Original Article

The ball recovery as an action related performance indicator in Football – an example using distinct operational definitions

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ABSTRACT

The aim of the study was to demonstrate the impact of different operational definitions (definition 1 – Amisco; definition 2 – Garganta, 1997; definition 3 – Garganta, 1997, adapted) over the frequency and location of ball recovery, and provide bases to select the most useful definition to an intended analysis. The sample is the first half of twelve matches from the Spanish soccer league. Matches were registered using AMISCO®. Data were examined using Cochran's Q test and Kruskal-Wallis test. Results showed that the frequency and location of ball recovery differ depending on the operational definition used. Definitions 1, 2 and 3 identified 909, 272 and 310 ball recoveries, respectively ($p < 0.001$ for all pairs of comparisons). The median distance from the goal to the location of ball recovery was, in meters, 40.0 (35.7) using definition 1, 32.2 (34.8) using definition 2 and 32.7 (34.3) when definition 3 was used ($p<0.001$ for comparisons between definition 1 and 2, and definition 1 and 3). The operational definitions impact in match analysis and consequently in the interpretation of the play. The criteria used should incorporate an instrumental selectivity that points to the purposes of the assessment. Concerning the frequency, definition 1 is the most glade, and definition 2 the most restrictive. Regarding the location, there were no significant differences between definition 2 and 3. Definition 2 allows to gain suitable and meaningful comparisons as previous studies has already based on it. Despite the differences, both definition 1 and 2 have a practical value. Ultimately, it is important to verify if the measurement instrument satisfies the logical intentions of the observational system. **Key words:** NOTATIONAL ANALYSIS, PERFORMANCE INDICATORS, OPERATIONAL DEFINITIONS, FOOTBALL, BALL RECOVERY

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INTRODUCTION

Performance profiles are frequently created using a series of performance indicators for teams, positional units or individual players to highlight specific patterns of performance behaviour (Hughes, Evans, & Wells, 2001; Redwood-Brown, Bussell, & Bharaj, 2012; Taylor, Mellalieu, & James, 2004). A performance indicator is a selection, or combination, of action variables that aims to define some or all aspects of a performance (Hughes & Bartlett, 2002). It is recognised the importance of its operational definition in the validity and reliability of data (James, 2006a, 2006b; Williams, 2012). It would be not enough to consider a performance indicator *per se,* since different operational definitions may capture and/or exclude relevant information. Thus, the selection of performance indicators should be established in several stages (James, Mellalieu, & Hollely, 2002; Tucker, Mellalieu, James, & Taylor, 2005). Is created an *ad hoc* observation instrument to make possible to detect the behaviors patterns under investigation (Silva, Bañuelos, Garganta, & Anguera, 2005). The criteria of the operational definitions must be accurately defined and unambiguous (James, 2006b; Williams, 2012). It is necessary to test the design of the system of analysis, ensuring that there is no error in the definitions and in the system of measurement (James et al., 2002; Tucker et al., 2005).

Researchers often utilizes data derived from commercial performance analysis data providers such as Amisco®, Prozone® or Tracab® (Carling, Wright, Nelson, & Bradley, 2014; Mackenzie & Cushion, 2013). These companies use their own list of definitions for coding match actions (Carling et al., 2014), which may provide to the partners teams but keep them restricted. It is plausible that these measures become often used in the academic world without accurate knowledge of the critters that define the operational definitions. Simultaneously, there are concerns related to a lack of operational definitions in the published papers (Carling et al., 2014; James, 2006a, 2006b; Mackenzie & Cushion, 2013; Sarmento et al., 2014; Williams, 2012). This raises many uncertainties about the exact meaning of the performance indicator, although there is an actual awareness on the need to address this problem. It has been postulated the need for consensus in operational definitions for sports (Williams, 2012), and if this is desirable, can also be argue the usefulness for a certain degree of adaptability in the operational definitions criteria. For instance, how restrictive should be the criterion that defines the occurrence of a ball recovery? The operational definition criteria should respond to this question as it serves a specific intent for the analysis, considering the wide variety of purposes for observational systems (see Lames & Hansen, 2001).

One of the most popular performance indicator in soccer is the frequency of ball recoveries in the match (e.g. Castelo, 1994; Lago-Peñas & Lago-Ballesteros, 2011; Mombaerts, 2000; Redwood-Brown et al., 2012). Indeed, being in possession is as important as recovering the ball when the opposing team attacks (Almeida, Ferreira, & Volossovitch, 2014). Ball recoveries establish the end of the defensive phase and the start of the attacking phase of one team, and it is considered an important action to achieve success in elite soccer (Armatas et al., 2009; Hughes & Churchill, 2005). Despite the importance of ball recovery, the research is predominantly concerned with the analysis of offensive play, being examined to a lesser extent the patterns of ball recovery (Barreira, Garganta, Guimarães, Machado, & Anguera, 2014; Vogelbein, Nopp, & Hökelmann, 2014). This is a considerable gap that must be recognized, promoting applied research on the ball of recovery.

