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INVESTIGATING THE TACTICAL PROFILE OF DEFENSIVE PLAYERS IN ELITE FOOTBALL. A NETWORK THEORY ANALYSIS

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INVESTIGATING THE TACTICAL PROFILE OF DEFENSIVE PLAYERS IN ELITE FOOTBALL. A NETWORK THEORY ANALYSIS

ABSTRACT

Keywords: football, network analysis, match analysis, defenders, goalkeeper

In the present study, a network theory analysis method was applied to examine the effectiveness of defensive players' contribution to the team's possession play and determine their tactical profile. The overall passing data-set was compared to passing data of passing sequences that entered the opposite penalty area. The player, pitch and pitch-player passing networks were investigated. The degree centralities of in, out, betweenness and closeness were used for player networks analysis. The degree centralities of in, out and within were applied to examine the most prominent pitch zones. There were statistically significant differences for degree centrality metrics when considering each defensive player position and passing condition. The main results revealed that the centre-backs were the most integral players to the team's possession play, whereas the goalkeeper contributed the least. For the in-degree metric, the goalkeeper and both centre-backs had a higher effectiveness ratio in the passing sequences that ended up in the opponent's penalty box compared to overall passing sequences. For the out-degree metric, both full-backs possessed a higher effectiveness ratio in the passing sequences that entered the opposite penalty area. For the betweenness centrality, everyone except from the goalkeeper made a greater impact on passing plays that reached the opponent's penalty area. For the closeness centrality, every single defensive player had less influence on the team's passing plays that ended up in the rivals penalty box. The most active pitch zones of the left-wing channel were zone 9, 13 and 17 with zones 16 and 20 on the opposite wing. The left-centre channel had zones 6, 10 and 14 as the most active areas, whereas zones 11 and 15 were the most prominent regions in the right-centre channel. The goalkeepers tended to connect the zones via a mixture of short and long passes. The full-backs were usually positioned higher up the pitch and opted for short backwards or forwards passes or crosses into the box. Both centre-backs preferred to retain ball-possession via short sideways, vertical and backwards passes.

GYNYBINIO PLANO ELITO FUTBOLININKŲ TAKTIKOS VEIKSMŲ ANALIZĖ/PROFILIS. TINKLO ANALIZĖS METODAS

SANTRAUKA

Tinklo analizės metodas buvo pritaikytas analizuojant gynybinio plano žaidėjų (vartininko, dešiniojo krašto gynėjo, kairiojo krašto gynėjo, dešiniojo centro gynėjo ir kairiojo centro gynėjo) efektyvumą bei formuluojant jų taktinius profilius. Bendras žaidėjo perdavimų skaičius buvo palyginamas su to pačio žaidėjo perdavimais perdavimų sekose, kurios pasiekė priešininkų baudos aikštelę. Žaidėjo, aikštės zonų ir žaidėjo-aikštės zonų ryšys buvo nustatytas naudojantis tinklo analizės metodą. Statistinis reikšmingumas buvo nustatytas kiekvienam analizės kintamąjam atsižvelgiant į gynybinio plano žaidėjo poziciją ir perdavimo kategoriją. Rezultatai parodė, kad abu centro gynėjai (kairysis ir dešinysis) buvo svarbiausi komandos gynybinio plano žaidėjai, daugiausiai prisidedantys prie komandos bendro pozicinio puolimo. Aktyviausios aikštės zonos kairiajame aikštės krašte buvo zona 9, zona 13 ir zona 17. Aktyviausios zonos kairiajame centriniame aikštės koridoriuje buvo zona 6, zona 10 ir zona 14. Aktyviausios aikštės zonos dešiniajame centriniame aikštės koridoriuje buvo zona 11 ir zona 15. Aktyviausios aikštės zonos dešiniajame aikštės krašte buvo zona 6 ir zona 10. Vartininkų žaidimo stilius turint kamuolį rėmėsi į trumpus perdavimus, kurie buvo skirstomi į

šalia esančias zonas arba ilgus perdavimus į zonas esančias varžovų aikštės pusėje. Abu krašto gynėjai dažniausiai užimdavo pozicijas priešininkų aikštės pusėje, paskutiniajame trečdalyje arba arti jo ir rinkdavosi atlikti trumpus perdavimus atgal arba toje pačioje zonoje, kai kurie kraštiniai gynėjai labiausiai koncentruodavosi į perdavimų atlikimą į baudos aikštelę. Abu centro gynėjai rinkosi įžaidinėti kamuolį atliekant trumpus horizontalius perdavimus į šalia esančias zonas arba trumpus vertikalius perdavimus į priekį.

INTRODUCTION

Football is a team sport where all four entities including the goalkeeper, defenders, midfielders and forwards have to work in synchronization to operate efficiently as a unit (Lusher et al., 2010 as cited in Clemente et al., 2016). However, it can be argued that some entities or some parts of the entity used to be treated or are treated as having more responsibility in certain phases of play than others. According to Wallace and Norton (2014), football has experienced some major changes over the past four or five decades in terms of its structure, game speed and playing patterns. It is safe to say that all these changes were only possible due to improved technical, tactical and physical abilities of players. As stated by Wallace and Norton (2014), the passing rate has shown the most significant changes increasing by 35% overall from 1966 to 2010. It denotes that the most influenced area of the game has been the utilisation of ball-possession.

Since a big part of a modern game is based around possession style of play (Collet, 2012), it can be argued that some entities were more prone to experience a need to broaden their playing profile. The goalkeeper and defenders can be described as the two entities of a football team that seem to have come to the fore when talking about their importance in the possession-based game. The reason for that is simple as the goalkeeper and defenders are the ones who start the build-up play in the defensive third (Williams, n.d.). However, most research studies have been investigating football teams as a complete mechanism regarding ball-possession (Collet, 2012; Jones, James & Mellalieu, 2004; Hughes & Franks, 2005; Lago & Martin, 2007). Consequently, none of them investigated the tactical profile of a single unit of players using the passing distribution data and assessing the effectiveness of that specific unit of players.

Traditionally, the most common tool used to investigate the passing distribution has been notational analysis (Hughes & Bartlett, 2002). However, using this approach to analyse passing distributions on its own usually lacks contextual information (Rein & Memmert, 2016). According to Carling, Williams and Reilly (2007) notational analysis can be defined as a method for recording events that take place on the pitch. However, for this study, the notation of events on its own would not explain which players and which passing sequences are more important. For this reason, a complementary tool that would compensate for the scarcity of contextual information when applying a traditional notational analysis concept has to be used.

Social network analysis can be regarded as such a tool that provides contextual information to the passing distribution data-set (Clemente et al., 2016). In a field of team sports, a concept of social network analysis refers to the interactions between the players via passing links (passes received and performed) that define the organisation of a team (Buldu et al., 2018). The main advantage of using the social network concept in football is that it permits the incorporation of social hierarchy to individual level measures (Lusher, Robins & Kremer, 2010). Some players are more influential than others and social network analysis considers that rather than assuming that each player contributes equally to the team (Lusher et al., 2010).

Nevertheless, just like any theoretical concept, social network analysis is susceptible to having limitations. So far, research studies on network analysis in football used overall passing data as a way to investigate individual players' metrics (Clemente et al., 2015; Mendes, Clemente & Mauricio, 2018; Gama et al., 2014; Gama et al., 2016). Unfortunately, the problem with such an approach is that majority of situational information is discarded. Clemente, Martins, Wong, Kalamaras and Mendes (2014) found that the midfielder is the prominent player in the overall passing network of the team showing the highest centrality values. However, this conclusion lacks contextual considerations regarding the effectiveness of passes for specific sequences. Therefore, the importance of specific players for the team can be evaluated by breaking down the overall passing network into a more contextual one. This allows to assess whether the effectiveness of the players passing distribution decreases or increases with the inclusion of situational game context.

The contextual element regarding overall passing distribution is not the only issue in network analysis research. McLean, Salmon, Gorman, Stevens and Solomon (2018) further criticise football research due to lack of match context in respect of pitch zones where possession can be tracked. If looking specifically at network analysis, only three studies investigated the most prominent pitch locations and connectivity between them (Clemente et al., 2016; Mclean et al., 2018; Vives et al., 2018). For this reason, the present study will not just add value to the limited research in this area but also by analysing the connectivity between the zones will establish the tactical profiles of defensive players.

Considering the reasons outlined in the earlier sections, the main aim of this study was to evaluate the effectiveness of defensive players' participation in the team's passing sequences concerning their passing networks and pitch zones' connectivity that overall determines the tactical profile of defensive players. The analysis is two-folded: 1) Comparing the defensive players' overall passing data with the data of passing sequences that ended up in the opponent's penalty area using degree centralities of networks. 2) Investigating the distribution of passes by defensive players over the zones of the pitch determining the zones with highest incoming and outgoing passing activities as well as the best-connected zones.

This study has both scientific and practical value of work. No study so far has investigated defensive players as a separate entity in the networks' context. Furthermore, as stated previously, only three studies incorporated the analysis of pitch locations as part of passing networks investigation. This would further deepen the knowledge in the aforementioned field of study.

As for the practical value of work, the present study aims to interpret the findings in a way that would apply to what supporters, coaches and players see in the actual game. Identifying whether the full-backs are more attacking or defensive-minded or the centre-backs tend to be more reserved on the ball or aim for more penetrative passes can bring practical value.

1. LITERATURE REVIEW

1.1 A network theory concept

Over the last few decades, Network Science has emerged as an interdisciplinary field of study to model different real world systems (Zaidi, Muelder & Sallaberry, 2014). It has the power to represent a wide variety of systems such as people related through social systems (Zaidi et al., 2014). One of the sub-systems of Network Science which has attracted a lot of practical and research attention in recent years is Social Network Analysis (Zaidi et al., 2014). This sub-part specifically focuses on the social relationships and the interconnected behaviour of different entities with people being at its core (Zaidi et al., 2014). The research, in particular, emphasises the social science analytic approach to a social network that is integral to Social Network Analysis (Lusher et al., 2010).

The technical concept of Social Network Analysis is based on Graph Theory (Barners & Harary, 1983 as cited in Clemente, Martins & Mendes, 2015). It is a mathematical construct where a set of nodes are connected by edges (Clemente et al., 2015). The relations between the nodes in Graph Theory, from a mathematical standpoint, are described by graphs that represent networks (Pavlopoulos et al., 2011 as cited in Clemente et al., 2015).

There are four types of graphs including unweighted graph, unweighted digraph, weighted graph and weighted digraph (Pavlopoulos et al., 2011 as cited in Clemente et al., 2015). An unweighted graph consists of two sets V and E where V is a set of nodes and E is a set of edges and each edge has a set of one or two nodes associated with it, which are called its endpoints and an edge is responsible for jointing its endpoints (Gross & Yellen, 2004 as cited in Clemente et al., 2015). An unweighted digraph is built on the same concept with the only difference being that it is directed meaning that it has a direction or is linked to a specific node (Gross & Yellen, 2004 as cited in Clemente et al., 2015). A weighted graph has the same concept as an unweighted graph but an edge, in a weighted graph, connecting the two nodes has a specific strength assigned to it (Wasserman & Faust, 1994 as cited in Clemente et al., 2015). Finally, a weighted digraph has not only a strength assigned to its edges but also a direction to a specific node (Gross & Yellen, 2004 as cited in Clemente et al., 2015).

The Social Network Analysis can be further broken down into micro and macro levels of analysis (Clemente et al., 2015). For this study, the emphasis should be placed on micro analysis that refers to the centralities of the actor in the group (Clemente et al., 2015). The centrality, as a metric, is related to the number of edges associated with a node, without special regard to the direction of the edge (Silva, Nguyen, Correia, Clemente & Martins, 2018). There is more than one centrality that can measure actor's prominence among other members but the four main ones are in-degree centrality, out-degree centrality, betweenness centrality and closeness centrality (Clemente et al., 2015).

