

Investigating lineout performance between the top and bottom four English Premiership rugby union teams in the 2016/17 season

MIGDALSKI, Adam and STONE, Joseph <<http://orcid.org/0000-0002-9861-4443>>

Available from Sheffield Hallam University Research Archive (SHURA) at:

<http://shura.shu.ac.uk/23772/>

This document is the author deposited version. You are advised to consult the publisher's version if you wish to cite from it.

Published version

MIGDALSKI, Adam and STONE, Joseph (2019). Investigating lineout performance between the top and bottom four English Premiership rugby union teams in the 2016/17 season. *International journal of performance analysis in sport*.

Copyright and re-use policy

See <http://shura.shu.ac.uk/information.html>

1 **Investigating lineout performance between the top and bottom four**
2 **English Premiership rugby union teams in the 2016/17 season**

3

4 Adam Henryk Migdalski¹ and Joseph Antony Stone¹.

5 *¹Academy of Sport and Physical Activity, Sheffield Hallam University, Sheffield, United*
6 *Kingdom*

7

8

9

10

11

12

13

14

15

16 Correspondence concerning this article should be addressed to Joseph Stone, Academy
17 of Sport and Physical Acitivity, Sheffield Hallam University, A213, Collegiate Hall,
18 Collegiate Crescent, Sheffield, S10 2BP. Tel: +44 0114 225 5413; E-mail:
19 joseph.stone@shu.ac.uk.

20

21

22 **Investigating lineout performance between the top and bottom four**
23 **Premiership rugby union teams in the 2016/17 season**

24 This study investigated lineout performance between the top and bottom four
25 English Premiership rugby union teams during the 2016/17 season. A season long
26 review was conducted analysing all of the top four ($n = 1152$) and bottom four
27 teams' ($n = 1124$) lineouts. Findings showed the number of tries scored
28 originating from a lineout play for the top four teams' (1.57 tries per match) was
29 higher in comparison to the bottom four teams' (1.10 tries per match) ($p < 0.05$).
30 Lineout success did not change between the top (87%) and bottom (85%) four
31 teams ($p > 0.05$). However, the top four teams were more effective in stealing
32 opposition possession at a lineout (17%) compared to the bottom four teams (9%,
33 $p < 0.05$). Additionally, top four teams showed a more forwards orientated style
34 of play using binding actions (top = 62%, bottom = 56%, $p < 0.05$) and maul
35 formation (top = 55%, bottom = 47%, $p < 0.05$). These results suggest coaches
36 should focus on analysis of opposition tactics in lineout play in an aim to develop
37 effective strategies to steal opposition possession at a lineout.

38 Keywords: contesting strategies; key performance indicators; lineouts; rugby
39 union; performance analysis

40

41

42

43

44

45

46

47

48

49 **1. Introduction**

50 Rugby union is a team invasion sport which has seen a growth in popularity
51 becoming a more commercialised, business orientated game with a larger emphasis
52 placed on maximising performance through the use of analytical and scientific support
53 (Austin, Gabbett, & Jenkins, 2011; Owen & Weatherson, 2004; Vaz, Mouchet, Carreras
54 & Morente, 2011). Analytical support is traditionally used by a method of notational
55 analysis which provides an objective way of quantifying performance in a reliable
56 manner (Hughes & Franks, 2015). An essential component of analysis in rugby union
57 match play is the ‘lineout’, which is a way of restarting the game once the ball has
58 passed the plane of touch and allows for a quick, safe and fair competition for the ball
59 (World Rugby, 2017). Two lines of players from opposing sides form within the 5 and
60 15-meter lines on the field of play with at least a meter gap separating them. The
61 attacking side dictates the number of players committed to the lineout and the
62 opposition can have an equal number or fewer players to contest for possession. An
63 attacking player stood beyond the plane of touch (generally referred to as the ‘hooker’)
64 throws the ball in an overhead manner down the centre of the two lines of players to
65 allow the teams to contest for possession (World Rugby, 2017).

