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EVALUATING THE OFFENSIVE DEFINITION ZONE IN FOOTBALL: A CASE STUDY

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ABSTRACT

New technological solutions have greatly improved match analysis systems for investigating players' performance. Nevertheless, there still remains a large gap in the collective analysis where improvements need to be made, mainly in the use of automated information gathering. Thus, the aim of this case study was to propose a set of three automated tactical metrics and their respective ratios for use in investigating and estimating the tactical performance of football teams. Three official football matches of the same professional team were analysed and Cartesian information about the position of players and the ball in the field was collected. Using this information, tactical metrics regarding penetration, offensive space and offensive unity were developed. The results showed that the unity principle was the tactical principle most often accomplished at the mean ratio of 0.83 and penetration was the principle performed with the least success (ratio of 0.42). This case study proposes some computational indicators to evaluate the collective performance of football teams whereby football coaches can be provided with some additional information that could be used to characterise their teams.

Key words: Match analysis; Metrics; Tactics; Offensive process; Football.

INTRODUCTION

Performance analysis seeks quantitative and qualitative methods that help to identify, characterise and estimate human performance during sport activities. In football, match analysis aims to assess the collective performance of players during games, to identify patterns of play and the weakness and strength of players' synchronisations (Clemente *et al*., 2013).

Traditionally, the focus of match analysis has been to characterise the individual actions, using notational analysis to measure the number of passes, shots or balls lost (Hughes & Bartlett, 2002). However, these statistical summaries are an over-simplification of football matches where the final outcome is the result of complex and dynamic processes of inter-player relationships (Duarte *et al*., 2012). Therefore, only observing the outcomes is insufficient to characterise complex team behaviour. A new vision for the complex process underlying team behaviour is necessary.

Match dynamics need to be supported by strategic and tactical processes that try to improve collective behaviour potentiality (Clemente *et al*., 2013). Tactics and strategy have always had a strong relevance to opposing actions between humans. Nevertheless, tactics and strategy are two different terms that need to be understood differently, considering their different meanings in a sporting context. ‘Strategic’ relates to the principles of play or the orientation of actions that allow the organisation and preparation of the team in readiness for the match (Bouthier, 1988). On the other hand, ‘tactics’ relates to operations performed during the game by players in order to adapt the initial requirements to the dynamic constraints imposed by the opposing team.

Thus, strategy is constituted of the elements previously discussed by the organisation (the team) to prepare for the match (Gréhaigne & Godbout, 1995), and relates to the general order, namely to the players' positioning and distribution on the field, as well as their specific missions (Gréhaigne *et al*., 1999). Tactics, on the other hand, relates to the punctual adaptation to new playing configurations as a function of the state of ball possession and the opponents’ positions (Gréhaigne & Godbout, 1995). The concept of tactics relates to behavioural adaptation in response to the opponents and the play status. Therefore, there are substantial differences between strategy and tactics at the levels of time and space. Strategies relate to more elaborate cognitive processes, due to the greater amount of time to prepare and the lower level of constraints (Gréhaigne *et al*., 1999). Compared to strategy, the tactical concept involves higher levels of decision-making and behavioural adaptations as a function of the contextual constraints; thus it is decision in action. During the game, tactical behaviour prevails (Gréhaigne *et al*., 1999).

Considering the above, there are some principles underlying the team’s strategies and tactical behaviour that provide a higher level of organisation and structure to collective behaviour (Costa *et al*., 2009). Without principles of play, the intra-team relationships may become less organised, which reduces the opportunity to play as a team and as a unit. Thus, over the years, football theory has developed some offensive principles that potentiate collective behaviour and quality of play (Metzler, 1987; Gréhaigne *et al*., 2005; Costa *et al*., 2010).