If ball recovery can be easily defined as the moment when a team recovers ball possession and re-launches the offensive phase, setting when a team has recovered ball possession is not a simple matter. Many times there are a doubtful situations, which require precise clarification. Castellano (2000) exposes this difficulty by arguing that, apart from the goalkeeper, the player will never get to have full control of the ball because he plays it through touches (contacts or strokes). According to Amisco® criteria, a team recovers the ball, starting

with ball possession, when one of their players contacts the ball after it having being previously contacted by an opposing team player. Such contacts include interceptions, clearances, aerial challenges, tackles, passes, shots, and are independent of the number of contacts made by the player. A ball recovery is considered if it is sent off the field by the opponent team or immediately after an opponent player from team B having contacted the ball during an offensive sequence of team A. This glade definition brings some problems since it may not be concretized on active ball recovery. For instance, Gréhaigne, Marchal e Duprat (2002) claim that true ball recoveries do not refer to passages of play in which the successive change of possession does not allow the identification of the real ball holder (either team or player). Different definitions focussed on when a team recovers the ball, starting with ball possession, has been identified. For example, several studies (see, Lago-Ballesteros, Lago-Peñas, & Rey, 2012; Tenga, Holme, Ronglan, & Bahr, 2010; Vogelbein et al., 2014) have been conducted using the Pollard and Reep (1997) team possession definition, while others (see, Barreira et al., 2014; Garganta, 1997; Santos, 2012) uses Garganta (1997) definition. The analysis of both operational definitions revels that they have a similar perspective, but are expressed in a slight different way. This can have a profound effect on the results, requiring caution when comparing between studies (James, 2006b; Williams, 2012).

Therefore, the aim of the this study is to demonstrate the impact of three distinct operational definitions over two performance indicators related to the ball recovery, and provide bases to select a definition that could be the most useful to an intended analysis.

MATERIALS AND METHODS

Sample and Match performance data collection procedures

The first half of twelve matches (six home and six away matches) from the Spanish soccer league were analysed. Set plays were excluded from the analysis. The sampled matches were registered by the AMISCO PRO® system, a multi-camera computerized video-tracking system that measures the movements of every player, the referee and the ball by sampling activity up to 25 times per second during the whole game. This system creates a 2-dimensional animated reconstruction of player movements and allows the simultaneous analysis of the movements of every player in a team throughout the entirety of a match. Information from each match is stored on a DVD, which can be extracted through specific software (Amisco Viewer®). This semi-automatic tracking system was validated elsewhere (Carling, Bloomfield, Nelsen, & Reilly, 2008; Randers et al., 2010; Zubillaga, Gorospe, Mendo, & Vilasenor, 2007).

The required information was extracted from the DVD`s by one observer that was assisted by another element that record the data. First, ball recovery situations were classified according to each operational definition. The values were double cheeked to ensure that there were no errors in the data. The intra-observer reliability was performed two weeks later to avoid any possible negative learning effects. One game was analysed and the two data sets were compared. The intra-observer Kappa value in ball recovery situations was 0.96.

Variables

Two performance indicators (the frequency and location of ball recoveries) and three different operational definitions were used in the data collection. The ball recovery incidence reflects de number of ball recoveries according to the operational definition considered. The ball recovery location is the shortest distance, recorded in meters, between the goal line and the ball location in the field of the ball. Three ball recovery definitions were considered (Table 1). The first one refers to the interpretation of the Amisco® concept of ball

recovery since we did not accede to the company definition. The second definition created is based on Garganta (1997). The third one is similar to ball recovery definition 2 except on criteria 1.

Table 1. Definitions of ball recovery considered in the study

Ball recovery definition 1	A team recovers the ball when one of their players contacts the ball after it has been previously contacted by an opposing team player. A ball recovery is accounted even if it is sent off the field or, immediately, if another opponent player contacts again the ball, making a new ball recovery for their team. With a new contact on the ball accomplished after a contact made by the opponent team, arise a new ball recovery, and team gains momentarily ball possession.
Ball recovery definition 2	A team recovers the ball when one of their players contacts the ball fulfilling one of three situations: (1) makes at least three consecutive contacts with the ball, (2) make a positive pass, (3) makes a shot. A positive pass is one that allows a player from the same team (following player) shoot at goal (criterion 3), or keep possession of the ball, getting it (criterion 1). A ball recovery only is considered if the opponent team has ball possession (i.e., has previously accomplished ball recovery according to the same criteria). An exception in ball recovery criteria appears when the goalkeeper grabs the ball, as he has an effective control on it. A ball recovery event could not be considering if the team hasn't loosed ball possession according to these criteria, i.e. the opponent team does not previously recovery the ball. Set plays situations define the team who has the ball possession to account for the subsequent ball recovery.
Ball recovery definition 3	Identical to ball recovery definition 2 except criteria 1: (1) makes at least two consecutive contacts with the ball.