66 Sayers (2011) suggested lineouts are an important aspect of a team’s attacking
67 game because they are an excellent try scoring modality, with lineout success shown to
68 be a factor that attributes to winning a match (Hughes & White, 1991; Jones, Mellalieu
69 & James, 2004; Vaz et al., 2011). Winning teams typically have a greater percentage of
70 success in winning the oppositions ball during the lineout in domestic European rugby
71 as well as the Six Nations Championship (SNC) (Jones et al., 2004; Ortega Villarejo, &
72 Palao, 2009). While losing teams have a greater number of lineouts lost (Ortega et al.,
73 2009). However, conflicting research suggests that lineout performance may not always

74 act as a key discriminator in determining match outcome (Bishop & Barnes, 2013;
75 Ortega et al., 2009; Vaz, Rooyen & Sampaio, 2010). For example, no differences were
76 found in lineout success between winning and losing teams in the 2011 Rugby World
77 Cup (RWC) knockout stages (Bishop & Barnes, 2013). Bishop and Barnes (2013)
78 suggested the reason for not finding differences in lineout statistics was due to the
79 importance of lineout success being highlighted as an area of success in the modern
80 game and therefore an increased emphasis was placed on having a successful lineout.

81 Since 2000 onwards there was an increase in defending teams contesting the
82 throwing in teams' lineout and using it as a method of regaining possession (Quarrie &
83 Hopkins, 2007). Contesting a lineout can be defined by a player from the defending
84 team being lifted by a player from his own team in the lineout in an attempt to win
85 possession on the oppositions throw in (Eaves & Hughes, 2003; Quarrie & Hopkins,
86 2007). Vaz et al. (2010) suggested winning teams when defending had a greater success
87 rate in 'stealing' the attacking teams' lineout ball. However, with no differences found
88 in number of lineouts stolen per game to make this conclusion further research would
89 have to be conducted into contesting strategies used by opposition teams to support this
90 statement (Vaz et al., 2010). In addition, Vaz et al. (2010) suggested that contesting
91 strategies may be more effective in winning teams as stolen lineouts can be convert into
92 possession which may result in point scoring opportunities. However, a KPI of 'lineouts
93 lost' was recorded (Vaz et al., 2010; Vaz et al., 2011), this could indicate that the
94 lineout was lost due to attacking error or the opposition stealing possession. Hence,
95 further detailed KPI's are required to understand if it is poor attacking play, or good
96 defensive play leading to success in the lineout. This would enable the effectiveness of
97 contesting strategies used by defending teams at a lineout to be examined.

98 Although lineouts in rugby have been suggested as being a key component in
99 rugby union, limited research has performed a detailed analysis specially focused on the
100 lineouts. One exception is Franken, van Vuuren, Kraak and Vaz (2017) who
101 investigated lineout statistics between the SNC and The Rugby Championship (TRC)
102 including lineout formations, pitch locations of the lineouts, throwing targets, actions
103 during the lineout and actions post lineout. Franken et al. (2017) concluded that most
104 lineouts occurred in an attacking area between the 22 m line and the halfway line with
105 binding formation followed by pass being the most utilised formats. Although research
106 has highlighted the importance of lineout performance there is a lack of research
107 explaining what the reasons are for these differences in performance. Furthermore,
108 research has traditionally focussed on international matches indicating a gap in literature
109 for investigating performance in domestic level rugby (Bishop & Barnes, 2013; Franken
110 et al., 2017; Orterga et al., 2011).

111 Therefore, this study aims to analyse lineout statistics and contesting strategies
112 between successful (top four) and unsuccessful (bottom four) teams within the English
113 rugby Premiership. This aim will help to clarify whether scoring or conceding tries from
114 a lineout attributes to a team being more successful across a season and the importance
115 of contesting strategies.

116 **2. Methods**

117 ***2.1 Design and sample***

118 Following institutional ethical approval eight teams were selected for analysis
119 based on their final league position during the 2016/17 Premiership season (the 4
120 highest and 4 lowest ranked teams, see table 1). The sample included all matches played
121 by the eight teams within the regular season ($n = 120$ matches) in which every lineout
122 taken ($n = 2276$; top four $n = 1152$; bottom four $n = 1124$) was analysed. The ‘play off’

123 matches (for teams finishing in the top four) were excluded from the study to avoid an
124 imbalance in number of games played between the two sets of teams.

125

126 [INSERT TABLE 1 HERE]

127 ***2.2 Performance indicators***

128 Guided by previous literature (e.g. Franken et al., 2017; Hughes & Bartlett,
129 2002) a series of KPI's were derived. These were; successful lineouts, unsuccessful
130 lineouts, formation, zonal location, intended target, actions during lineout, actions after
131 lineout, scores originating in lineouts and contesting strategies used to compete for
132 opposition ball. Operational definitions of these KPI's can be found in table 2 and the
133 zonal locations are described in figure 1.