An in-degree centrality is defined as the propensity of an actor to be nominated by others, whereas an out-degree refers to the propensity to reach out and connect with others (Lusher et al., 2010). An actor who shows higher values in both in and out-degree centralities is considered as a key figure within a group (Clemente et al., 2015). In regard to other two centralities, closeness centrality measures the geodesic distance of the connections of a node to all other nodes with betweenness centrality measuring the ratio of shortest paths that pass through the node (Silva et al., 2018). An actor possessing higher closeness centrality values is related to having a lower average distance to all other nodes (Silva et al., 2018). Likewise, an actor with a higher betweenness centrality value is considered as having a higher measure of control and acts as a bridge when connecting the other nodes (Silva et al., 2018).

As mentioned in the beginning, networks focus on relationships between the actors within the entity; thus, it can be further applied to other areas like team sports that possess similar social dynamics.

1.2 The application of Social Network Analysis to football

Football is a team sport where a collection of players work in synchronism to achieve common goals (Lusher et al., 2010 as cited in Clemente et al., 2015). For this reason, the team can be perceived as a social network structure where players constantly interact with each other by receiving and sending information (Clemente et al., 2015). The way the players can send and receive information within the network structure is via passing links turning the structure into a passing network (Clemente et al., 2015). In the passing network structure, the players are defined as nodes and passes as edges that connect the players (Pena & Touchette, 2012). The passing networks of a team are always directed (links between players go in one direction) and weighted (the weight of the links is dependent on the numbers of passes interchanged between the players) that make it a weighted digraph (Buldu et al., 2018).

The general concept of passing networks in football can be further divided into four different types: team passing networks (Clemente et al., 2015); player passing networks; pitch passing networks; and pitch-player passing networks (Buldu et al., 2018). Starting with the passing networks of the whole team, it helps to obtain immediate information about the team's style of play determining which areas of the pitch are overused or underused or detect certain problems between specific players (Buldu et al., 2018). The most common network metrics computed for the whole team analysis are total links, density and homogeneity (Clemente et al., 2015). As a whole, they look at the team's ball circulation determining the level of involvement of all players (Clemente et al., 2015). It can be stated that an overall team network is a good platform for more detailed analysis.

The overall network structure of a team can be further investigated as a microscale seen as player passing networks (Buldu et al., 2018). It allows to assess the individual level of contribution of each player in a team from centrality measures (Pena & Touchette, 2012). One of the ways to identify the importance of a player for the team is by looking at their degree centralities (Cotta et al., 2013 as cited in Buldu et al., 2018). An out-degree centrality corresponds to the passes made by a player while an in-degree centrality focuses on passes received (Clemente et al., 2015). In the context of football network analysis, a higher out-degree value means more passes performed by a player considering all the players (Clemente et al., 2015). On the other hand, a player with a higher in-degree value receives more passes when taking into account every single player of a team (Clemente et al., 2015). Even more specifically, a larger out-degree score means that a player contributes more to the team's offensive play, whereas a higher in-degree measurement denotes player's popularity since the teammates are mostly looking for that specific player (Clemente et al., 2015). Finally, the other two individual metrics that describe certain characteristics of the player's performance are closeness and betweenness centralities (Pena & Touchette, 2012). The former measures how easy it is to reach the player via passes whilst the latter looks at how integral the player B is for the ball flow between players A and C (Pena & Touchette, 2012).

Another way to deepen the analysis of the team's performance is by looking at the pitch passing networks (Buldu et al., 2018). In this case, nodes represent the pitch locations that are connected through passes made by players (Cintia et al., 2015 as cited in Buldu et al., 2018). Mclean et al. (2018) claim that tracking possession through different pitch zones is often a missing component in match analysis methods. It enables to determine the most and least used regions that can indicate the team's style of play (Mclean et al., 2018).

Along with pitch passing networks, a player's position at the time of a pass can be added to pitch zones making it a combination of pitch-player passing network (Cotta et al., 2013 as cited in Buldu et al., 2018). It allows to capture the dynamics of players passing choices that can provide rich information on which specific zones are the most prominent among certain players' positions. The pitch passing approach alone containing incoming and outgoing passes from the zones does not portray the main players performing the passes, it only depicts the zones (Cotta et al., 2013). Therefore, the addition of players to the zones complements the analysis of possession tracking through pitch locations.

1.3 Current research in football network analysis and its problems

One of the studies that dwell into football networks and specifically individual player networks was conducted by Clemente et al. (2015). It investigated interactions between the players across the team based on their playing positions and team's tactical line-up using in-degree, out-degree, closeness and betweenness metrics for measurement. The results revealed that the central midfielders possessed the highest average values in all four metrics for most tactical line-ups with 3-5-2 formation being the only exception. The investigation showed some interesting results; however, the lack of contextual information does not allow to fully interpret the findings. The central midfielders possessed the largest centrality scores based on all passing sequences.

However, the highest scores do not necessarily mean that the player was the most effective among all others. No other contextual variables were used in this study that would provide more details with respect to passing distribution and subsequently the importance of certain players for the team.

A slightly more contextual study was conducted by Mendes et al. (2018). The authors aimed to analyse network centrality levels in correlation to general variables of elite and highly-competitive young players over the periods of a full-season. The network variables consisted of total links, network density, in and out-degree centralities and betweenness centrality. In addition, goals scored and conceded and the final score were also taken into consideration to assess possible correlation. The findings revealed that central midfielders were the most prominent players in the elite and U19 team in mid-season, whereas centre-backs of U15 and U17 teams showed the highest centrality scores at the start and end of the season. Moreover, there were positive correlations between network density and final score and negative correlations between density and goals conceded.

On a positive note, a larger time span and inclusion of general performance variables allowed to explore the results from a broader point of view. However, only the overall passing sequences were considered that ruled out the possibility to evaluate the effectiveness of players' passes during different phases of play.

The following study conducted by Mclean et al. (2018) analysed the passing networks of goals scored at the 2016 European Football Championship (EURO 2016). Individual players were not emphasised as the study looked at the team's goals scoring passing networks in conjunction with match status, stage of the competition, and division of successful and unsuccessful teams. Most importantly, the authors also explored the most prominent pitch zones by assigning degree centralities to them. The study revealed significant differences for macro network metrics (density, cohesion and sociometric status) with a change in match status and for micro network metrics (in, out and within-degree centralities) in relation to pitch locations. In terms of the most active and passive zones for incoming and outgoing passes, zone 4 (closest to the opposition's goal) showed the largest degree centralities out of all four zones. Conversely, zone 1 (closest to your own goal) possessed the lowest values in all degree centralities compared to other zones.

Even though the study revealed some interesting findings the analysis was limited to only goals scored passing networks. The inclusion of overall passing networks and its comparison with goals scored passing networks could have provided valuable insight into mechanisms of team's offensive play.

Another study that looked at the progression of attacks through different pitch locations using networks concept was conducted by Vives, Martin, Hileno, Torrents and Ric (2018). The passing dynamics of the Spanish football club RCD Espanol over two seasons were determined by the interactions between different pitch regions in relation to the area of ball recovery. Only the passing plays that consisted of no more than five passes and lead to a shooting opportunity were analysed. The results showed that when the ball was recovered in Espanol's own half, the most prominent areas for recovery were the central defensive areas. Consequently, the most likely passing actions also took place in the same zones. In contrast, after regaining ball possession in the outer flanks, the most probable passing option was down the same flank into opponent's half. Moreover, when the ball was won back in the team's own half, the central zones in the final third were more accessible from the central corridors rather than flanks. For the shooting opportunities, zone 2 in the final third (the left side of the penalty area) was the leading area when Espanol recovered the ball in their own half. Conversely, when the Spanish side regained ball possession in the opponent's half, zone 3 (the right side of the penalty area) lead the way for shots taken.

The reviewed study, however, did not highlight the players who took part in the passing sequences. As a result, it fails to emphasise the importance of particular players for ball progression from one region to another. The analysis of the pitch regions on its own lacks the contextual depth that is crucial to better understand the involvement of players in sequences of possession play.

A similar study to Mclean et al. (2018) was carried out by Clemente, Martins and Mendes (2016). The authors investigated the passing networks of scored and conceded goals by a single Portuguese team. It aimed to find out the connectivity levels between team members and pitch zones considering only the attacking plays that resulted in a goal scored or conceded. Network metrics of clustering coefficient, in and out-degree centralities and closeness and betweenness centralities were assigned to the players and pitch regions. The results revealed that the attacking midfielder, right and left forwards had the highest in-degree values, whereas the largest out-degree score belonged to the right-back. In terms of the betweenness and closeness scores, the former was found to be the highest in both wide forwards with the attacking midfielder and the striker possessing largest closeness centrality value. In the case of pitch zones, the central zones closest to the opposition's goal showed the highest in-degree centrality value in the goals scored passing sequences. The wide areas and the central attacking midfield region were those with the highest out-degree score. Additionally, in the goals conceded passing plays, the regions closest to the goal possessed the largest in-degree score showing similar results to the goals scored sequences. The highest out-degree value was recorded for the regions 14 (central attacking midfield) and 15 (wide area) in the same sequences of goals conceded.

In this paper, the authors chose a more specific approach that complements the traditional method of network analysis that tends to focus only on overall passing data. However, as in the previous studies, the comparison between the selected passing sequences and overall passing distribution is missing. It would allow to analyse the changes in players' passing dynamics and their contribution to specific patterns of play while still considering the overall tendencies coming from the full passing sequences. Besides that, the study is also missing the information on which players tend to connect with which zones. Knowing that can provide a more in-depth view on how the team and its players use ball possession in certain phases of play.

All things considered, the key issues with the above mentioned studies mainly revolve around the aspect of specificity. None of them explored how only a single specific sub-group (the goalkeeper, defenders, midfielders or forwards) operates within the team creating a potential profile for that specific sub-group within the overall network of the team. It would determine how important or not that particular sub-group is for the team's ball progression with regard to its passing sequences. Additionally, a few studies did include pitch zones in relation to network metrics analysis; however, it greatly lacked specificity regarding the pitch zone and player connectivity where players' incoming and outgoing passing destinations are emphasised (which player chose to pass the ball to which zone). As mentioned previously, the present study will try to eliminate the limitations observed in previous work.

2. RESEARCH METHODOLOGY AND ORGANISATION

2.1 Research object

The mean differences between the defensive player position for two passing conditions were examined. The two independent variables were passing condition and player position. The independent variable of the passing condition was assigned to the *within-subjects* factor and had two levels: overall passes and passes of passing sequences that entered the opposite penalty area. The independent variable of player position was assigned to the *between-subjects* factor and had five levels: the goalkeeper, the right-back, the right centre-back, the left centre-back and the left-back. The dependent variable of this study was the degree centrality metric (in, out, closeness and betweenness).

2.2 Research strategy and logic

A number of studies found that shots taken from inside the penalty box are more effective than those taken from outside (Acar et al., 2009; Bergier, Soroka, & Buraczewski, 2008; Grant, Williams & Reilly, 1999 as cited in Ruiz-Ruiz, Fradua, Fernandez-Garcia & Zubillaga, 2013). It indicates that entering the penalty area is one of the key objectives when having ball possession since it has the potential to end up in a shot and eventually a goal. Additionally, Ruiz-Ruiz et al. (2013) found that winning teams received significantly fewer penalty area entries than losing teams. However, even though the key performance indicator of penalty area entries is a valid measurement for the effectiveness of offensive actions, only counting the number of times the team enters the opposition's penalty box can miss important contextual information. According to Gama, Dias, Couceiro, Sousa and Vaz (2016), if a limited approach is used, it fails to consider both the dynamics of the whole team and certain inter-players' interactions when in possession that may lead to a certain outcome. For this reason, the strategy used for this research was to accompany the entries into the penalty area with network theory.

The logic behind this was already explained to some extent in the introduction section. Adding to that, the implementation of network concept into the analysis of players' passing sequences provides an element of contextuality that assists in determining the effectiveness of players' contribution. For this reason, the comparison between defensive players' full passing data set and passing sequences involving defensive players that ended up in the penalty area was carried out. Using the networks' principle, this comparison considers the level of players' engagement in passing interactions that can lead to successful collective actions (Gama et al., 2016) that can be seen, in this case, as the penalty area entrances.