The offensive tactical principles aim to give fundamental information to players, allowing an improvement in their collective behaviour (Costa *et al*., 2009). These tactical principles provide some behavioural rules for organising and attuning the behaviour of players in accordance with the main goal of the team, namely to successfully create goal-scoring opportunities so that goals are ultimately scored. Thus, tactical principles are essential guidelines for allowing an improvement in the team’s collective behaviour in order to overtake the defensive organisation of the opposing team. According to Costa *et al*. (2010), the five offensive fundamental principles of play in football are: (1) penetration; (2) offensive coverage; (3) depth mobility; (4) width and length (space); and (5) offensive unit. Of these principles, penetration, width and length, and offensive unit were chosen to be the subject of this study.

The penetration principle is characterised by the progress of the attacker with ball possession in the direction of the score zone (Costa *et al*., 2009). The main objective of the attacker is to reach the zone closest to the goal with the aim of scoring in the goal of the opponents. The guidelines of this tactical principle are to overtake direct opponents and unbalance their defensive organisation in order to bring the ball to a favourable position in the score zone (near enough to increase the accuracy of the shot and far enough to avoid being tackled by the opponents). Progress with the ball is made by trying to approximate the position of the attacker to the goal or overtaking the direct opponent and trying to take advantage of this by creating space to play or to perform actions that are characteristic of the penetration principle.

The width and length (space) principle aims to extend and use a larger effective play space (Costa *et al*., 2010). By increasing the dispersion of the players during the offensive phase it will be easier to attract defensive players into non-vital zones (side-lines), removing them from the vital zone (the middle), thus trying to throw the defensive concentration of opposing team off balance. By removing some opposing defenders to non-vital areas, it will be possible to explore the central area of the score zone. Furthermore, it will be possible for the player with ball possession in the central area to attempt to overtake the direct opponent, benefiting from more space to conclude the offensive process successfully.

The offensive unit principle involves the positioning of off-ball defenders so as to decrease the effective play space of the opponents. To keep the collective cohesion and balance between team sectors it is important to have an effective and functional distribution of players in relation to the ball position, the phase and match status of the game, and the positioning of the opponents. Thus, the team needs to function as a whole, positioning itself functionally on the field. The fundamental guideline for this principle is the efficient positioning of players on the field, which not only takes into account the individual missions of the players, but also to consider the collective objective and functionality of the team as a whole (Castelo, 1996). The offensive unit principle assumes a balance between the sectors (defenders, midfielders, forwards) of the team as a determining factor for success when the team loses possession of the ball. By maintaining the proximity between the team sectors and a balanced organisation, it will be easier to move to the defensive organisation (Teodorescu, 1984), thus increasing the opportunities to improve the quality of the defensive action. The ultimate goal is not to unbalance the team at any stage of the game.

RESEARCH PROBLEM

These tactical principles have been observed using manual and semi-automated methods. The manual system depends totally on a human operator who controls and records the necessary data, whereas the semi-automated system assists the human operator to collect, store and treat the data. Nevertheless, the human operator has a preponderant influence during all these processes. From these systems, it is possible to identify: tactical performances of players; network analysis of team mates; and *t*-patterns of collective interactions. Such an analysis can be used in any situation and requires only the software and the video-recording of a match. Any coach or analyst can thus use such a system to observe the behaviour of a team, even an amateur team. The great amount of time spent on observation is, however, a disadvantage. Online observation (during a game) is also very difficult due to the complexity of data recording and processing. Despite the many advantages that football teams can gain from these systems, the technique is under-used and will remain that way until a fast, automated and user-friendly system is developed.

Therefore, the aim of this study was to propose a computational method to analyse the penetration (width and length) and offensive unit principles of play during football matches. These metrics will be computed using kinematic information about the positioning of players on a Cartesian field. This automated analysis will allow a step forward in increasing the speed at which analysis can be undertaken and thus its usefulness for coaches during and after matches.

METHODS

Sample

Three official home matches of a professional team were analysed. At each match the final score was different: winning; losing; and drawing. Thus, each of the matches was considered according to its final score. All of the collected data complied with the ethical standards for the treatment of human or animal subjects of the American Psychological Association.