134

135 [INSERT TABLE 2 HERE]

136

137 [INSERT FIGURE 1 HERE]

138 ***2.3 Procedure***

139 Each rugby match was downloaded from Elitehub[®] (Version 2017.12.1137) and
140 analysed using SportsCode Elite (Version 9.0, Sportstech, Warriewood, Australia). The
141 matches were coded by an experienced professional analyst, with in-depth knowledge
142 of rugby union. The analysis took place by coding each lineout using the KPI's defined
143 in table two. The data was then exported from SportsCode into Microsoft Excel 2013
144 (Microsoft Corporation, Washington, USA) for data processing.

145 **2.4 Reliability**

146 Intra-rater reliability was examined by randomly selecting two games (65
147 lineouts) which were reanalysed 2 weeks post initial analysis by the primary analyst (in
148 line with Hughes, Barnes, Churchill, & Stone, 2017). For each KPI's, Cohen's Kappa
149 Coefficient was used as an assessment of reliability. Using classification of Kappa
150 values (Altman, 1990) the system showed a very good level of agreement (ranging from
151 0.88 to 1.00) across the range of KPI's coded (see Table 3)

152 [INSERT TABLE 3 HERE]

153 **2.5 Data analysis**

154 Data analysis was conducted using Microsoft Excel 2013 (Microsoft
155 Corporation, Washington, USA) and SPSS 24.0 (IBM Corporation, New York, USA).
156 A Kolmogorov-Smirnov test for normality revealed the data to be non-normally
157 distributed across all KPI's. Therefore, non-parametric tests were used for statistical
158 analysis of the data. A series of Mann-Whitney U tests were conducted to identify
159 statistical differences between the top four and bottom four teams. Statistical
160 significance was accepted at a 95% level. To allow for comparison of data descriptive
161 statistics were presented in absolute and percentage values (means and standard
162 deviations). Cohen's *d* effect size (ES) testing was conducted across all variables with
163 Cohen's (1992) criteria for effect size tests used for interpreting findings; $ES \geq 0.1 < 0.3$
164 indicating a small effect, $ES \geq 0.3 < 0.5$ indicating a medium effect and $ES \geq 0.5$
165 indicating a large effect.

166 **3. Results**

167 Table two presents descriptive statistics as well as *Cohen's Effect Sizes* between
168 the top and bottom four teams (see table 4). The top four team's number of lineouts per

169 game did not differ significantly from the bottom four teams number of lineouts per
170 game, $U = 3918, z = .138, p = .890, d = 0.006$.

171
172

[INSERT TABLE 4 HERE]

173 **3.1 Tries from lineouts**

174 The number of tries scored originating from a lineout play for top four teams'
175 was significantly higher than the number of tries scored originating in lineout play for
176 bottom four teams', $U = 3121, z = -2.312, p = .021, d = 0.39$. In addition, the number of
177 tries conceded from a lineout play for top four teams' was significantly lower than
178 number of tries conceded from a lineout play for bottom four teams', $U = 5183, z =$
179 $4.036, p < .001, d = 0.66$.

180 **3.2 Lineout Success**

181 Top four teams' lineout success percentage did not differ significantly from
182 bottom four teams' lineout success percentage, $U = 3654, z = -0.65, p = .519, d = 0.05$.
183 The percentage of unsuccessful lineouts due to attacking error for the top four teams'
184 did not differ significantly from the bottom four teams', $U = 3612, z = -.786, p = .432, d$
185 $= 0.09$. Top four teams' percentage of unsuccessful lineouts due to opposition stealing
186 possession did not differ significantly from bottom four teams' $U = 4405, z = 1.68, p =$
187 $.094, d = 0.02$.

188 **3.3 Zones**

189 Percentage of lineouts that occurred in Zone A for the top four teams did not
190 differ significantly from the bottom four teams, $U = 3482, z = -1.16, p = .248, d = 0.21$.
191 Percentage of lineouts that occurred in Zone B for the top four teams did not differ
192 significantly from the bottom four teams, $U = 4453, z = 1.72, p = .085, d = 0.18$.
193 Percentage of lineouts that occurred in Zone C for top four teams did not differ

194 significantly from bottom four teams, $U = 3909$, $z = .113$, $p = .910$, $d = 0.04$. Percentage
195 of lineouts that occurred in Zone D for the top four teams did not differ significantly
196 from bottom four teams, $U = 3735$, $z = -.411$, $p = .681$, $d = 0.05$.