Along with it, the pitch-player connectivity was investigated for the passing sequences that entered the opponent's penalty box. The most connected pitch zones in terms of passes expressed by network degree centralities was the chosen method. The logic for that was to determine the ways the defensive players opt to contribute to the team's overall possession play when trying to reach the opposing penalty area. Finally, the logic for analysing only defensive players came from the fact that the team's build-up play usually starts from its defensive third where the goalkeeper and defenders are positioned and begin the possession play. Consequently, the increased prevalence of possession-based game plan suggests that the goalkeeper and defenders can be of pivotal importance to the team's passing networks and their effectiveness.

2.3 The nature of research

The present master's thesis falls under the category of observational studies to collect and organise the data in order to carry out the subsequent analysis. Observation is seen as a particular systematic strategy of the scientific method that quantifies the spontaneous behaviour which is perceived in its usual context (Casal, Maneiro, Arda, Mari & Losada 2017). It requires that a series of stages such as problem definition, study design, data collection and data analysis are implemented in order to achieve the results (Casal et al., 2017). For this reason, a systematic observation can be seen as an effective and objective tool to collect information and identify the most relevant events that occur during a game of football (Carling, Reilly & Williams, 2009 as cited in Casal et al., 2017).

The observational methodology can be further split into specific methods for data collection and analysis. Qualitative, quantitative or mixed techniques all go in hand with observational methodology (Casal et al., 2017). In respect to the qualitative method, it focuses on the gathering of non-numerical data that looks for deeper meaning (Maruster, 2013). Traditionally, interviews or focus group discussions have been the most commonly used data collection methods for qualitative research (Maruster, 2013). However, recently video analysis has emerged as a fresh alternative to traditional qualitative research methods (Ramey, Hilppo, Dyer & Krist, 2017). According to Jacobs, Kawanaka and Stigler (1999), video data can be used as both qualitative and quantitative research tools that allow for a unique cyclical analytical process consisting of watching, coding and analysing the data.

In the case of this master's thesis, the process of using video analysis to record and code the passing sequences that entered the penalty area can be identified as a mixture of qualitative and quantitative techniques. Video observation was crucial for selecting only necessary passing sequences indicating the qualitative method, whereas the codification of those sequences can be seen as a way of quantifying them. Adding to that, the visual analysis of the network graphs can be described as a qualitative technique as well. Maruster (2012) pointed out that content analysis of visual material is one of the techniques of the qualitative analysis tool. The visual network graphs of a team's overall passing network and network with passing sequences that ended up in the opposition's penalty box are perfect to visually inspect and assess the changes of players' involvement in the game.

In terms of the quantitative method, it focuses on numerical indicators that can be quantified and counted (Poizat, Carole & Saury, 2013). In the case of this master's thesis, the codification of passing sequences and computation of network variables were all part of the quantitative analysis technique. Additionally, the process of quantifying the passing data can be identified through the semi-computational approach (Clemente et al., 2016). Such a system requires a human operator who is responsible for collecting, storing, and analysing data (Clemente et al., 2016). The video software used for notating the passing sequences together with the network analysis software for computation of network metrics both fall under the semi-computational approach in this regard. In essence, the present master's thesis used an observational methodology accompanied by mixed qualitative and quantitative methods based on semi-computational approach.

2.4 The research sample and sampling procedure

2.4.1 Sample

Twenty-nine official matches of the 2017/18 UEFA Champions League knockout stage were analysed in this study. These were the matches of 16 teams that progressed from the group stage to the knockout stage which consisted of round-of-16, quarterfinals, semi-finals, and the final. As a result, a total of 58 player adjacency matrices were generated from the coded passing sequences that entered the opponent's penalty area. Moreover, the overall passing distribution data from all 29 matches were obtained from the official UEFA website. Consequently, another 58 player adjacency matrices were generated from the overall passing data. The analysed defensive players were the goalkeeper, the right-back, the right centre-back, the left centre-back and the left-back. The centre-defender in a back three system was excluded from the analysis since only two teams played with a back three system making it a disproportionate analysis.

In addition to player adjacency matrices, a total of 58 pitch zone adjacency matrices were generated using the data retrieved from the passing sequences that ended up in the opponent's penalty box. All in all, a total of 98 defensive players (80 defenders and 18 goalkeepers) were analysed.

2.4.2 Procedures

For the purpose of this study, the overall passes and passes of sequences that entered the opponent's penalty area were investigated. According to Ruiz-Ruiz et al. (2013), an entry into the penalty area is defined as an action that takes place when the team having possession of the ball passes the ball into the opposition's penalty area having a teammate receiving the ball there (taking a touch and controlling it) or if a player carried the ball into the opponent's penalty area (the last action was not a pass). A key thing to note is that if a pass that reached the penalty area was not received by the team's own player inside the opponent's penalty box (the ball went through the area with no one stopping it or it was cleared away by the opponent), such passing sequence was discarded. Additionally, in cases when the ball was delivered straight into the box, for example, from a free-kick or a corner-kick, these passing sequences were also discarded.

In order to carry out the analysis of passing networks, an adjacency matrix that represents the connection between the node (player) and an adjacency node (teammate) has to be built (Clemente, Martins, Kalamaras, Wong & Mendes, 2015). In the case of football network analysis, the connection between the nodes is defined as a pass (Clemente et al., 2015). Every time the player performs a successful pass to his teammate, it is codified as 1 (Clemente, Martins, Kalamaras, Oliveira, Oliveira & Mendes, 2015). If more than one pass is performed to the same teammate, it is codified based on the number of passes performed (Clemente et al., 2015). If no passes are performed between the players, it is codified as 0 (Clemente et al., 2015). Consequently, each interaction between the teammates contributes to the unit of attack that is described as a passing sequence starting with a successful pass and ending when the team loses ball possession (Clemente et al., 2015). An example of a passing sequence until the ball is lost can be seen in Figure 1.

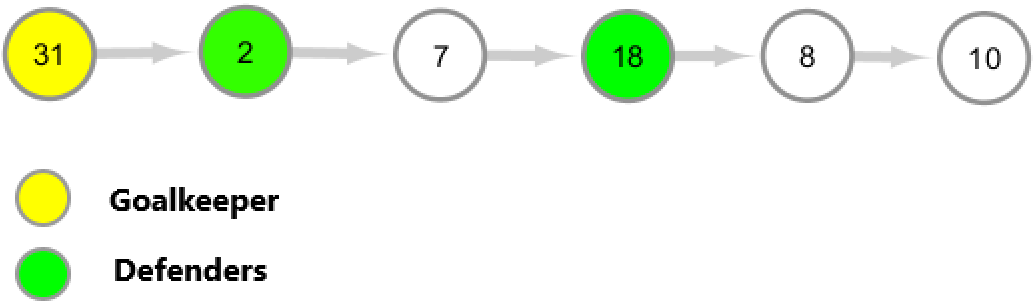

Figure 1. Example of data collecting. Passing sequence (single unit of attack) that entered the penalty area involving defensive players

Once all the passing sequences are coded, an overall adjacency matrix summing up all of them is generated (Clemente et al., 2015). In respect to this paper, an overall adjacency matrix based on overall passing data-set for each team was already generated by the UEFA in their post-match reports. However, an overall adjacency matrix for each team based on passing data of sequences that only entered the penalty area had to be generated manually using the above mentioned technique. An example of an overall adjacency matrix and its visual network graph can be seen in Table 1 and Figure 2, respectively.

Table 1. Example of data coding representing an overall adjacency matrix of passing sequences that entered the penalty area involving defensive players (highlighted in bold)

	P31	**P2**	**P4**	**P7**	**P8**	**P10**	**P17**	**P18**	**P20**	**P25**	**P30**
P31	-	0	0	0	**1**	0	0	0	0	**1**	0
P2	0	-	**1**	0	0	**1**	0	0	**2**	**1**	**1**
P4	**1**	**1**	-	0	0	0	0	0	0	0	**3**
P7	0	0	0	-	0	0	0	0	0	0	0
P8	0	0	0	0	-	0	0	0	0	0	0
P10	0	0	0	0	0	-	0	0	0	0	0
P17	0	0	0	0	0	0	-	0	0	0	0
P18	0	**1**	0	0	0	0	**1**	-	0	**1**	**2**
P20	0	0	0	0	0	0	0	0	-	0	0
P25	0	0	0	0	0	0	0	0	0	-	0
P30	0	0	**1**	**2**	**1**	0	0	**3**	0	0	-

* P-player; 00-player shirt number

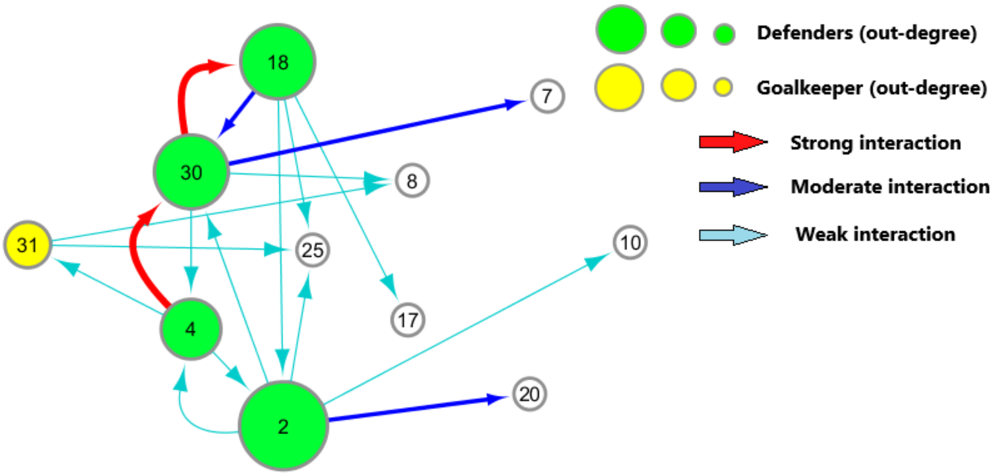

Figure 2. Example of visual network graph representing an overall adjacency matrix of passing sequences that entered the penalty area involving defensive players

* The size of the node and thickness of the arrow both refer to the out-degree value (performed passes) that denotes the level of contribution from the player to the network in terms of passes

Along with the players' adjacency matrix, an overall pitch zone adjacency matrix for each team was generated based only on passing data of sequences that entered the opponent's penalty area. Additionally, a pitch-player adjacency matrix for each defensive player position was also generated based on the data of passing sequences that ended up in the opposition's penalty area. The same codification method as for player adjacency matrix was used to generate pitch zone adjacency matrices. A pass from one zone to another or within the same zone was codified as 1, with no passes between certain zones or within the same zone codified as 0. If there was more than one interaction between different zones or within the same zone, the number of interactions were codified. An important thing to note is that a pass between zones was codified only if a player received the ball and fully controlled it. A pass that only travelled through the zone but did not stop in the zone was not considered.

Continuing a theme of pitch zones' networks, the playing football field was divided into 24 zones to carry out the analysis of pitch zones' and pitch-player connectivity (Figures 3 and 4). Zones 1; 5; 9; 13; 17 and 21 belong to left-wing. Zones 2; 6; 10; 14; 18 and 22 belong to left-centre corridor. Zones 3; 7; 11; 15; 19 and 23 belong to right-centre corridor. Zones 4; 8; 12; 16; 20 and 24 belong to right-wing. Additionally, zones from 1 to 8 belong to the defensive third, zones from 9 to 16 to the middle third, and 17 to 24 to the attacking third.

