified the key determinants of success in Twenty20 cricket, providing an English domestic coach with the objective information to plan team selection, strategy and tactics. Batting strategy should focus on retaining wickets in the first 10 overs of an innings, utilising specialist batsmen during this period, without necessarily maximising the number of runs scored. In the final 10 overs of an innings batsmen capable of hitting boundaries, particularly boundary 4's, should be selected. Additionally, at least one batsman should contribute a score of 50 or above, rather than having several batsmen contributing smaller scores. Subsequently, bowling strategy should focus on taking wickets in the first 10 overs of an innings. Bowlers should recognise the importance of deliveries at a yorker and full length, while attacking field placements should be used. Conversely, in the final 10 overs of an innings run restriction should be the primary objective. Therefore, bowlers should focus on bowling a high percentage of deliveries at a yorker and short length, with sufficient variations in pace to remain unpredictable to the batsman.

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