197 **3.4 Formation**

198 The percentage of 7-man lineout formations for the top four teams did not differ
199 significantly from the bottom four teams, $U = 3857$, $z = -.043$, $p = .966$, $d = 0.02$.

200 Across the remaining lineout formations which include; 3, 4, 5 and 6 man lineouts there
201 were also no significant differences found between the top and bottom four teams (all p
202 $> .05$).

203 **3.5 Intended Target**

204 The percentage of lineouts with a front intended target for top four teams (*Mdn*
205 did not differ significantly from bottom four teams, $U = 3735$, $z = -.411$, $p = .681$, $d =$
206 0.06 . Percentage of lineouts with a middle intended target for top four teams did not
207 differ significantly from the bottom four teams, $U = 3784$, $z = -.259$, $p = .796$, $d = 0.00$.
208 Percentage of lineouts with a back intended for top four teams did not differ
209 significantly from bottom four teams, $U = 3704$, $z = -.495$, $p = .621$, $d = 0.11$.

210 **3.6 Action during**

211 Bottom four teams had a significantly higher percentage of off the top actions
212 during the lineout than top four teams, $U = 4536$, $z = 1.968$, $p = .049$, $d = 0.38$.
213 Whereas, top four teams had a significantly higher percentage of binding actions during
214 the lineout than bottom four teams, $U = 2982$, $z = -2.634$, $p = .008$, $d = 0.29$. All other
215 actions during the lineout; overthrow, slap and direct transfer showed no significant
216 differences (all $p > .05$).

217 **3.7 Actions post**

218 Top four teams had a significantly higher percentage of maul actions post
219 lineout than bottom four teams, $U = 2979$, $z = -2.644$, $p = .008$, $d = 0.36$. All other
220 actions post lineout; pass, kick, ruck and carry showed no significant differences (all $p >$
221 $.05$) (see table 5).

222 [INSERT TABLE 5 HERE]

223 **3.8 Contest**

224 The top four teams' percentage of lineouts contested on opposition ball did not
225 differ significantly from the bottom four teams, $U = 3615$, $z = -.761$, $p = .447$, $d = 0.02$.
226 However, top four teams' percentage of successful contests on opposition was
227 significantly higher than bottom four teams' percentage of successful contests, $U =$
228 2560 , $z = -3.984$, $p = .000$, $d = 0.54$. Bottom four teams' percentage of lineouts
229 contested on 7-man formation was significantly higher than top four teams' percentage
230 of lineouts contested on 7-man formation, $U = 4870$, $z = 3.132$, $p = .002$, $d = 0.41$.
231 Across all other formations; 3, 4, 5, and 6-man the percentage of contested lineouts did
232 not differ significantly between top and bottom four teams (all $p > .05$). In addition,
233 percentage of lineouts contested in Zones; A, B, C and D did not differ significantly
234 between top and bottom four teams (all $p > .05$).

235 **4. Discussion**

236 The aim of this study was to analyse lineout statistics and contesting strategies
237 between the top and bottom four rugby teams in the English Premiership. Analysis
238 indicated that the top four teams (1.57 tries per game) were more effective at using
239 lineouts as a platform to score tries than the bottom four teams (1.10 tries per game). In
240 addition, results demonstrate the top four teams conceded less tries from lineouts (0.89

241 tries per game) than bottom four teams (1.63 tries per game) proposing the top 4 had a
242 more effective defence following a lineout.

243 Importantly, despite more tries being scored from lineouts by successful teams,
244 lineout success was not significantly different between the top (87%) and bottom four
245 teams (85%) supporting previous findings that lineout success is not a discriminatory
246 factor in winning matches (Bishop & Barnes, 2013; Vaz et al., 2010). Rather, our data
247 suggests the ability to win possession on opposition ball could be a more important
248 factor in influencing match outcome and league positions. Although the top four teams
249 did not contest a greater number of lineouts (57%) than the bottom four teams (55%),
250 the top four teams had a significantly higher success rate (17%) than bottom four teams
251 (9%) when contesting the ball. This finding suggests that top four teams are more
252 effective in ‘stealing’ opposition possession at a lineout and could be an important
253 factor for successful performance (Vaz et al., 2010). Vaz et al. (2011) suggested that
254 winning teams enjoyed a greater success rate on stealing opposition ball having found
255 that losing teams lose more lineouts than winning teams. The present study adds clarity
256 to previous research that used a KPI of ‘lineouts lost’ (Vaz et al., 2010; Vaz et al.,
257 2011), this could indicate that the lineout was lost due to attacking error or the
258 opposition stealing possession. With the present study using ‘successful contesting
259 strategies’ as a KPI this clearly identifies that the top four teams were more successful
260 in stealing opposition possession at a lineout and this was not due to an attacking error.