Statistical analysis

Mean and standard deviation are presented for ball recovery incidence and ball recovery location according to the three operational definitions considered.

Due to violations of normality, median plus interquartile range for ball recovery location are reported according to operational definition. Cochran's Q test was used to scrutinize for differences between the three sets of frequencies of each criterion and also for analysing multiple pairwise comparisons. The Kruskal-Wallis test was used to compare differences between distances measured according to each of the three criteria. Significant results were followed up with Bonferroni pairwise comparisons. Post hoc comparisons were run separately with Mann-Whitney tests. The significant level was set at $p = 0.05$. In either case, type I errors across post hoc comparisons were controlled with the Bonferroni adjustment that was applied by dividing the significance level by the number of tests (0.05/3 = 0.017). Therefore, the significance level used in the Mann-Whitney tests and Cochran's Q for considering a statistically significant result was 0.017. All statistical analyses were performed with the statistic software package SPSS Version 19.

RESULTS

The AMISCO® criterion (definition 1) identified 909 ball recoveries. According to the definitions 2 and 3 there were 272 and 637 ball recoveries, respectively. The Cochran's Q test revealed a systematic difference between the three definitions [$Q(2) = 1196{,}88$, $p < 0{,}001$]. Post hoc comparisons revealed significant statistical differences between all definitions ($p < 0.001$ for all pairs).

The median distance from the goal to the location of ball recovery was 40.0 meters (35.7) using the definition 1, 32.2 meters (34.8) using definition 2 and 32.7 meters (34.3) when definition 3 was used. The Kruskal-Wallis test showed significant differences between distances measured with each criterion [$\chi^2(2) = 37.95$, $p< 0.001$]. Post hoc analysis revealed significant differences between definition 1 and both definitions 2 and 3 ($p< 0.001$ in both cases), but no significant differences were found between definitions 2 and 3 ($p= 0.527$) (Table 2).

Table 2. Incidence (n) and ball recovery location [Descriptive Statistics: Median (Mdn) and Interquartile Range (IQR)] as a Function of the operational definition used (definition 1, 2 and 3)

Ball recovery	Definition 1	Definition 2	Definition 3
Incidence (n) ◊	909†‡	272*	310
Location in the field Mdn (IQR) #	40,0 (35,7) † ‡	32.2 (34.8)	32.7 (34.3)

◊ Cochran's Q test; # Mann-Whitney test.
†Differences between the definition 1 and 2 ($p<0.001$); ‡ Differences between the definition 1 and 3 ($p<0.001$); * Differences between the definition 2 and 3 ($p<0.001$);

DISCUSSION

The aim of this study is to examine the impact of three distinct operational definitions over the frequency and location of ball recoveries, and provide bases to select the definition that could be the most useful to an intended analysis. As expected, the results overall evidence that the value of these performance indicators differ depending on the operational definition used.

Concerning the frequency of ball recoveries, there were significant variations between the three definitions used. This suggests that the selected definition should consider the purposes of the analysis as there are implications by using a more comprehensive (e.g. definition 1) or strict criteria (e.g. definition 2). These factors have practical consequences in the interpretation of the play made by coaches and match analysts. Hence, the potential use of the information should guide how the analysis system will be designed, being important to decide the level or degree of detail of output early in the analytical process, i.e. prior to the system design (Hughes & Franks, 2004). This calls for care when deciding exactly what is required. The selection of performance indicators should be established in several stages, and the design of the system tested (James et al., 2002; Tucker et al., 2005). The criteria that determine the information to be incorporated or excluded in the posterior data collection is previously subjected to consideration, which represents one of the steps for the establishment of a performance indicator and elaboration of the analysis system. This should be done according to the purposes of the information gathered in search of a less fragmented understanding of the subject matter.

These data assist to the selection of a ball recovery definition for use on empirical research. It is known that the ball recovery allows a double purpose: stopping the opponent's ball possession and offensive phase (a crucial defensive goal) and regaining ball possession. The quality of ball recovery determines the content of technical actions and the sequence of a team's ball possession (Barreira et al., 2014; Garganta, 1997). If the collected data serves to analyse general facets concerning frequency of ball recoveries, it should be used a more glade definition of ball recovery (e.g. definition 1). If it is intended to focus on a more restrictive aspect

of ball recovery and subscribe for more detailed interpretations based on the number of occurrences, the definition selected should reflect that intent. Despite the differences found between them, definition 2 and 3 serves this intention. We need to be aware that the main value of the performance indicators is to facilitate the extraction, treatment, interpretation and further use of information derived from the game (Lago-Ballesteros, 2011). In this sense, it has been argue that performance indicators should be defined according to coaches personal match philosophy, which includes the team player style, and tactical approach and individual demands (Carling et al., 2014). It seems that the choice of the operational definition criteria should incorporate an instrumental selectivity that points to the purposes of the evaluation.