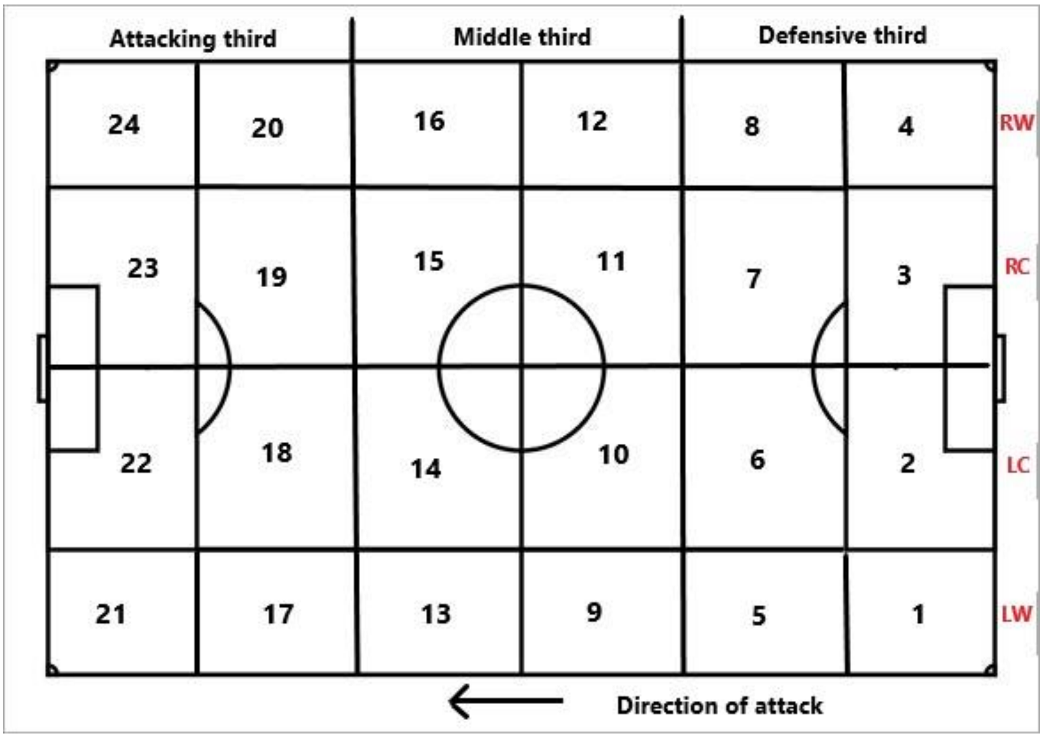

Figure 3. Football field divided into 24 zones. Direction of attack: from right to left. Adapted from Gama et al. (2014)

*LW – left wing; LC – left centre; RC – right centre; RW – right wing

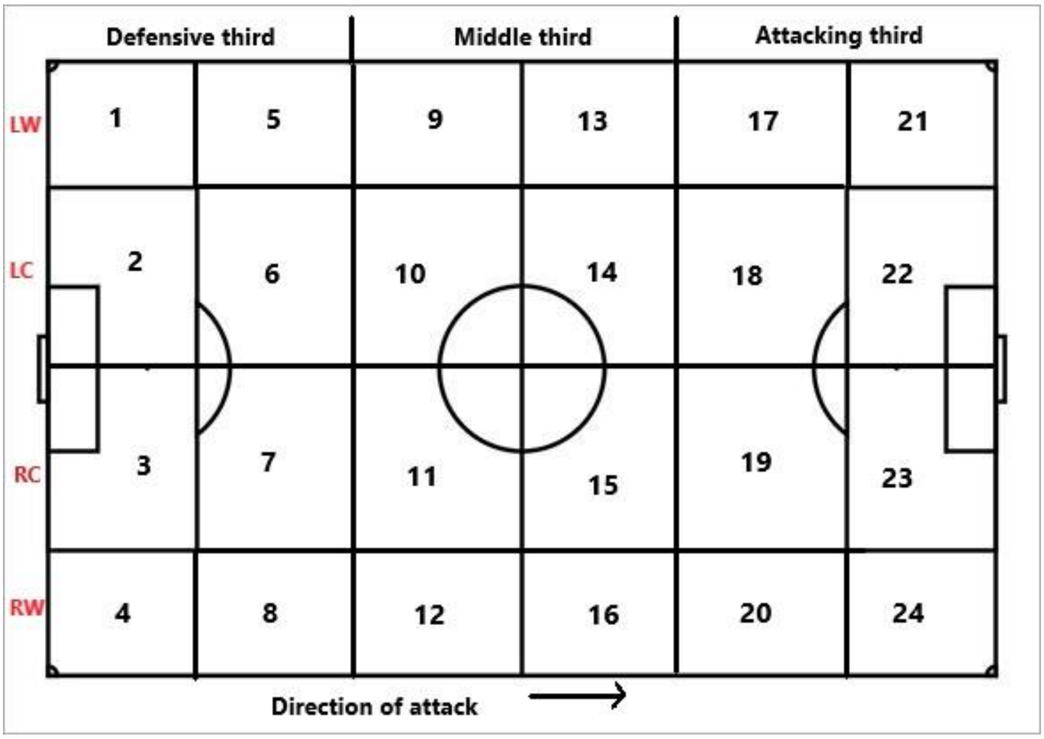

Figure 4. Football field divided into 24 zones. Direction of attack: from left to right. Adapted from Gama et al. (2014)

*LW – left wing; LC – left centre; RC – right centre; RW – right wing

The network metrics were developed for the passing sequences of overall data-set and a sample of sequences that ended up in the opponent's penalty area. The three sets of metrics were computed: 1) Player metrics 2) Pitch zone metrics 3) Pitch-player metrics.

In respect to player metrics, four centralities were selected to evaluate defensive players' performance. Firstly, the centrality of in-degree was measured that looks at the passes received by a player (Trequattrini, Lombardi & Battista, 2015). It determines the popularity of a player with a higher number of passes received meaning a more popular figure (Trequattrini et al., 2015). Secondly, an out-degree variable was computed that measures the passes performed by a player (Trequattrini et al., 2015). The more important the player is for distributing the ball, the higher the out-degree value (Trequattrini et al., 2015). Thirdly, the betweenness centrality was looked at to determine how often a player is situated between teammates, thus showing players who act as a link (Mendes et al., 2018). A higher betweenness score indicates that a particular player is key for connecting other players in a team (Clemente et al., 2016). Fourthly, the closeness score allows to determine how easy it is to reach a player in a team in terms of passes (Pena & Touchette, 2012). A player possessing higher closeness score is easier to access via passes (requires fewer passes to be reached by teammates) than a player with a lower score (Pena & Touchette, 2012).

For the pitch zone analysis, the zones represent the nodes allowing the analysis of passes in, out and within the zone (Mclean et al., 2018). In this case, degree centrality metrics were measured to evaluate zone importance. Firstly, an in-degree metric was computed that counts the number of incoming passes to the zone (Mclean et al., 2018). A higher number of passes entering a certain zone denotes that to be a target zone (Mclean et al., 2018). If very few passes reach a specific zone, it can be described as a neglected or ignored region of the pitch where the play does not take place very often (Mclean et al., 2018). Secondly, an out-degree centrality computed the outgoing passes from one zone to another (Mclean et al., 2018). A pitch region that records more outgoing passes automatically holds a higher out-degree score indicating a prominent zone for distributing the ball to other zones (Mclean et al., 2018). Lastly, a within degree centrality was measured to identify the most prominent intra-zones (Mclean et al., 2018). It means that the passes performed within the same zone were taken into consideration. A large within score suggests slower ball movement and progression of play since more than one player is positioned in the same zone (Mclean et al., 2018).

2.5 Research methods

As it has been mentioned in the previous segment, the observational methodology was chosen for this master's thesis. The main advantage of such a methodology is that it allows the data to be collected directly from playing participants in the competition (Casal et al., 2017). Following this concept, the passing sequences involving defensive players that resulted in penalty area entries were collected for this study. Every single aforementioned type of passing sequence was observed from the footage and afterwards entered into the Excel spreadsheet as shown in Figure 1, additionally highlighting the defensive player's position and passing zones. Subsequently, the passing data of those sequences were entered into another Excel spreadsheet to compose an overall adjacency matrix as displayed in Table 1. Furthermore, the existing passing data available from the official UEFA website were downloaded and later entered into the Excel spreadsheet to compile an overall adjacency matrix as shown previously in Table 1. Lastly, for the pitch zone network analysis, the regions for incoming and outgoing passes were also observed from the footage and notated down in the Excel spreadsheet. Afterwards, the collected passing data from zone to zone were compiled to make an overall pitch zone and pitch-player adjacency matrices as presented in Table 1.

The first part of network analysis was performed using the free software Social Network Visualizer (SocNetV 2.4). The aforementioned software allows to compute various network metrics from previously coded players' interactions and pitch zones' connectivity that mathematically describe the connectivity of the graph (Clemente et al., 2016). A text file converted from an Excel file was imported to the software for every adjacency matrix created. The network metrics of in-degree, out-degree, closeness and betweenness centralities were computed for player network analysis, whereas for the pitch zone analysis only in-degree and out-degree measures were taken. The mathematical calculations were done by the software. However, with regard to the calculations of within degree centrality for pitch zones and pitch-player connectivity they were done manually following a below displayed formula:

$$\frac{\text{no.of ties (interactions)}}{\text{no.of all possible ties (interactions)}}$$

The second part of network analysis was conducted using the software Cytoscape (Cytoscape 3.7.1). This software was used to develop both the players' and the pitch zones' visual network graphs. According to Goncalves et al. (2017), in this case, the nodes represent players and connecting edges represent the number of successful passes performed between them.

2.6 Research organisation

The permission to carry out the present study was issued by the University Ethics Committee on 29th October 2019. The number of approved protocol to conduct social research is 16803. The video footage of all 29 games of the 2017/18 UEFA Champions League season knockout stage was downloaded from the public domain sources together with the passing data that was obtained from the official UEFA website. The video footage and passing data laid the foundations for this research. The research did not require direct participation and there was no human intervention involved; thus, it was conducted remotely.

2.7 Methods of statistical analysis

The data-set containing the mean values of degree centrality metrics for each passing condition and player position were analysed using the Two-Way Mixed ANOVA after validating the normality and homogeneity assumptions.

The independent variable of the passing condition was assigned to the *within-subjects* factor and had two levels: overall passes and passes of passing sequences that entered the opposite penalty area. The independent variable of player position was assigned to the *between-subjects* factor and had five levels: the goalkeeper, the right-back, the right centre-back, the left centre-back and the left-back. The dependent variables of this study were the degree centrality metrics (in, out, closeness and betweenness). Additionally, the post-hoc analysis using Bonferroni correction was done.

The procedures were performed using IBM SPSS Statistics package (version 25.0, Chicago, Illinois, USA). Statistical significance was set at $p < 0.05$. Partial eta squared (η^2) was used as a measure for overall effect size and interpreted as no effect if ($\eta^2 < 0.04$), minimum effect if ($0.04 < \eta^2 < 0.25$), moderate effect if ($0.25 < \eta^2 < 0.64$) and strong effect if ($\eta^2 > 0.64$) (Ferguson, 2009 as cited in Conte et al., 2016). Subsequently, Cohen's d was used as a measure for the player position comparisons and interpreted as trivial if (< 0.2), small if (0.2-0.59), moderate if (0.6-1.19), large if (1.2-1.99) and very large if (> 2.0) (Cohen, 2013). Only descriptive analysis was performed for pitch zones and pitch-player connectivity.

3. RESEARCH FINDINGS

3.1 Overall passes vs Passes of passing sequences that entered the penalty area

The results of the Two-Way Mixed ANOVA showed that there was no statistically significant effect of passing condition on in-degree centrality scores overall [($F(1, 75) = 0.000012$, p =

0.997, $\eta^2 < 0.001$] (Table 2). The overall passes (*M* = 0.200, *SD* = 0.042) and passes of passing sequences that entered the penalty area (*M* = 0.200, *SD* = 0.103) showed an identical average in-degree score overall.