261 A further important finding was that bottom four teams contested 7-man lineouts
262 more times (29%) than top four teams (20%). With 7-man formations generally being
263 used to have more players involved in setting up an effective maul post lineout (Franken
264 et al., 2017), top four teams may choose to not contest 7-man lineouts but stay on the
265 ground to defend the maul post lineout. In addition, research has suggested that
266 successful teams enjoy greater forward dominance in matches (Hughes & White, 1997)

267 which might indicate why bottom four teams choose to contest to win possession at the
268 lineout rather than attempt to defend the subsequent driving maul. When lifting a player
269 in the air to contest possession at the lineout this can leave the defensive team with less
270 players on the ground to then defend a driving maul and subsequently could be the
271 reason as to why more tries are scored, particularly if the lineout is close to the try line.
272 Future research is required to further investigate whether tries come from mauls or from
273 phases after the lineout and in which zone they originated.

274 Analysis of actions during the lineout showed that top four teams used binding
275 actions more times (62%) than bottom four teams (56%). This tactic has been
276 considered by previous research as a safer option in terms of being able to retain
277 possession (Franken et al., 2017). Additionally, actions post lineout often depend upon
278 actions during the lineout and as previously mentioned top four teams opt for binding
279 actions during the lineout which is how mauls are formed. This can offer explanation as
280 to why the top four teams went into maul actions following a lineout significantly more
281 times (55%) than bottom four teams (47%). A maul is also considered as a safer option
282 in securing possession rather than distributing possession to the backs immediately post
283 lineout (Franken et al., 2017). With the top four teams enjoying this greater forward
284 dominance this may be why bottom four teams choose to use off the top actions
285 significantly more (28%) than top four teams (23%) in an attempt to distribute the ball
286 to the backs away from opposition forwards.

287 Investigating frequency of contests in different zone locations found no
288 significant differences indicating that zone location was not a factor in determining
289 whether teams contested possession at a lineout. An aspect of zone location that may
290 see differences is in which zone teams enjoyed greater success in stealing opposition
291 possession which is an area of further research. In addition, an area that could identify
292 differences is what the intended target at the lineout was when the ball is stolen. For

293 example, whether this occurs more often when the ball this thrown to the back of the
294 lineout which can be perceived as a more difficult skill (Kraak, Venter, & Coetzee,
295 2016).

296 **5. Conclusion**

297 In conclusion, this study demonstrates successful teams score more tries from
298 lineouts than less successful teams. Although lineout success was not found to be
299 different between the top and bottom four teams, top four teams did enjoy a greater
300 success rate while contesting the ball. This indicates although lineout success is an
301 important factor, success rate on the opposition ball is also a critical factor that can
302 influence team success. Here, the data supports the practical recommendations to players
303 and coaches that an area of training and analysis should be focussed on attempting to
304 steal opposition possession at a lineout. Finally, this study presents findings which
305 suggest that top four teams use a more forward originated approach to lineouts in that
306 they choose to use maul actions more frequently post lineout as well as securing
307 possession through binding actions during a lineout.

308

309 Word Count: 3222

310 **6. References**

- 311 Altman, D. G. (1990). *Practical statistics for medical research*, CRC Press.
- 312 Austin, D., Gabbett, T., & Jenkins, D. (2011). The physical demands of Super 14 rugby
313 union. *Journal of Science and Medicine in Sport*, 14(3), 259-263.
- 314 Bishop, L., & Barnes, A. (2013). Performance indicators that discriminate winning and
315 losing in the knockout stages of the 2011 rugby world cup. *International Journal*
316 *of Performance Analysis in Sport*, 13(1), 149-159.
- 317 Cohen, J. (1992). A power primer. *Psychological Bulletin*, 112(1), 155.

318 Eaves, S., & Hughes, M. (2003). Patterns of play of international rugby union teams
319 before and after the introduction of professional status. *International Journal of*
320 *Performance Analysis in Sport*, 3(2), 103-111.

321 Franken, L., Van Vuuren, H., Kraak, W., & Vaz, L. (2017). Investigation and comparison
322 of lineouts during the 2013 the rugby championship and six-nations
323 competition. *International Journal of Performance Analysis in Sport*, 17(1-2), 65-
324 76.