Data collection

The teams' actions were captured using a digital camera (*GoPro Hero* with 1280 x 960 resolution), with capacity to process images at 30Hz (30 frames per second). The camera was placed on an elevated surface above the ground in a way that would capture the whole field. The field dimensions were 104 x 68hm. After recording the football match, the physical space was calibrated using direct linear transformation (DLT), which measures the position of the elements (players and ball) in pixels to the metric space (Abdel-Aziz & Karara, 1971).

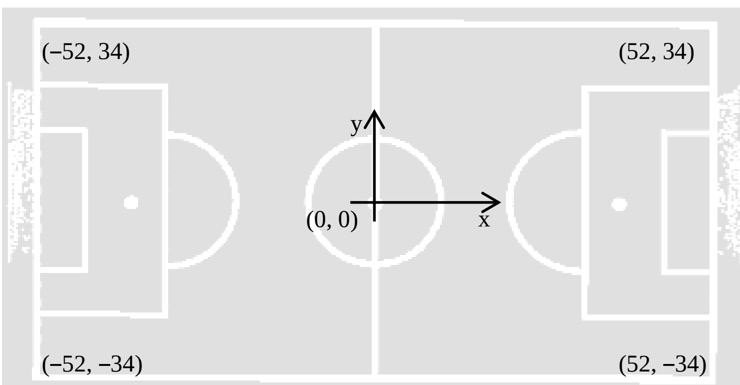

FIGURE 1. **FOOTBALL REFERENTIAL FIELD**

The tracking of the players was accomplished after the calibration, which returned the virtual coordinates into real coordinates per each second, thus providing the Cartesian (x and y) position of players during the match (Figure 1). The whole process associated with this approach (detection and identification of trajectories of players, space transformation and computation of metrics), was performed using the *MatLab* (versionR2013) software. By using this software, it was possible to analyse the data, develop algorithms and create models and applications for this particular study.

For the sake of efficiency, only the time when the ball was in play was considered and all moments when the ball was not in the field (out of bounds) were excluded from the analysis. Since the methodology proposed here has some computational complexity, each second corresponded to an analysed instant for each player and the ball. From the 3 matches, 9218 instants were collected.

Computing the offensive tactical principles

The first concept that had to be developed was the offensive zone definition (ODZ). This concept comes from Costa *et al.* (2009), and consists of the development of a circumference of 5m radius around the ball. Using the centre-of-game, it is possible to identify the closest and farthest players from the ball and the zone of definition. From all this information, a set of metrics can be computed based on the indicators that characterise the effectiveness of the offensive principles of play.

Penetration metric

Two main indicators were used to evaluate the effectiveness of the tactical principle of the penetration metric:

1. The centre-of-game must maintain forward movement at each second, thus the centre-of-game should move to a forward position compared to the immediate previous position.
2. The numeric relationship between the team mates and opponents should not be an inferior one; thus, if the position is 2 against 2 (equality) in the centre-of-game, the next movement cannot pass to a numeric disadvantage (Figure 2).