Contrarily, there was a statistically significant effect of player position on in-degree centrality scores overall [($F(4, 75) = 16.210$, $p < 0.001$, $\eta^2 = 0.464$] (Table 2). The left centre-back (*M* = 0.258, *SD* = 0.067) and right centre-back (*M* = 0.243, *SD* = 0.096) showing the highest average in-degree scores for both passing conditions overall, with the right-back (*M* = 0.201, *SD* = 0.063) and left-back (*M* = 0.206, *SD* = 0.075) slightly behind them, whilst the goalkeeper (*M* = 0.092, *SD* = 0.060) had the lowest average in-degree score for both passing conditions overall. The post-hoc analysis using Bonferroni correction showed the goalkeeper to have the lowest average in-degree score compared to the right-back [mean diff (95% CI) = 0.109 (0.043; 0.175); $p < 0.001$; *ES* = 1.772 (Large)], the right centre-back [mean diff (95% CI) = 0.151 (0.085; 0.217); $p < 0.001$; *ES* = 1.886 (Large)], the left centre-back [mean diff (95% CI) = 0.166 (0.100; 0.232); $p < 0.001$; *ES* = 2.610 (Very large)] and the left-back [mean diff (95% CI) = 0.114 (0.048; 0.180); $p < 0.001$; *ES* = 1.679 (Large)]. Conversely, the post-hoc analysis did not reveal any statistically significant difference between any of the defenders.

Furthermore, there was also statistically significant interaction between the player position and passing condition [($F(4, 75) = 5.144$, $p = 0.001$, $\eta^2 = 0.215$] (Table 2). The right centre-back (*M* = 0.269, *SD* = 0.153) and left centre-back (*M* = 0.284, *SD* = 0.097) both showed higher average in-degree scores for passes of passing sequences that entered the opponent's penalty area compared to in-degree scores of overall passes (right centre-back *M* = 0.218, *SD* = 0.038; left centre-back *M* = 0.232, *SD* = 0.036). The goalkeeper also showed a higher average in-degree score for passes received in passing sequences that ended up in the penalty box (*M* = 0.098, *SD* = 0.082) compared to overall passes (*M* = 0.086, *SD* = 0.037). However, both full-backs possessed higher average in-degree values for overall passes (right-back *M* = 0.224, *SD* = 0.053; left-back *M* = 0.240, *SD* = 0.043) than passes of passing sequences that entered the penalty area (right-back *M* = 0.178, *SD* = 0.073; left-back *M* = 0.172, *SD* = 0.107).

Table 2. Two-Way Mixed ANOVA values for in-degree centrality metric

In-deg.		**Mean (SD)**	**p-value**	**Effect size (η^2)**	**Mean difference (95% CI)**
Player position	GK*	0.092 (0.060)	<0.001	0.464 (moderate)	0.109 (0.043; 0.175) 0.151 (0.085; 0.217)

					0.166 (0.100; 0.232)
					0.114 (0.048; 0.180)
	RB	0.201 (0.063)			
	RCB	0.243 (0.096)			
	LCB	0.258 (0.067)			
	LB	0.206 (0.075)			
Overall	GK	0.086 (0.037)	0.001	0.215	
	RB	0.224 (0.053)		(minimum)	
	RCB	0.218 (0.038)			
	LCB	0.232 (0.036)			
	LB	0.240 (0.043)			
Penalty area	GK	0.098 (0.082)			
	RB	0.178 (0.073)			
	RCB	0.269 (0.153)			
	LCB	0.284 (0.097)			
	LB	0.172 (0.107)			
Passing condition	Overall	0.200 (0.042)	0.997	<0.001	
	Penalty area	0.200 (0.103)		(no effect)	

Note: GK – goalkeeper; RB – right-back; RCB – right centre-back; LCB – left centre-back; LB – left-back

* indicates statistically significant differences compared to RB, RCB, LCB and LB (all p < 0.001)

Continuing the analysis, the Two-Way Mixed ANOVA revealed that there was no statistically significant effect of passing condition on out-degree centrality scores overall [(F(1, 75) = 0.010, p = 0.920, η^2 < 0.001] (Table 3). The overall passes (M = 0.200, SD = 0.038) and passes of passing sequences that entered the penalty area (M = 0.200, SD = 0.065) showed an identical average out-degree score overall.

Additionally, the results revealed that there was a statistically significant effect of player position on out-degree centrality scores overall [(F(4, 75) = 23.974, p < 0.001, η^2 = 0.561] (Table 3). The left centre-back (M = 0.232, SD = 0.044) and left-back (M = 0.233, SD = 0.054) showing the highest average out-degree scores overall. Both right-sided players, the right centre-back (M = 0.225, SD = 0.212) and right-back (M = 0.212, SD = 0.059) also showed fairly similar results, whereas the lowest average out-degree score overall was possessed by the goalkeeper (*M* = 0.097, *SD* = 0.047). The post-hoc analysis using Bonferroni correction showed the goalkeeper to have the lowest average out-degree score compared to the right-back [mean diff (95% CI) = 0.115 (0.066; 0.163); $p < 0.001$; *ES* = 2.156 (Very large)], the right centre-back [mean diff (95% CI) = 0.128 (0.080; 0.176); $p < 0.001$; *ES* = 2.502 (Very large)], the left centre-back [mean diff (95% CI) = 0.135 (0.086; 0.182); $p < 0.001$; *ES* = 2.965 (Very large)] and the left-back [mean diff (95% CI) = 0.136 (0.087; 0.184); $p < 0.001$; *ES* = 2.687 (Very large)]. Conversely, the post-hoc analysis did not reveal any statistically significant difference between any of the defenders.

Adding to the above, there was also a statistically significant interaction between the player position and passing condition [($F(4, 75) = 12.647$, $p < 0.001$, $\eta^2 = 0.403$] (Table 3). The descriptive statistics revealed that the goalkeeper (*M* = 0.121, *SD* = 0.034), right centre-back (*M* = 0.234, *SD* = 0.042) and left centre-back (*M* = 0.247, *SD* = 0.038) possessed higher average out-degree scores for overall passes compared to passes of passing sequences that entered the penalty area (goalkeeper *M* = 0.074, *SD* = 0.061; right centre-back *M* = 0.216, *SD* = 0.067; left centre-back *M* = 0.216, *SD* = 0.050). In contrast, the right-back (*M* = 0.231, *SD* = 0.075) and left-back (*M* = 0.263, *SD* = 0.075) showed higher average out-degree scores for passes performed in sequences that entered the opponent's penalty box than overall passes (right-back *M* = 0.193, *SD* = 0.042; left-back *M* = 0.203, *SD* = 0.033).

Table 3. Two-Way Mixed ANOVA values for out-degree centrality metric

Out-deg.		**Mean (SD)**	**p-value**	**Effect size (η^2)**	**Mean difference (95% CI)**
Player position	*GK	0.097 (0.047)	<0.001	0.561 (moderate)	0.115 (0.066; 0.163) 0.128 (0.080; 0.176) 0.135 (0.086; 0.182) 0.136 (0.087; 0.184)
	RB	0.212 (0.059)			
	RCB	0.225 (0.055)			
	LCB	0.232 (0.044)			
	LB	0.233 (0.054)			

Overall	GK	0.121 (0.034)	<0.001	0.403
	RB	0.193 (0.042)		(moderate)
	RCB	0.234 (0.042)		
	LCB	0.247 (0.038)		
	LB	0.203 (0.033)		
Penalty area	GK	0.074 (0.061)		
	RB	0.231 (0.075)		
	RCB	0.216 (0.067)		
	LCB	0.216 (0.050)		
	LB	0.263 (0.075)		
Passing condition	Overall	0.200 (0.038)	0.920	<0.001
	Penalty area	0.200 (0.065)		(no effect)

Note: GK – goalkeeper; RB – right-back; RCB – right centre-back; LCB – left centre-back; LB – left-back

* indicates statistically significant differences compared to RB, RCB, LCB and LB (all $p < 0.001$)

In respect of betweenness centrality, the Two-Way Mixed ANOVA showed that there was a statistically significant effect of passing condition on betweenness centrality scores overall [($F(1, 75) = 43.121$, $p < 0.001$, $\eta^2 = 0.365$] (Table 4). The overall passes ($M = 0.026$, $SD = 0.016$) showed lower average betweenness score than passes of passing sequences that entered the opposition's penalty area ($M = 0.053$, $SD = 0.032$).

Adding to that, the test also revealed statistically significant effect of player position on betweenness centrality scores overall [($F(4, 75) = 10.782$, $p < 0.001$, $\eta^2 = 0.365$] (Table 4). The left centre-back (M = 0.058, SD = 0.029) and right centre-back (M = 0.051, SD = 0.031) possessing the largest average betweenness scores overall. Both full-backs showed slightly lower average betweenness scores overall (right-back M = 0.032, SD = 0.019; left-back M = 0.036, SD = 0.020), whilst the goalkeeper had on average the lowest betweenness value overall ($M = 0.020$, $SD = 0.022$). The post-hoc analysis using Bonferroni correction showed the goalkeeper to have a lower average betweenness score compared to the right centre-back [mean diff (95% CI) = 0.031 (0.012; 0.050); $p < 0.001$; $ES = 1.153$ (Moderate)] and left centre-back [mean diff (95% CI) = 0.038 (0.019; 0.057); $p < 0.001$; $ES = 1.476$ (Large)]. Additionally, the right-back [mean diff (95% CI) = 0.026 (0.007; 0.045); $p = 0.001$; $ES = 1.061$ (Moderate)] and the left-back [mean diff (95% CI) = 0.022 (0.003; 0.041); $p = 0.012$; *ES* = 0.883 (Moderate)] both showed to have a lower average betweenness score compared to the left centre-back. Conversely, the post-hoc analysis did not indicate any statistically significant differences between the goalkeeper and right-back ($p = 0.718$), the goalkeeper and left-back ($p = 0.167$), the right-back and right centre-back ($p = 0.053$), the right-back and left-back ($p = 1.000$), the right centre-back and left centre-back ($p = 1.000$) and the right centre-back and left-back ($p = 0.272$).

In addition, there was also statistically significant interaction between the player position and passing condition [($F(4, 75) = 6.543$, $p < 0.001$, $\eta^2 = 0.259$] (Table 4). All defensive players, apart from the goalkeeper, showed higher average betweenness scores for passes of passing sequences that entered the opponent's penalty area (right-back $M = 0.043$, $SD = 0.023$; right centre-back $M = 0.071$, $SD = 0.041$; left centre-back $M = 0.085$, $SD = 0.045$; left-back $M = 0.049$, $SD = 0.028$). The goalkeeper was the only defensive player who possessed a higher average betweenness score for overall passes ($M = 0.024$, $SD = 0.021$) compared to passes of passing sequences that reached the opposite penalty box ($M = 0.015$, $SD = 0.021$). The right-back ($M = 0.020$, $SD = 0.014$), right centre-back ($M = 0.030$, $SD = 0.021$), left centre-back ($M = 0.030$, $SD = 0.013$) and left-back ($M = 0.023$, $SD = 0.011$) all showed lower average betweenness values for overall passes.

Table 4. Two-Way Mixed ANOVA values for betweenness centrality metric

Betweenness		**Mean (SD)**	**p-value**	**Effect size (η^2)**	**Mean difference (95% CI)**
Player position	GK*	0.020 (0.022)	<0.001	0.365 (moderate)	0.031 (0.012; 0.050) 0.038 (0.019; 0.057)
	RB**	0.032 (0.019)			0.026 (0.007; 0.045)
	RCB	0.051 (0.031)			
	LCB	0.058 (0.029)			
	LB**	0.036 (0.020)			0.022 (0.003; 0.041)
Overall	GK	0.024 (0.021)	<0.001	0.259 (moderate)	
	RB	0.020 (0.014)			
	RCB	0.030 (0.021)			
	LCB	0.030 (0.013)			
	LB	0.023 (0.011)			

Penalty area	GK	0.015 (0.021)		
	RB	0.043 (0.023)		
	RCB	0.071 (0.041)		
	LCB	0.085 (0.045)		
	LB	0.049 (0.028)		
Passing condition	Overall	0.026 (0.016)	<0.001	0.365 (moderate)
	Penalty area	0.053 (0.032)		

Note: GK – goalkeeper; RB – right-back; RCB – right centre-back; LCB – left centre-back; LB – left-back

* indicates statistically significant differences compared to RCB (p < 0.001) and LCB (p < 0.001)

** indicates statistically significant differences compared to LCB (p = 0.001 and p = 0.012)

Finally, the results produced by Two-Way Mixed ANOVA revealed that there was a statistically significant effect of passing condition on closeness centrality scores overall [(F(1, 75) = 41.880, p < 0.001, η^2 = 0.358] (Table 5). The overall passes (M = 0.783, SD = 0.103) showed a higher average closeness score than passes of passing sequences that entered the opponent's penalty area (M = 0.667, SD = 0.149).