325 Hughes, A., Barnes, A., Churchill, S. M., & Stone, J. A. (2017). Performance indicators
326 that discriminate winning and losing in elite men's and women's rugby
327 union. *International Journal of Performance Analysis in Sport*, 17(4), 534-544.

328 Hughes, M., & White, P. (1997). An analysis of forward play in the 1991 rugby union
329 world cup for men. *Notational Analysis of Sport I & II*, 183-191.

330 Hughes, M. D., & Bartlett, R. M. (2002). The use of performance indicators in
331 performance analysis. *Journal of Sports Sciences*, 20(10), 739-754.

332 Hughes, M., & Franks, I. (2015). *Essentials of performance analysis in sport*. Routledge.

333 Jones, N. M., Mellalieu, S. D., & James, N. (2004). Team performance indicators as a
334 function of winning and losing in rugby union. *International Journal of*
335 *Performance Analysis in Sport*, 4(1), 61-71.

336 Kraak, W., Venter, R., & Coetzee, F. (2016). Scoring and general match profile of super
337 rugby between 2008 and 2013. *International Journal of Performance Analysis in*
338 *Sport*, 16(2), 786-805.

339 Ortega, E., Villarejo, D., & Palao, J. M. (2009). Differences in game statistics between
340 winning and losing rugby teams in the six nations tournament. *Journal of Sports*
341 *Science & Medicine*, 8(4), 523-527.

- 342 Owen, P. D., & Weatherston, C. R. (2004). Uncertainty of outcome and super 12 rugby
343 union attendance: Application of a general-to-specific modeling strategy. *Journal*
344 *of Sports Economics*, 5(4), 347-370.
- 345 Quarrie, K., & Hopkins, W. (2007). Changes in player characteristics and match activities
346 in bledisloe cup rugby union from 1972 to 2004. *Journal of Sports*
347 *Sciences*, 25(8), 895-903.
- 348 Sayers, M. G. (2011). Kinematic analysis of line-out throwing in elite international rugby
349 union. *Journal of Sports Science & Medicine*, 10(3), 553-558.
- 350 Van Rooyen, K. M., Diedrick, E., & Noakes, D. T. (2010). Ruck frequency as a predictor
351 of success in the 2007 rugby world cup tournament. *International Journal of*
352 *Performance Analysis in Sport*, 10(1), 33-46.
- 353 Vaz, L., Mouchet, A., Carreras, D., & Morente, H. (2011). The importance of rugby
354 game-related statistics to discriminate winners and losers at the elite level
355 competitions in close and balanced games. *International Journal of Performance*
356 *Analysis in Sport*, 11(1), 130-141.
- 357 Vaz, L., Rooyen, M. V., & Sampaio, J. (2010). Rugby game-related statistics that
358 discriminate between winning and losing teams in irb and super twelve close
359 games. *Journal of Sports Science & Medicine*, 9(1), 51-55.
- 360 World Rugby (2017). *Laws of the Game 2017*. Dublin: World Rugby.

361

362 Table 1. The finishing positions of the top and bottom four teams' in the
363 Premiership 2016/17 season once all matches had been played including total
364 points.

Position	Team	Points
1 st	Wasps	84
2 nd	Exeter Chiefs	84
3 rd	Saracens	77
4 th	Leicester Tigers	66
9 th	Gloucester	46
10 th	Sale Sharks	40
11 th	Worcester Warriors	33
12 th	Bristol	20