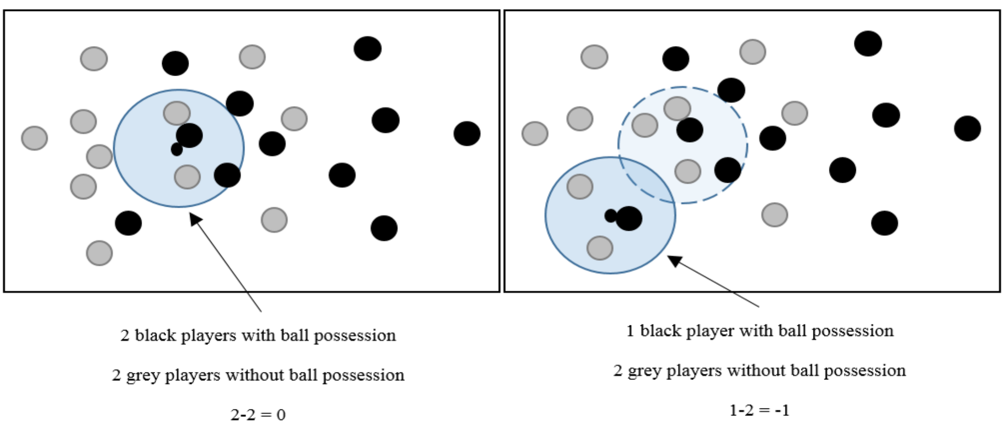

FIGURE 2. **CENTRE-OF-GAME MOVEMENT: EXAMPLE OF NON-PENETRATION EFFECTIVENESS**

Note: The blue circle represents a 5m radius around the ball. A solid line represents the current ball location and a dotted line represents the previous position.

From the effectiveness calculation, the numeric relationship during the match can be analysed, identifying the evolution of better, equal or worse numeric situations. Moreover, from the relative metric the effective penetration ratio can be computed:

$$P_r = \frac{Number\ of\ effective\ penetrations}{Number\ of\ ODZ} \tag{1}$$

This ratio is developed at each iteration and, therefore, it is cumulative.

Width and length offensive principle

The width and length principle depends on the exploitation of all the spaces in the field in order to expand the playing space and create new opportunities to perform the attack (Figure 3). Therefore, two criteria were defined for considering the effectiveness of this tactical principle:

1. At least one forward player performs the mobility principle (the movement of players between the last defender and the goal line (Costa *et al*., 2010). When one team mate offers a line of pass in proximity to the last opposition defender, this will be considered as effective attacking depth mobility. This proximity will be considered as the 5m behind the line of the last opposition defender (considering the x-axis).
2. At least one player who does not perform the mobility principle moves to the position out of the opponents' surface area on the lateral axis (width).

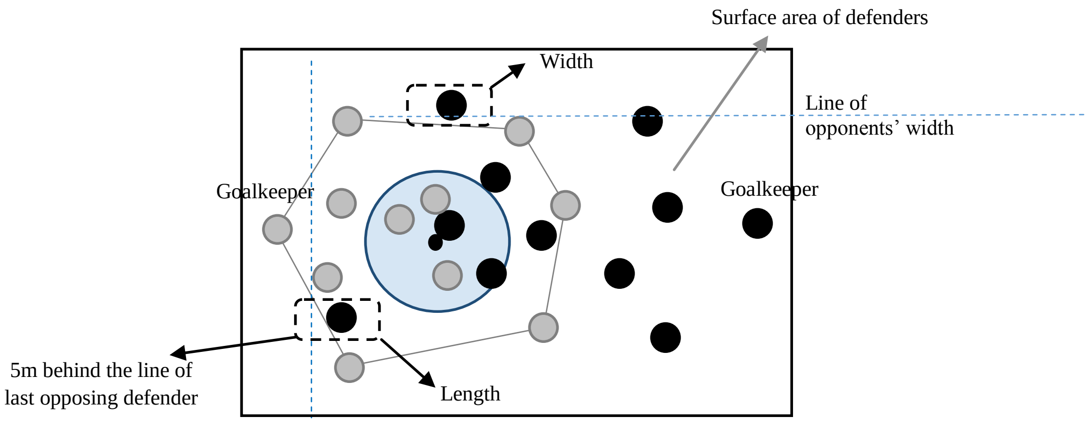

FIGURE 3. **EXAMPLE OF WIDTH AND LENGTH EFFECTIVE MOVEMENTS**

By using this metric, the ratio of the effective width and length principle of play can be computed:

$$WL_r = \frac{Number\ of\ width\ and\ length}{Number\ of\ ODZ} \tag{6}$$

The width and length principle is an extremely important one in play that brings about the expansion of offensive moments by ensuring opportunities to avoid the penetration of the midfield where there are more opposing players. Therefore, the ratio of width and length allows the identification of how the team applies this principle during offensive play.