Furthermore, there was a statistically significant effect of player position on closeness centrality scores overall [(F(4, 75) = 3.498, p = 0.011, η^2 = 0.157] (Table 5). The right centre-back (M = 0.752, SD = 0.124) and left centre-back (M = 0.773, SD = 0.124) possessing the highest average closeness scores overall. Both the right-back (M = 0.725, SD = 0.120) and left-back (M = 0.736, SD = 0.152) had slightly lower average closeness values overall. Contrarily, the goalkeeper showed the lowest average closeness score overall (M = 0.641, SD = 0.111). The post-hoc analysis using Bonferroni correction showed the goalkeeper to have a lower average closeness score compared to the left centre-back [mean diff (95% CI) = 0.106 (0.003; 0.210); p = 0.038; ES = 0.901 (Moderate)] and left-back [mean diff (95% CI) = 0.118 (0.015; 0.222); p = 0.014; ES = 0.887 (Moderate)]. Conversely, the post-hoc analysis did not reveal any statistically significant difference between any of the defenders.

In addition to that, there was also statistically significant interaction between the player position and passing condition [(F(4, 75) = 4.356, p = 0.003, η^2 = 0.189] (Table 5). Every defensive player showed higher average closeness scores for overall passes with the left centre-back (M

= 0.835, *SD* = 0.085) and right centre-back (*M* = 0.799, *SD* = 0.141) leading the way having the left-back (*M* = 0.773, *SD* = 0.126), right-back (*M* = 0.756, *SD* = 0.096) and goalkeeper (*M* = 0.754, *SD* = 0.065) slightly behind them. As a result, every defensive player had lower average closeness scores for passes of passing sequences that ended up in the penalty area (goalkeeper *M* = 0.528, *SD* = 0.156; right-back *M* = 0.695, *SD* = 0.145; right centre-back *M* = 0.705, *SD* = 0.106; left centre-back *M* = 0.711, *SD* = 0.162; left-back *M* = 0.698, *SD* = 0.177).

Table 5. Two-Way Mixed ANOVA values for closeness centrality metric

Closeness		**Mean (SD)**	**p-value**	**Effect size (η^2)**	**Mean difference (95% CI)**
Player position	*GK	0.641 (0.111)	0.011	0.157 (minimum)	0.111 (0.003; 0.210) 0.132 (0.015; 0.222)
	RB	0.725 (0.120)			
	RCB	0.752 (0.124)			
	LCB	0.773 (0.124)			
	LB	0.736 (0.152)			
Overall	GK	0.754 (0.065)	0.003	0.189 (minimum)	
	RB	0.756 (0.096)			
	RCB	0.799 (0.141)			
	LCB	0.835 (0.085)			
	LB	0.773 (0.126)			
Penalty area	GK	0.528 (0.156)			
	RB	0.695 (0.145)			
	RCB	0.705 (0.106)			
	LCB	0.711 (0.162)			
	LB	0.698 (0.177)			
Passing condition	Overall	0.783 (0.103)	<0.001	0.358 (moderate)	
	Penalty area	0.667 (0.149)			

Note: GK – goalkeeper; RB – right-back; RCB – right centre-back; LCB – left centre-back; LB – left-back

* indicates statistically significant differences compared to RCB (p = 0.038) and LCB (p = 0.014)

3.2 The most active pitch zones

The four tables displayed below present the most actively used zones in four corridors of the pitch (left-wing corridor, left-centre corridor, right-centre corridor, right-wing corridor). The determination of the most active zones in four vertical strips can portray and describe the profile of the defensive player assigned to one of the four vertical strips since only passes performed by defensive players were coded. Hypothetically speaking, the left-wing corridor (zones 1; 5; 9; 13; 17; 21) belongs to the left-back, the left-centre corridor (zones 2; 6; 10;14; 18) to the left centre-back while his partner occupies the right-centre corridor (zones 3; 7; 11; 15; 19) with the right-back taking up the right-wing corridor (zones 4; 8; 12; 16; 20; 24).

The in, out and within degree centrality scores of most active pitch zones located on the left-wing strip are presented in Table 6. The findings revealed that three zones were the most popular among 16 teams regarding an in-degree metric. It was zone 13 (sum 0.514), zone 9 (sum 0.427) and zone 17 (sum 0.424). The most prominent zone for an in-degree value down the left-wing was zone 13 (0.138) showed by Roma. In contrast, Basel's most active pitch zone down the left-wing was zone 1; however, the in-degree score was the lowest out of all teams regarding the most active zones down that side (0.042).

The network metric of out-degree centrality was the most noticeable with zones 13 (sum 0.522) and 9 (sum 0.269) with nine teams having it as their most active zone down the left-wing. However, none of the remaining zones were able to match with zone 17 that was the most actively used zone for passes performed by Barcelona (0.185). The lowest value of all the teams for most active zones again belonged to Basel which had zone 5 (0.022) as their most active region on the left-wing.

The most active pitch zones for the within degree centrality were mainly two: zone 9 (sum 0.191) and zone 17 (sum 0.137). Despite that, the highest within degree score was shown by zone 5 (0.063) which was Basel's most active zone on the left side of the pitch. Even though zone 17 was the most popular region for within degree value, in Liverpool's case, it showed the lowest score (0.006) despite being the most active zone on Liverpool's left-flank.

Table 6. The in, out and within degree centrality scores of most active pitch regions on the left-wing following the sequence of zones in this order: 1->5->9->13->17->21

Team	**Zone**	**In-degree**	**Zone**	**Out-degree**	**Zone**	**Within**
Bayern	13	0.072	9	0.103	9	0.050
Juventus	17	0.112	13	0.125	13	0.014

Real Madrid	5	0.062	5	0.078	17	0.016
Barcelona	17	0.129	**17**	**0.185**	17	0.045
Sevilla	13	0.097	1	0.079	9	0.018
PSG	9	0.075	1	0.063	9	0.038
Porto	9	0.085	5	0.050	9	0.014
Chelsea	17	0.129	9	0.074	-	0
Man City	13	0.105	13	0.060	13	0.046
Basel	1	0.042	5	0.022	**5**	**0.063**
Man Utd	9	0.101	13	0.093	9	0.036
Shakhtar	9	0.098	17	0.098	9	0.035
Liverpool	9	0.062	9	0.092	17	0.006
Tottenham	17	0.054	13	0.065	17	0.022
Besiktas	13	0.108	13	0.052	17	0.034
Roma	**13**	**0.138**	13	0.127	17	0.014

* Highlighted in black corresponds to highest value; highlighted in grey corresponds to lowest value

Going further, Table 7 presents the results of the aforementioned degree centralities of most active pitch regions in the left-centre corridor. The in-degree centrality measures revealed that zone 10 (sum 0.754) and zone 14 (sum 0.590) were the most active zones regarding the incoming passes in the left-centre vertical strip. Specifically, Liverpool had the highest out-degree score for zone 10 among all the teams (0.160), whereas Chelsea showed the lowest (0.056) even though it was also its most active zone in the left-centre corridor of the pitch.

The out-degree centrality scores revealed that zone 10 (sum 1.218) was unprecedentedly the most active region in terms of outgoing passes across all 16 teams. Zone 6 (sum 0.267) was the second most active zone for performed passes. Shakhtar was the team with the highest mean value of out-degree metric (0.191) with PSG showing the lowest score of the same metric even though zone 10 was also the most active zone for the Parisians in the left-centre corridor (0.038).

Only three different zones in total were captured for the within degree centrality measures. Zones 6, 10, and 14 were the only ones that had passes completed within the zone itself. Zone 10 (sum 0.250) dominated once again being the most active region for eight teams with zone 6 (sum 0.094) and zone 14 (sum 0.117) both acting as the most prominent pitch areas for the remaining eight teams. The Spanish side Sevilla possessed the largest withing degree score showing zone 10 as its most active region in the left-centre corridor (0.068). On the other hand, another Spanish team Barcelona possessed the lowest within degree score among all the teams having zone 14 as its most active zone (0.011).

Table 7. The in, out and within degree centrality metrics of pitch regions down the left centre corridor following the sequence of zones in this order: 2->6->10->14->18

Team	**Zone**	**In-degree**	**Zone**	**Out-degree**	**Zone**	**Within**
Bayern	6	0.108	6	0.089	6	0.023
Juventus	14	0.083	10	0.111	-	0
Real Madrid	10	0.125	10	0.121	10	0.037
Barcelona	14	0.141	10	0.101	14	0.011
Sevilla	10	0.118	10	0.118	**10**	**0.068**
PSG	2	0.113	10	0.038	10	0.013
Porto	10	0.093	6	0.099	10	0.025
Chelsea	10	0.056	10	0.056	-	0
Man City	10	0.126	14	0.149	10	0.034
Basel	6	0.084	2	0.105	14	0.063
Man Utd	14	0.087	6	0.079	6	0.036
Shakhtar	14	0.106	**10**	**0.191**	6	0.035
Liverpool	**10**	**0.160**	10	0.135	10	0.019
Tottenham	14	0.087	10	0.109	14	0.043
Besiktas	14	0.086	10	0.086	10	0.017
Roma	10	0.076	10	0.152	10	0.037

* Highlighted in black corresponds to highest value; highlighted in grey corresponds to lowest value

The degree centrality scores of most active zones in the right-centre corridor are displayed in Table 8. The in-degree measure revealed that zone 11 (sum 0.889) was the most active area for passes received for nine teams in total. The second most active region for incoming passes in the right-centre corridor was zone 15 (sum 0.516). Nonetheless, it was zone 7 (0.209) that had the highest in-degree score showed by Juventus among all other most active zones. Conversely, Sevilla showed the lowest in-degree value out of all 16 teams even though zone 7 was its most active zone in the right centre-corridor.

A similar trend was observed when analysing out-degree scores. Once again, zone 11 (sum 0.801) and zone 15 (sum 0.565) were the most popular regions for passes performed for half of the teams. Tottenham showed the highest out-degree value having zone 15 (0.142) as its most active area. In regard to the lowest score, Sevilla were the ones that had zone 7 (0.068) as its most active region in the right-centre corridor but the score was the lowest among all 16 teams.

The within degree centrality scores revealed similar results compared to in and out-degree centralities. Zone 15 (sum 0.369) was noted as the most functional zone for passes performed within the same area with Besiktas showing the largest score (sum 0.100) and Bayern possessing the lowest (0.004). Zone 11 (combined 0.127) was the second most active region for the within degree metric.

Table 8. The in, out and within degree centrality metrics of pitch regions down the right centre corridor following the sequence of zones in this order: 3->7->11->15->19

Team	**Zone**	**In-degree**	**Zone**	**Out-degree**	**Zone**	**Within**
Bayern	15	0.103	11	0.109	15	0.004
Juventus	**7**	**0.209**	3	0.125	7	0.014
Real Madrid	11	0.109	15	0.072	11	0.043
Barcelona	15	0.097	15	0.123	15	0.045
Sevilla	7	0.068	7	0.068	7	0.025
PSG	11	0.088	11	0.075	19	0.025
Porto	11	0.099	11	0.107	11	0.014
Chelsea	15	0.109	11	0.091	7	0.018
Man City	11	0.080	15	0.141	15	0.045
Basel	19	0.084	3	0.084	15	0.063
Man Utd	11	0.079	15	0.087	11	0.036
Shakhtar	11	0.136	11	0.125	11	0.014
Liverpool	11	0.094	11	0.115	11	0.020
Tottenham	15	0.207	**15**	**0.142**	15	0.087
Besiktas	11	0.091	11	0.073	**15**	**0.100**
Roma	11	0.113	11	0.106	15	0.025

* Highlighted in black corresponds to highest value; highlighted in grey corresponds to lowest value

The final table (Table 9) presents the results for degree centralities of most active pitch zones on the right-wing. The results of in-degree scores revealed that zone 16 (sum 0.634) was the most active region for half of the teams with zone 20 (sum 0.534) being the second most prominent zone on the right-wing. Chelsea had the largest in-degree score for zone 20 (0.183), whereas Roma showed the lowest value out of all teams having zone 16 (0.037) as team's most active zone on the right side of the pitch.