365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384

385 Table 2. KPI's with operational definitions (adapted from Franken et al., 2017).

KPI	Definition
Successful Lineout	Lineout won by attacking team
Unsuccessful Lineout (Attacking Error)	Lineout lost by attacking team due to: Not straight throw, free-kick/penalty conceded, handling error, overthrow.
Unsuccessful Lineout (Opposition Steal)	Lineout won by defending team
Zonal Location (See figure 1)	Zone A: Attacking area between try line and 22m line Zone B: Attacking area between 22m line and halfway line Zone C: Defending area between halfway line and 22m line Zone D: Defending area between 22m line and try line
Formation	3-man: Three attacking players in lineout 4-man: Four attacking players in lineout 5-man: Five attacking players in lineout 6-man: Six attacking players in lineout 7-man: Seven attacking players in lineout
Intended Target	Front: First third of the 15m area Middle: Second third of the 15m area Back: Final third of the 15m area
Action During Lineout: (What the player who catches the ball does with it)	Off the top: When the player who caught the ball in the lineout throws the ball to the scrum-half whilst still in the air Tap-back: When the ball is knocked back in a controlled or uncontrolled fashion by the player being lifted Over throw: When the thrower throws the ball over the intended target Binding formation: When teammates of the player who caught the ball bind onto him Direct transfer: When the ball is passed to another player standing in the lineout.
Action After Lineout: (Play directly after lineout)	Pass: When the ball carrier passes the ball to a teammate Kick: When the ball carrier kicks away possession. To deck: When only the ball carrier goes directly to ground To maul: When the ball carrier is held up by an opponent and at least one of his team mates is binding onto him Carry: When the ball carrier immediately breaks away from the lineout
Try scored originating from lineout	Whether a try was scored as a result of a lineout (from phase play after the lineout or maul)
Try conceded originating from lineout	Whether a try was conceded as a result of a lineout (from phase play after the lineout or maul)
Contesting Strategies	Contest: When a player on the defending team jumps or is lifted by teammates to compete for opposition ball. No Contest: Defending teams stay down and do not contest for the ball. Zonal locations: Which zone of the field of play do defending teams contest, A, B, C, D.

387 Table 3. Intra-observer reliability values for the notional analysis data quantified
388 through the calculation of Cohen's Kappa Co-efficient.

KPI	KAPPA
Lineout Success	1.00
Formation	0.89
Zonal Location	1.00
Intended Target	0.88
Actions During	1.00
Actions After	1.00
Tries Originating	1.00
Contest	1.00
Contest Success	1.00
Contest Formation	0.91
Contest Zonal Location	1.00

389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410

411 Table 4. Comparison of KPI's including effect sizes for the 2016/17 Aviva Premiership
 412 season between the top four and bottom four teams.

KPIs	Top 4				Bottom 4				<i>d</i> -value
	F	Mean	SD	%	F	Mean	SD	%	
Lineouts	1152	12.94	3.63	-	1124	12.92	3.62	-	.006
Try scored	140	1.57*	1.36	-	96	1.10*	1.05	-	0.39
Try conceded	79	0.89*	0.96	-	145	1.67*	1.38	-	0.66
Zone A	324	3.64	2.28	28	278	3.20	1.97	25	0.21
Zone B	449	5.04	2.65	39	478	5.49	2.33	43	0.18
Zone C	267	3.00	1.83	23	267	3.07	1.69	24	0.04
Zone D	112	1.26	1.19	10	101	1.16	1.15	8	0.09
Successful	998	11.21	3.37	87	961	11.05	3.39	85	0.05
Unsuccessful: Attacking Error	88	0.99	0.91	7	79	0.91	0.92	7	0.09
Unsuccessful: Opposition Steal	64	0.72	0.95	6	84	0.95	1.11	8	0.22
Quick Throw in	28	0.31	0.56	2	30	0.34	0.61	3	0.05
3 man	12	0.13	0.46	1	9	0.10	0.31	1	0.08
4-man	24	0.27	0.52	2	28	0.32	0.62	2	0.09
5-man	332	3.73	2.03	29	341	3.92	1.89	30	0.10
6-man	449	5.04	2.37	39	422	4.85	2.79	38	0.07
7-man	335	3.76	2.21	29	324	3.72	2.48	29	0.02
Front	540	6.07	2.60	47	543	6.23	2.70	48	0.06
Middle	377	4.24	1.85	33	369	4.24	2.28	33	0
Back	234	2.63	1.76	20	212	2.44	1.71	19	0.11
Off the top	245	2.75*	1.63	23	291	3.34*	1.95	28	0.38
Tap-back	90	1.01	1.19	8	100	1.15	1.03	10	0.13
Overthrow	54	0.61	0.81	6	51	0.59	0.79	5	0.02
Bind	663	7.45*	2.76	62	574	6.60*	3.03	56	0.29
Direct transfer	14	0.16	0.40	1	11	0.13	0.37	1	0.08
Pass	347	3.90	1.94	35	380	4.37	2.33	39	0.22
Kick	11	0.12	0.39	1	16	0.18	0.47	2	0.14
To deck	27	0.30	0.63	2	41	0.47	0.87	4	0.22
To maul	548	6.16*	2.56	55	452	5.20*	2.73	47	0.36
Carry	70	0.79	0.90	7	79	0.91	0.95	8	0.13

413 Notes. KPIs – Key performance indicators, F - Frequency, SD - Standard deviation, *d* – Cohen's
 414 effect size, * indicates $p < 0.05$.