Offensive unit

The offensive unit was measured using 2 main criteria:

1. Only the players behind the ball's longitudinal line will be considered in this metric.
2. At least half of the players behind the line of the ball always move in synchrony with the ball's trajectory on at least one axis (Figure 4), i.e. if the ball moves to the right and forward, then the player needs to move right or forward.

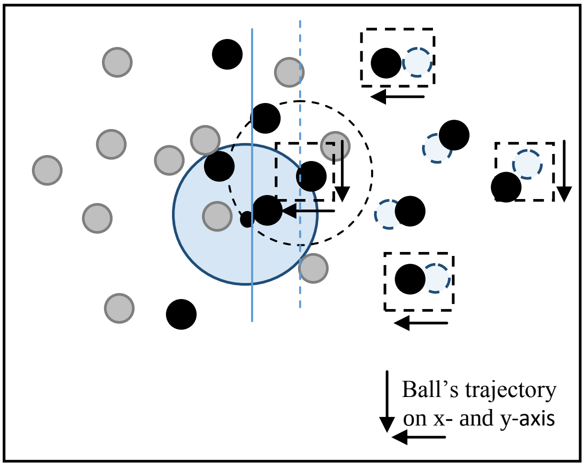

FIGURE 4. **EXAMPLE OF EFFECTIVE OFFENSIVE UNIT**
[Offensive unit following the ball's trajectory once the ball has changed location, forward (in the longitudinal axis) and down (to the middle) on the pitch.]

NOTE: Large solid-line circle = Position of the centre of the game
Large dashed-line circle = Previous positions of the centre of the game
Small dashed-line circle = Previous positions of players
Arrows = Direction change in ball position
Solid vertical line = Current line of ball Dashed vertical line = Previous line of ball

By using this metric, it was possible to count for each offensive play the number of players moving in synchrony with the ball's trajectory and the relative frequency. Moreover, it was possible to develop the following offensive unit ratio:

$$OU_r = \frac{Number\ of\ offensive\ unit}{Number\ of\ ODZ} \qquad (7)$$

This ratio indicates whether the players behind the line of the ball move in synchrony with the ball's trajectories and the centre-of-game. This is very important in preventing the eventual loss of the ball, as well as in giving a closer line of pass to team mates with ball possession.

Statistical procedures

For the descriptive analysis the mean values, standard deviation, minimum and maximum values, and the coefficient of variation were determined. The classification of dispersion using the coefficient of variation was performed using the following scale (Pestana & Gageiro, 2008:114):

Coefficient of variation (%)	Classification of dispersion level
0–15	Low dispersion
15–30	Moderate dispersion
≥30	High dispersion

The box plots for each principle of play were also presented. All statistical procedures were computed in the SPSS statistics software (version 21).

RESULTS

Descriptive statistics were used to inspect the results for the 3 tactical principles. The data on the 3 case-study matches were organised by each half, thus resulting in 6 variables: M1H1 (Match 1 and Half 1), M1H2, M2H1, M2H2, M3H1 and M3H2. Despite this procedure, no statistical differences were found between matches. As can be seen in Table 1, the mean values of the ***penetration*** principle were around 0.42±0.13. The mean coefficient of variation, namely 32.03, was higher than 30%, which suggests a great degree of dispersion from play to play.

TABLE 1. **DESCRIPTIVE STATISTICS OF PENETRATION RATIO**

Variables	Mean±SD	% Coefficient of variation	Minimum	Maximum
M1H1	0.46±0.15	31.35	0.24	0.81
M1H2	0.39±0.12	29.84	0.16	0.65
M2H1	0.41±0.07	17.43	0.24	0.59
M2H2	0.41±0.15	36.82	0.12	0.75
M3H1	0.41±0.15	35.41	0.10	0.77
M3H2	0.42±0.13	32.31	0.11	0.71
Total	0.42±0.13	32.03	0.10	0.81

From the descriptive statistics for the ***offensive space*** principle (Table 2), it is evident that the mean ratio of the 3 matches was 0.80±0.24. It was also observed that the mean for each play ranged from 0.1 to 1 (the maximum). The coefficient of variation was higher than 30% for the majority of matches, suggesting a considerable level of dispersion. Nevertheless, no statistical differences were found between matches.