In terms of the out-degree score, an almost identical situation was present where zone 16 (sum 0.738) was recorded to be the most active pitch area on the right-wing for nearly half of the teams. Zone 20 (sum 0.449) was again the second most active region on the right-wing having five teams on its list. Once again, it was Chelsea that showed the highest value, this time for an out-degree metric of zone 16 (0.201). In contrast, Besiktas recorded the lowest out-degree score among all the teams having zone 20 as its most active region on the right-wing.

Finally, the within degree scores revealed that the same zones (16 and 20) dominated the chart again. This time, zone 20 (sum 0.353) was the most active with seven teams having it as their most functional region on the right-wing for passes within the same area. Chelsea for the third time showed the largest degree score having zone 20 (0.129) as its most active region. On the other hand, zone 16 (sum 0.228) was the second most active zone after zone 20 for the majority of the remaining teams. In this instance, Man City's most active pitch zone on the right-wing was zone 16; however, it produced the lowest withing degree score of all the teams (0.019).

Table 9. The in, out and within degree centrality metrics of most active pitch regions on the right-wing following the sequence of zones in this order: 4->8->12->16->20->24

Team	Zone	In-degree	Zone	Out-degree	Zone	Within
Bayern	16	0.072	12	0.051	20	0.016
Juventus	8	0.070	8	0.112	12	0.014
Real Madrid	16	0.059	16	0.061	20	0.023
Barcelona	20	0.168	20	0.118	20	0.084
Sevilla	20	0.061	20	0.072	-	0
PSG	20	0.050	20	0.125	16	0.025
Porto	8	0.072	20	0.099	20	0.053
Chelsea	**20**	**0.183**	**16**	**0.201**	**20**	**0.129**
Man City	20	0.069	16	0.094	16	0.009
Basel	16	0.105	16	0.105	16	0.063
Man Utd	16	0.087	16	0.079	16	0.050
Shakhtar	12	0.098	12	0.106	16	0.016
Liverpool	16	0.074	16	0.078	20	0.020
Tottenham	16	0.109	16	0.120	16	0.065
Besiktas	16	0.091	20	0.035	-	0
Roma	16	0.037	12	0.040	20	0.028

* Highlighted in black corresponds to highest value; highlighted in grey corresponds to lowest value

3.3 Strongest interactions between the zones by position

Further findings presented in the following four tables dwelled into the analysis of the most connected pitch regions by position alluding to pitch-player connectivity. Starting with Table 10, the strongest interactions between the zones for the goalkeeper are presented. The results revealed that Man City goalkeeper's preferred passing direction was from zone 3 to zone 7 (0.444) showing the highest level of interaction between these zones. On the other hand, the goalkeeper of PSG favoured the passing path of zone 2 to zone 1; however, the strength of the interaction was the weakest among all 16 teams. In general, the majority of goalkeepers preferred to pass the ball from either zone 3 (occurred eight times) or zone 2 (occurred five times) to the zones located in the defensive third. Passes performed from zone 2 or 3 to more advanced regions in the middle third were less frequent.

Table 10. The best connected pitch zones for the goalkeeper

Team	Zone	Out-degree	⟶	Zone	In-degree
Bayern	3	0.333		6	0.333
Juventus	3	0.180		14	0.180
Real	3	0.150		5	0.150
Barcelona	3	0.230		6	0.230
Sevilla	3	0.145		8	0.145
PSG	2	0.125		1	0.125
Porto	2	0.400		14	0.400
Chelsea	2	0.135		14	0.135
Man City	**3**	**0.444**		**7**	**0.444**
Basel	2	0.140		6	0.140
Man Utd	7	0.240		16	0.240
Shakhtar	3	0.174		6	0.174
Liverpool	3	0.174		6	0.174
Tottenham	6	0.265		14	0.265
Besiktas	2	0.310		13	0.310
Roma	7	0.130		6	0.130

* Highlighted in black corresponds to highest value; highlighted in grey corresponds to lowest value

The connectivity between pitch regions was also measured for the right-back position and is presented in Table 11. The strongest interaction was observed between zone 24 and zone 23 (0.429) which was the preferred passing route for Chelsea's right-back. On the flip side, Besiktas' right-back showed the least strong connection for his preferred passing route out of all 16 teams which was from zone 20 to zone 15 (0.200). Generally, the most popular pitch zone amongst all the right-backs for releasing the pass was zone 20 (occurred seven times). The destination zone, however, produced mixed results with a few zones located further back (zone 15 and 16) and in the opponent's penalty area (zone 23) indicating backwards passes and crosses into the box.

Table 11. The best connected pitch zones for the right-back

Team	Zone	Out-degree	⟶	Zone	In-degree
Bayern	20	0.222		23	0.222
Juventus	8	0.364		7	0.364
Real	16	0.292		20	0.292
Barcelona	20	0.414		20	0.414
Sevilla	20	0.308		20	0.308

PSG	16	0.278	19	0.278
Porto	16	0.353	23	0.353
Chelsea	**24**	**0.429**	**23**	**0.429**
Man City	15	0.286	11	0.286
Basel	12	0.400	19	0.400
Man Utd	16	0.385	16	0.385
Shakhtar	12	0.333	11	0.333
Liverpool	20	0.250	16	0.250
Tottenham	20	0.350	15	0.350
Besiktas	20	0.200	15	0.200
Roma	20	0.333	23	0.333

* Highlighted in black corresponds to highest value; highlighted in grey corresponds to lowest value

The best connected pitch zones for the right-centre back are presented in Table 12. The findings revealed that Barcelona right-centre back's favoured passing route was zone 11 to zone 10 (0.421) and possessed the strongest interaction out of all teams. The right-centre back of Man United preferred the passing route of zone 7 to zone 16; however, the level of interaction between the two zones was the lowest. Additionally, some similarities can be drawn upon the previous findings of right-back. This time it was zone 11 as the main region for performing a pass (occurred seven times) but the destination regions (pass received by a teammate) were mixed (zones 10; 11; 15 and 16).

Table 12. The best connected pitch zones for the right-centre back

Team	**Zone**	**Out-degree**	→	**Zone**	**In-degree**
Bayern	15	0.389		20	0.389
Juventus	7	0.300		6	0.300
Real	11	0.276		11	0.276
Barcelona	**11**	**0.421**		**10**	**0.421**
Sevilla	7	0.200		6	0.200
PSG	11	0.313		11	0.313
Porto	11	0.357		15	0.357
Chelsea	16	0.333		20	0.333
Man City	15	0.289		15	0.289
Basel	4	0.250		8	0.250
Man Utd	7	0.190		16	0.190
Shakhtar	11	0.409		10	0.409
Liverpool	11	0.400		10	0.400
Tottenham	15	0.346		15	0.346
Besiktas	11	0.280		16	0.280
Roma	7	0.200		6	0.200

* Highlighted in black corresponds to highest value; highlighted in grey corresponds to lowest value

The strongest interactions between the pitch zones for the left centre-backs are shown in Table 13. The results revealed that Liverpool left centre-back's preferred passing direction was from zone 6 to zone 10 (0.364) displaying the strongest connection between these zones among all knockout stage teams. In contrast, the left centre-back of Basel favoured the passing path of zone 5 to zone 7; however, the strength of the interaction was the weakest among all the teams. In general, the majority of left centre-backs preferred to pass the ball from zone 10 (occurred nine times) to the forward zones (zones 13 and 14).

Table 13. The best connected pitch zones for left centre-back

Team	**Zone**	**Out-degree**	⟶	**Zone**	**In-degree**
Bayern	10	0.278		11	0.278
Juventus	10	0.273		14	0.273
Real	10	0.292		14	0.292
Barcelona	10	0.316		14	0.316
Sevilla	10	0.200		10	0.200
PSG	1	0.222		6	0.222
Porto	6	0.214		7	0.214
Chelsea	9	0.222		13	0.222
Man City	14	0.267		13	0.267
Basel	5	0.143		7	0.143
Man Utd	10	0.190		9	0.190
Shakhtar	10	0.243		14	0.243
Liverpool	**6**	**0.364**		**10**	**0.364**
Tottenham	14	0.318		14	0.318
Besiktas	10	0.200		13	0.200
Roma	10	0.261		13	0.261

* Highlighted in black corresponds to highest value; highlighted in grey corresponds to lowest value

The best connected zones for the left-backs are given in Table 14. In this instance, the within interaction in zone 17 (passes from zone 17 to zone 17) was the favoured passing route for Barcelona's left-back showing the highest level of interaction (0.379). Conversely, Basel's left-back showed the weakest connection for his preferred passing route (from zone 5 to zone 21) out of all 16 teams (0.123). For the rest of the teams, a more widespread scenario was observed regarding the pitch-player connectivity. The left-backs of four teams favoured the passing route of zone 17 to either zone 17 or 22. The other four left-backs of PSG, Porto, Shakhtar and Man United preferred to interchange passes within the zone 9 or go more direct to zone 21 in Man United's case.

Table 14. The best connected pitch zones for the left-back

Team	Zone	Out-degree	→	Zone	In-degree
Bayern	17	0.308		17	0.308
Juventus	17	0.357		22	0.357
Real	5	0.182		10	0.182
Barcelona	**17**	**0.379**		**17**	**0.379**
Sevilla	13	0.133		14	0.133
PSG	9	0.222		9	0.222
Porto	9	0.187		9	0.187
Chelsea	21	0.375		22	0.375
Man City	14	0.292		14	0.292
Basel	5	0.123		21	0.123
Man Utd	9	0.174		21	0.174
Shakhtar	9	0.208		9	0.208
Liverpool	17	0.226		22	0.226
Tottenham	13	0.300		17	0.300
Besiktas	13	0.182		13	0.182
Roma	21	0.346		23	0.346

* Highlighted in black corresponds to highest value; highlighted in grey corresponds to lowest value

4. CONSIDERATIONS

4.1 Passing condition, player position and interaction between the two

The aim of the present study was to examine the effectiveness of the defensive players' participation in a team's passing sequences as well as to determine the tactical profile in regard to their passing networks and pitch zones' connectivity. The first part of analysis compared the defensive players' overall passing data with the data of passes in passing sequences that entered the opponent's penalty area using degree centralities. Such type of analysis assesses the level of players' engagement in passing interactions that can lead to successful collective actions (Gama et al., 2016).

To start with, the results revealed that an average in-degree score was not affected by the passing condition. In this instance, the defensive players as an entity were not less prominent to receive passes in passing sequences that ended up in the opposition's penalty area when compared to overall passes' data-set. It means that as an entity defensive players remained targeted by other teammates that signifies their popularity which showcases the effectiveness of defensive players' contribution to the team's efforts of reaching the opponent's penalty area.

Additionally, the findings revealed that there was a statistically significant effect of defensive player position on in-degree scores overall. It means that the player's position had an impact on how often he was going to receive a pass from other teammates indicating the player's higher or lower prominence level. The centre-back (right and left) position showed the highest average in-degree score compared to other defensive positions for both overall passes and passes of passing sequences that entered the opponent's penalty area. It means that the centre-backs are more likely to receive more passes from teammates suggesting their important role when starting the build-up play from the back and circulating the ball in the first phase. These results are in line with those of Clemente, Silva, Martins, Kalamaras and Mendes (2016) and Mendes et al. (2018) who also found that central defenders on average receive the most passes among defensive players. In contrast, the goalkeeper's position possessed the lowest in-degree score among all defensive players indicating that they do not receive many passes from their teammates. The same studies from Clemente et al. (2016) and Mendes et al. (2018) can confirm that goalkeepers are the ones who receive fewest passes among defensive players. It denotes that only in specific situations other players try to involve the goalkeeper in the general build-up play.