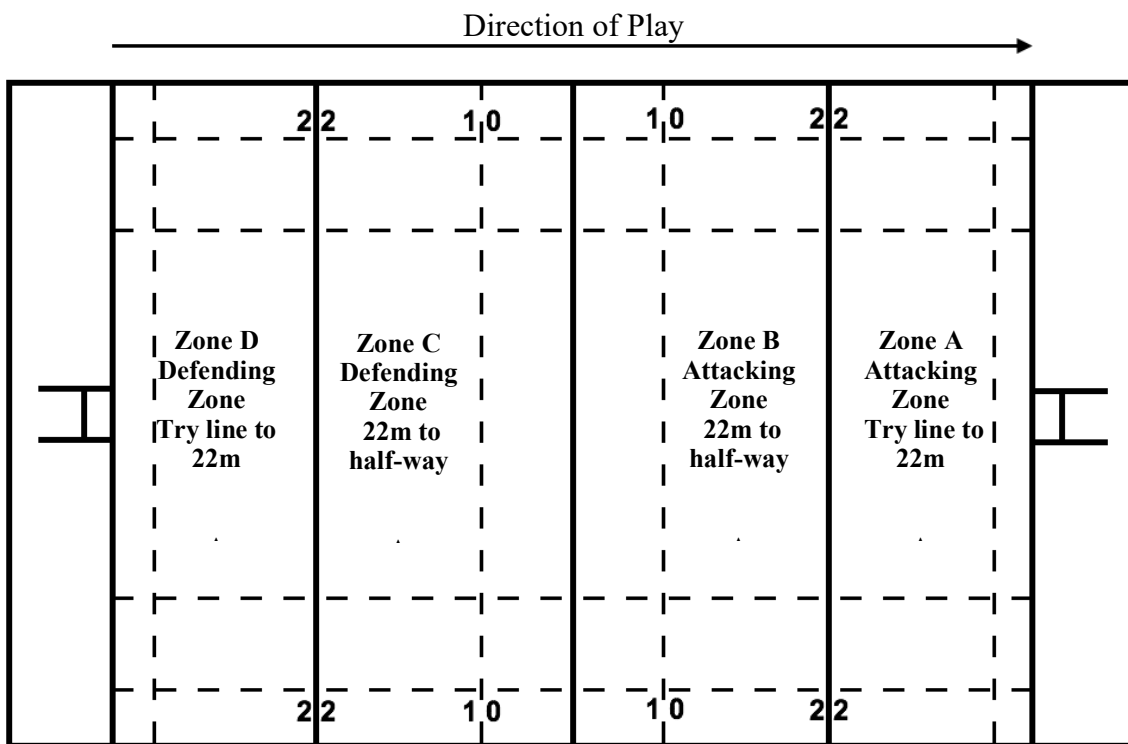
415
 416
 417

418 Table 5. Comparison of contesting strategies KPI's including effect sizes for the
 419 2016/17 Aviva Premiership season between the top four and bottom four teams.

KPIs	Top 4				Bottom 4				<i>d</i> -value
	F	Mean	SD	%	F	Mean	SD	%	
Contest	642	7.21	2.90	57	615	7.07	2.85	55	0.02
Successful Contest	110	1.24*	1.23	17	56	0.64*	0.99	9	0.54
Contest Zone A	67	0.75	0.86	11	67	0.77	0.98	11	0.02
Contest Zone B	176	1.98	1.34	27	162	1.86	1.47	26	0.09
Contest Zone C	292	3.27	1.97	45	271	3.11	1.74	44	0.09
Contest Zone D	107	1.19	1.14	17	115	1.32	1.23	19	0.11
Contest 3 man	6	0.07	0.25	1	6	0.07	0.25	1	0
Contest 4-man	37	0.42	0.77	6	26	0.30	0.70	5	0.16
Contest 5-man	224	2.51	1.62	35	185	2.13	1.59	30	0.24
Contest 6-man	244	2.73	1.70	38	218	2.51	1.63	35	0.13
Contest 7-man	131	1.47*	1.38	20	180	2.07*	1.51	29	0.41

420 Notes. KPIs – Key performance indicators, F - Frequency, SD - Standard deviation, *d* – Cohen's
 421 effect size, * indicates $p < 0.05$.
 422

423 Figure 1. Illustration of the pitch being divided into various zonal locations (adapted
 424 from Van Rooyen, Diedrick, & Noakes, 2010).
 425
 426
 427



428