TABLE 2. **DESCRIPTIVE STATISTICS OF THE OFFENSIVE SPACE RATIO**

Variables	**Mean±SD**	**%Coefficient of variation**	**Minimum**	**Maximum**
M1H1	0.79±0.26	32.82	0.10	1
M1H2	0.72±0.26	35.90	0.18	1
M2H1	0.79±0.26	32.69	0.24	1
M2H2	0.88±0.15	17.27	0.45	1
M3H1	0.84±0.20	23.76	0.36	1
M3H2	0.76±0.29	38.75	0.12	1
Total	0.80±0.24	30.58	0.10	1

The result for the ***unity*** principle suggests that this was accomplished at a high level during the matches (Table 3). The mean value was 0.83±0.19 and the coefficient of variation showed a moderate dispersion of 23%. Nevertheless, no statistical differences were found between matches.

TABLE 3. **DESCRIPTIVE STATISTICS OF UNITY RATIO**

Variables	**Mean±SD**	**% Coefficient of variation**	**Minimum**	**Maximum**
M1H1	0.78±0.19	24.77	0.33	1
M1H2	0.83±0.20	24.13	0.33	1
M2H1	0.87±0.15	17.11	0.50	1
M2H2	0.77±0.22	27.91	0.18	1
M3H1	0.84±0.18	21.41	0.40	1
M3H2	0.87±0.19	21.21	0.41	1
Total	0.83±0.19	23.22	0.18	1

DISCUSSION

The first tactical principle that was inspected was penetration. The main aim of this principle is to ensure that the ball progressed in a forward movement in an attempt to disrupt the defensive organisation of the opponents (Costa *et al*., 2009). To identify the success of this principle, the algorithm proposed considered the forward movement of the ball, as well as the non-deterioration of the numerical relationship with opponents inside the centre-of-game.

It was observed that the mean of the 3 analysed matches was 0.42, suggesting a low level of success. Such a result can be expected by the requirements imposed by this algorithm. In fact, the requirement to ensure the non-deterioration of the numerical relationship inside the centre-of-game reduces the possibilities for accomplishment, as it is natural for the density of defenders to increase as the ball progresses towards their defending goal. Therefore, if the team with the ball moves forward more opposing players will appear in the centre-of-game, thereby reducing the possible numerical advantage of the team with ball possession. In that sense, the possible higher values of this ratio can mean that the strategy of the team is to move the ball forward to areas without a great concentration of opponents, such as to the lateral sides (Dooley & Titz, 2011).

Another principle of play investigated in this case study was the offensive space (width and length). This principle offers the player with possession of the ball some options to take the ball from the middle zone, where there is more opponent pressure, to try to open the space to play at the lateral sides or closer to the last defensive line of opponents (Castelo, 1996). The aim of this principle is to reduce the concentration of opponents in their central zone, thus attempting to open up some spaces to penetrate between the opposing players (Trapattoni, 1999).

A high mean value was observed for the accomplishment of this principle. The ratio of 0.80 for the 3 matches suggests that team mates attempted to ensure this principle during the offensive process. In this case study, the team used 2 forward wings, making it is easier to accomplish this principle because of the strategic position of the 2 players playing in the wings. In other cases, such as the diamond 1-4-4-2, there are not 2 fixed players in the forward wings, thus, it is possible that the space ratio may be smaller than in this specific case. In that sense, it would be interesting in future studies to compare different teams that used different player strategic distributions on the field.