With regards to the location of ball recoveries, there were no significant differences when comparing definition 2 and definition 3. This suggests that it is not necessary to use the formulation presents on definition 3, by comparison with definition 2. Making at least three consecutive contacts with the ball (criteria one of ball recovery definition 2), instead of considering two consecutives contacts (criteria one of ball recovery definition 3), constitutes a robust criteria for the study of the location of ball recoveries. The criteria detail that distinguishes both definitions is not sufficient to differentiate the results. Both of these definitions conduct to similar results in ball location recovery, although they report, as we already saw, differences in the frequency of ball recoveries. Earlier investigations have already used this definition 2 criteria when studying characteristics associated to ball recovery (Barreira et al., 2014; Garganta, 1997; Santos, 2012), making this one a valid option that allows more suitable comparisons between studies. The choice between definition 1 and 2 deserves reflection. The commercial analysis system – e.g. Amisco®, validated elsewhere (Carling et al., 2008; Zubillaga et al., 2007), or the Prozone®, also scientifically validated (Di Salvo, Collins, McNeill, & Cardinale, 2006; Di Salvo, Gregson, Atkinson, Tordoff, & Drust, 2009) – allow good datasets based on their own list of performance indicators and definitions (e.g. definition 1/Amisco®), providing a measure system. These datasets can be checked and used to produce new and more selective datasets, based on a more ascertained definition (e.g. definition 2). Despite the differences, both definition 1 and 2 have a practical value for performance assessment. Ultimately, it is important to verify what is enclosed in the definition selected, and if effectively it reflects the key features of performance in team sports, and also if it satisfies the logical intentions or the purposes of a particular analysis.

Future research should be addressed to the ball recovery instant, as it is crucial to offensive play (Almeida et al., 2014; Barreira et al., 2014; Vogelbein et al., 2014). To provide more details about ball recovery, it should also be considered a comparison of results between the first and second half of the game. This was not done because during the second half of seven of the sampled games there was an expulsion of a player from the pitch for having a red card. For this, the criteria of having an equal number of players present in the field in the first and second half of the matches was not fulfilled. Apart from the effect of the half's period, the research should examine the effect of others situational variables over the ball recovery. Indeed, several studies (e.g. Almeida et al., 2014; Bradley, Lago-Peñas, Rey, & Sampaio, 2014; Castellano, Blanco-Villaseñor, & Álvarez, 2011; Lago-Peñas & Dellal, 2010; Lago-Peñas, Rey, Lago-Ballesteros, Casáis, & Domínguez, 2011; Lago, 2009; Lago, Casáis, Domínguez, & Sampaio, 2010; Taylor, Mellalieu, James, & Shearer, 2008), qualify the quality of opposition, match location, and match status, as factors that induce influence over the teams behavior, and thus affect the expression of the performance indicators. It should be noted that the resource to a case study incorporates the problem associated to the generalization of results (Bradley et al., 2014; Carling et al., 2014; Harrop & Nevill, 2014; Lago-Ballesteros et al., 2012; Lago-Peñas & Dellal, 2010; Taylor, Mellalieu, James, & Barter, 2010; Taylor et al., 2008), requiring new investigations, with other teams, to validate the findings concerning the frequency and location of ball recovery during the first half of matches.

CONCLUSSIONS

The need for correct performance indicators and accurate, clear and reliable operational definitions has not been a matter of discussion on performance analysis literature. Nonetheless, the selection of performance indicators and its operational definitions continues to be a significant issue in the analysis of sportive performance because it is reflected on practical consequences for match analysts and coaches in the interpretation of the play. Overall, the results showed that the frequency and location of ball recoveries differ depending on the operational definition used. These data assist to the selection of a ball recovery definition for use on empirical research. It was argued that the selected performance indicators and its operations definitions must be coherently involved by the purposes of the analysis in the pursue process of getting meaningful and robust information. In this study, definition 1 (table 1) is the most general of the three ball recovery operational definitions. It may involve situations that are not a true active ball recovery and represents the embracing operational definition of the commercial match analysis system AMISCO®. These definitions incorporate different scenarios that give to the coach and players substantial and objectively information to identify the keys to success by establishing normative profiles based on several games. Other definitions, such as definition 2, may be more exclusive to investigate some facets of the game. If the high-tech tracking analysis systems are critical to build databases, they must be carefully considered when evaluating performance since the criteria for defining a variable may be less tight and therefore the algorithm may have little power of scrutiny. It is required professional and scientific approaches to validate tighter operational definitions that filter more information.

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