The last principle of play investigated in this case study was that of offensive unity. This principle aims to ensure that there is a reduced space between the different lines of the team (defensive, midfield, forward), thus providing greater and closer support to the player with ball possession. Furthermore, offensive unity ensures that in the case of the loss of the ball, the reduced spaces between the lines will immediately put pressure on the opposing team (Costa *et al*., 2009). Both objectives are very important for increasing the possibilities of success in collective action.

In this case study it was possible to observe a mean of 0.83 in the ratio for offensive unity. Such a result suggests a high degree of synchronisation between team mates following the ball location during the offensive process. The accomplishment of this tactical principle is very important for any strategy adopted by a team. The capability to move players in a synchronised way is essential for improving the collective behaviour and for playing as a team. It is very important that further studies be undertaken on a large sample and on different teams to help us understand how team mates synchronise their movements to achieve the unity principle during the offensive process.

Furthermore, a set of 3 tactical metrics were proposed and their respective ratios measured the tactical behaviour in the offensive processes. By using the Cartesian information about the positions of players and the ball, it was possible to develop automatic metrics that provided information about tactical behaviour. Such metrics mean a step forward to an easier and quicker match analysis process, reducing the time spent by human operators. It was not possible to generalise the results of this case study. Future research should compare a larger sample of teams and matches to investigate differences from team for team. Furthermore, future studies could be expected to identify some of the specific characteristics of each team using these tactical metrics. It would be very important to cross match the information about these tactical metrics with other indicators of match analysis, such as notational analysis and spatio-temporal analysis.

PRACTICAL APPLICATION

Novel estimation, detection and identification techniques have been applied to sport, resulting in the Cartesian positional information of players over time. This information has been considered vital within the sport science literature as it proposes new computational tactical metrics that may allow the investigation of the spatio-temporal relationship between team mates. Such technological approaches can improve the understanding of the collective match, providing coaches and analysts with a real-time augmented perception of the game.

It is suggested that all these new technological metrics need to be understood by a great range of coaches and analysts. A user-friendly system must be the essence of such metrics. Moreover, the opportunity to collect simple and pertinent information should be taken into account for the system to be generalised for the whole football community. There must be a threshold between the complexity of such metrics and the applicability of information for coaches and analysts.

These metrics have a valuable strength in comparison with the semi-automated systems. The use of an integrated system that is totally autonomous from the data retrieval to the data processing makes the use of such analyses possible during official matches or even in daily training sessions without a great effort on the part of a human operator. Nevertheless, one main issue can be mentioned. The system depends on an automatic tracking method that is now too expensive for amateur or even some professional teams. Thus, the tracking method must be prioritised in an integrated system. A solution, such as a single camera or even a low-cost GPS with heart rate monitor, must be considered to reduce the possible costs of such a match analysis system.

To enhance the coaches' visualisation, it is possible to discuss the introduction of Augmented Reality (AR), during daily sessions and games. The possibilities of information provided in real time can actually increase the optimisation of training sessions. From the individual data about physiological responses, time-motion profiles and individual technique of players, to the whole real-time picture about the collective organisation, the possibilities of applying AR to enhance coaches' perceptions are massive. However, it is noteworthy that the available information will always depend on the number of devices and data collected during training sessions and matches.

About this proposal, only in April 2014 it was possible to observe the first system that used the AR glasses during a match. This happened in Spain, in the game Getafe vs Atletico Madrid. With this first trial only notational analyses were visualised. Thus, the natural evolution is the introduction of new collective metrics to analyse the interaction between team mates during the match.

CONCLUSION

In this case study three metrics and ratios were proposed to investigate and estimate the tactical behaviour of football teams. Three automated metrics were developed that were derived from the Cartesian players' positions on the field: penetration; width; and length and unity. From the results it was possible to identify that the highest ratio was achieved for the unity principle in play and the lowest ratio was observed in the penetration ratio. Nevertheless, due to the limited amount of data general conclusions cannot be drawn. Further studies need to be conducted involving an increased number of matches for analysis and comparing the influence of possession of the ball as well. Using current technologies, it would be possible to provide some automated solutions for the investigation of the performance of a team, thus providing new opportunities to develop match analysis systems.

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REFERENCES

ABDEL-AZIZ, Y. & KARARA, H. (1971). Direct linear transformation from comparator coordinates into object space coordinates in close-range photogrammetry. ASP symposium on close-range photogrammetry (1-18). Falls Church, VA: American Society of Photogrammetry.

BOUTHIER, D. (1988). Les conditions cognitives de la formation d'actions sportives collectives [*trans.*: Cognitive conditions for the formation of actions in team sports activities]. Nouvelle thesis, Paris (France): Université Paris, V. EPHE.

CASTELO, J. (1996). *Futebol a organização do jogo: Como entender a organização dinâmica de uma equipa de futebol e a partir desta compreensão como melhorar o rendimento e a direcção dos jogadores e da equipa* [*trans.*: The organisation of football: How to understand the dynamic organisation of one football team and how to improve the understanding of such organisation to improve the performance of players and the team]. Lisbon, Portugal: Jorge Castelo.

CLEMENTE, F.M.; COUCEIRO, M.S.; MARTINS, F.M.; MENDES, R. & FIGUEIREDO, A.J. (2013). Measuring tactical behaviour using technological metrics: Case study of a football game. *International Journal of Sports Science and Coaching*, 8(4): 723-739.

COSTA, I.T.; GARGANTA, J.M.; GRECO, P.J. & MESQUITA, I. (2009). Princípios Táticos do Jogo de Futebol: Conceitos e aplicação [*trans*.: Tactical principles of the game of Soccer: Concepts and application]. *Motriz*, 15(3): 657-668.

COSTA, I.T.; GARGANTA, J.; GRECO, P.J.; MESQUITA, I. & SEABRA, A. (2010). Influence of relative age effects and quality of tactical behaviour in the performance of youth football players. *International Journal of Performance Analysis in Sport*, 10(2): 82-97.

DOOLEY, T. & TITZ, C. (2011). *Football: The 4-4-2 system.* Germany: Meyer & Meyer Sport.

DUARTE, R.; ARAÚJO, D.; CORREIA, V. & DAVIDS, K. (2012). Sports teams as superorganisms: Implications of sociobiological models of behaviour for research and practice in team sports performance analysis. *Sports Medicine*, 42(8): 633-642.

GRÉHAIGNE, J.F. & GODBOUT, P. (1995). Tactical knowledge in team sports from a constructivist and cognitivist perspective. *Quest*, 47: 490-505.

GRÉHAIGNE, J.F.; GODBOUT, P. & BOUTHIER, D. (1999). The foundations of tactics and strategy in team sports. *Journal of Teaching in Physical Education*, 18: 159-174.

GRÉHAIGNE, J.F.; RICHARD, J.F. & GRIFFIN, L. (2005). *Teaching and learning team sports and games.* New York, NY: Routledge Falmar.

HUGHES, M.D. & BARTLETT, R.M. (2002). The use of performance indicators in performance analysis. *Journal of Sports Sciences*, 20(10): 739-754.

METZLER, J. (1987). Fondements théoriques et pratiques d'une démarche d'enseignement des sports collectifes [*trans*.: Theoretical and practical foundations of an approach to teaching team sports]. *Spirales*, 1 (Complément): 143-151.

PESTANA, M.H. & GAGEIRO, J.N. (2008). *Análise de Dados para Ciências Sociais: A complementaridade do SPSS* [*trans*.: Data analysis for the social sciences: The complement of the SPSS]. Lisbon, Portugal: Edições Sílabo.

TEODORESCU, L. (1984). *Problemas de teoria e metodologia nos jogos desportivos* [*trans.*: Theoretical and methodological issues in team sports]. Lisbon, Portugal: Livros Horizontes Lda.

TRAPATTONI, G. (1999). *Coaching high performance football.* Spring City, PA: Reedswain.

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