Adding to that, there was also statistically significant interaction between the defensive player position and passing condition on in-degree score overall. It means that an in-degree score was influenced by the combination of the player's playing position and passing condition. Both centre-backs and the goalkeeper showed higher average in-degree scores for passes received in passing sequences that entered the opposite penalty area compared to overall passes. It denotes that these players were more integral to the team's mechanism by receiving more passes and retaining ball possession in passing sequences that ended up in the opponent's box when compared to all other passing sequences that fit into an overall passes criteria. In contrast, both full-backs showed lower in-degree scores for passing sequences that reached the opposition's penalty area meaning that they received fewer passes from teammates compared to passes received in all other passing sequences of overall data-set. It may imply that both the right-back and the left-back were less likely to be involved in the first phases of build-up due to usually being positioned in fairly advanced zones higher up the pitch. Both centre-backs and centre-midfielders are more likely to circulate the ball around in the initial build-up phase, thus taking it longer until the ball reaches the full-backs who are usually positioned wide and high up the pitch.

The average out-degree centrality scores revealed to be identical for overall passes and passes of passing sequences that entered the opponent's penalty area. It implies that defensive players as a group were equally important and effective in distributing the ball to progress the play in passing sequences that ended up in the opponent's penalty area as well as passing sequences of overall passing data-set. Most importantly, it indicates that defensive players as an entity remained prominently involved in ball circulation and passing combinations to progress the ball to more advanced zones that would eventually end up in the opponent's penalty area.

Furthermore, the results revealed that there was a statistically significant effect of defensive position on out-degree scores overall. It implies that the position of the player affected how many passes he was able to perform successfully revealing player's importance to the team's possession play. All four defenders showed fairly similar average out-degree scores for both passing conditions with both left-sided defenders (left-back and left centre-back) getting slightly ahead of right-sided defenders. It denotes that every defender in the back four is almost equally important for distributing the ball and contributing to the build-up play. The findings from Clemente et al. (2015) showed that central defenders perform the most passes when playing in a back three system, whereas external defenders (full-backs) are the most active in terms of passes performed in a four men defence. Contrarily, the goalkeeper had the lowest average out-degree score for both passing conditions indicating that goalkeepers are less likely to contribute to their team's positional play in terms of passes. The goalkeeper was also the least contributing defensive player in terms of passes performed as revealed by Mendes et al. (2018) and Clemente et al. (2016).

Statistically significant interaction was observed between player position and passing condition on out-degree scores overall. Both full-backs showed higher average out-degree scores for passes performed in passing sequences that ended up in the opponent's penalty box compared to overall passing sequences. It signifies that the full-backs were more important in distributing the ball and contributing to the attacking play in passing sequences that entered the box. It can be suggested that when the ball is delivered by other players to more advanced zones higher up the pitch, the full-backs become integral to the team's attacking network due to the license they have to situate themselves in those advanced positions. Consequently, the full-backs are in good positions to deliver crosses into the box or combine with wide-forwards that usually tend to move inside to overload the opposition's defenders and create space on the wings for overlapping full-backs. Gomez, Gomez-Lopez, Lago and Sampaio (2012) found that majority of crosses into the box are delivered from side areas in the offensive third which are predominantly occupied by full-backs when they join the attack. What is more, it may indicate teams' tendency to attack down the wings rather than central areas.

The results of betweenness centrality revealed that there was a statistically significant effect of passing condition on betweenness scores with higher values belonging to passes of passing sequences that entered the opposition's penalty area. It means that on average defensive players were more effective at linking with others which meant they had more influence on the ball flow between other players in passing sequences that reached the penalty box.

It was also found that defensive position had a statistically significant effect on betweenness scores overall. Both centre-backs showed the highest average values for both passing conditions implying that the centre-backs had the most impact on passing flow between other players out of all defensive players. The studies of Mendes et al. (2018) and Clemente et al. (2016) confirm the findings of the present study having both central defenders as the highest valued defensive players regarding the betweenness score. In contrast, the goalkeeper was again found to be least impactful to the team's network showing the lowest average betweenness score for both passing conditions. The same studies of Mendes et al. (2018) and Clemente et al. (2016) are in line with the findings also reporting lowest betweenness scores for goalkeeper's position. It can be argued that a lower betweenness score might refer to discrepancy between passes received (in-degree) and passes performed (out-degree). A player has to be situated between other players in terms of receiving and then passing the ball often enough to act as a link to other players. If a player performs more passes in isolation and receives few passes in return, it may indicate that such a player is rarely involved in fluid passing combinations.

In addition to that, both centre-backs retained the highest average betweenness scores when playing position showed statistically significant interaction with passing conditions. Together with both full-backs, they were more effective in bridging other players in passing plays that reached the opponent's box when compared to overall passing plays. On the other hand, the goalkeeper was the only one who had his average betweenness score decreased. It can be said that most of the possession play originates in higher zones of the defensive third with connection to the middle third and due to goalkeeper's positioning, he becomes less involved in a set of passing plays that end up in the penalty area. Brooks, Kerr and Guttag (2016) analysed the 2012/13 Spanish La Liga season and discovered that most of the attempted passes originated from the central and wing zones in the middle third. It shows that most of the passing interactions occur higher up the pitch where the goalkeeper is usually absent.

Lastly, the average closeness scores were also significantly affected by the passing condition. This time, the higher values belonged to overall passes. It denotes that on average it was harder to reach defensive players in terms of passes in passing sequences that reached the opposition's penalty area. Despite that, both centre-backs dominated the closeness centrality metric by showing the highest average scores among all defensive players in both passing conditions. It goes in line with the findings of betweenness scores where both centre-backs were on top as well. It indicates that both centre-backs were very well connected and could be reached by other players via the shortest possible route. In the study conducted by Clemente et al. (2015), the central defensive position shared similar closeness values with the full-backs. Contrarily, the goalkeeper's position possessed the lowest average closeness score for both passing conditions. It went in line with the findings of Clemente et al. (2015) who recorded the lowest closeness score for goalkeeper's position. It denotes that it takes on average more passes to reach the goalkeeper in a passing sequence and they are not so well connected to the rest of the team.

4.2 Active zones of left-wing corridor

The most active zones in every vertical pitch corridor were investigated in the second part of the analysis. The zones 9, 13, and 17 were the most prominent regions for an in-degree metric (incoming passes) of the left-wing corridor where the left-back usually operates. Teams that showed the highest in-degree value in zones 9 and 13 supposedly had their left-backs situated in the middle third of the left-wing corridor when receiving a pass from teammates. Receiving a pass in zone 9 can indicate that the left-back is slightly more reserved and does not strive to push forward into the attacking half that much. What is more, it may signify that the opposition presses higher up the pitch, thus, forcing the left-back to receive passes deeper inside his team's half. Passes that were received in zone 13 can be interpreted similarly with an exception that the left-back is supposedly more attacking minded by positioning himself in the zone that is located in the opponent's half. Finally, teams that had zone 17 as the most active region for in-degree centrality, supposedly have left-backs that are particularly attacking minded by receiving passes from teammates in the attacking third close to the opponent's penalty area. Likewise, it may indicate that the opposition defends quite deep, thus, the attacking team uses their left-back as an attacking asset.

Zone 13 was way ahead of all other zones regarding an average out-degree score. It means that generally assuming most left-backs tended to perform passes to their teammates when already being positioned in the opponent’s half. It indicates that they are generally more attacking minded and not pressed so heavily by the opposition. However, before passes were performed from zone 13 in a case of most teams, some of them were received in lower zones, some of them in higher zones as discussed in a paragraph above. It can be argued that if passes are received in lower zones (for instance, zone 9) and then performed from a higher zone (for instance, zone 13 or 17), the left-back tends to carry the ball into more advanced areas of the pitch to threaten the opposition with passes from higher up the pitch. Conversely, if passes are received in higher zones (for example, zone 17) and then performed from a lower zone (for example, zone 13 or 9), the left-back possibly does not want to take major risks of losing the ball and plays a safe pass back or carries the ball himself to a lower zone.

Interestingly, the study by Gama et al. (2014) revealed that left-back was the centroid player implying that he received and performed the most passes in a team. On average, he tended to occupy both zones in the middle third of the left-wing corridor that corresponds to zones 9 and 13 of this study.

The average within degree score was highest for zones 9 and 17. It implies that teams and potentially their left-backs tended to interchange passes within the same zone with a nearby teammate. Teams that had zone 9 as their most active region for passes performed within the zone, possibly had their left-backs interacting with a left centre-back, whilst left-backs who spent the most time in zone 17 were most likely to connect with left-wingers or left-midfielders. The highest within degree value belonged to Basel for zone 5 that is located in a team’s defensive half. It implies that the Swiss side was usually pressed quite deep into its own half and had both the left wing-back and left centre-back (Basel played with a back five) interacting fairly frequently within the same zone. All in all, a combination of zones 9, 13, and 17 were evidently most active in the left-wing corridor where the left-back normally operates.

4.3 Active zones of left-centre corridor

The average in-degree values of most active pitch zones in the left-centre corridor revealed similar results to most prominent regions in the left-wing corridor. The middle third zones 10 and 14 were the most active areas of the pitch for the majority of the teams potentially having their left centre-backs receiving most passes from teammates in those two areas. It can be argued that teams that had their left centre-backs receiving passes in zone 10 were usually facing the opposition’s strikers who pressed slightly higher up the pitch. Contrarily, the left centre-backs who received the majority of passes in zone 14 were facing the opposition’s deep block (defending deep in their own half) and were able to position themselves in higher zones to receive passes from teammates.

Zone 10 was arguably the most active zone for out-going passes (out-degree value) in the left-centre corridor. A similar trend in the out-degree scores for the left-wing corridor pitch areas can be seen here as well. Even though, a high number of passes were performed from zone 10, not necessarily all of them were received in zone 10. Teams that had the highest average in and out-degree values for zone 10, potentially had their left centre-backs receiving and performing the pass from the same zone. However, some teams had zone 14 as their most active zone for receiving passes in the left-centre corridor and zone 10 for outgoing passes. It implies that usually the left centre-back would receive the ball higher up the pitch but possibly be pressed by the opponent's striker or would not be able to find a passing option right away, thus having to carry the ball backwards into a lower zone and distribute the ball from there.

Zone 10 was also the most prominent region for passes performed within the same area. It denotes that left centre-backs usually tended to interchange passes with a nearby teammate would it be possibly a left-back, a right centre-back or a holding midfielder who drops deeper to aid the build-up process. The other two fairly prominent zones for within passes were zone 6 and zone 14. For zone 6, it can be stated that the opposition was more likely to press higher up the pitch or the team having ball possession deliberately invited the pressure on themselves having the left sided centre-back interchanging the passes in his defensive third. For zone 14, the opposite can be said meaning that the opponent retrieved deeper into their own half allowing the left centre-back to position himself in a higher pitch zone. Gama et al. (2016), who used the same pitch division concept as this study, had zone 10 as the most prominent region for successful passes performed within the zone. All in all, the consensus seems to be that zones 10 and 14 were overall the most active zone in the left-centre corridor where the left centre-back is usually positioned.

4.4 Active zones of right-centre corridor

The average in-degree scores of most used regions in the right-centre corridor showed identical similarities to its neighbour corridor on the left. The in-degree measures revealed that both regions in the middle third (zone 11 and zone 15) were the most active for incoming passes. It means that most likely it was the right centre-back who received passes in these zones replicating similar dynamics of the colleague centre-back on the left. Thus, the interpretation is similar to the one outlined previously. The right centre-backs who tended to receive passes in zone 11 possibly were pressed slightly more intensively by opponent's strikers than those who received most passes in zone 15.

The average out-degree scores had zone 11 as the most active zone for out-going passes. It goes in line with the findings of the left-centre corridor which had zone 10 (the same horizontal corridor) as its most prominent region for out-degree metric. Performing majority of passes from a lower middle third zone indicates that the right centre-back is potentially pressed a bit higher by the opposition's striker. Consequently, the fact that a high number of passes were also received in zone 11 denotes that most of the right centre-backs did not aim to carry the ball up the pitch into higher zones. Nevertheless, zone 15 was the second most active region in the right-centre corridor for out-going passes. A few teams that had zone 11 as the most frequent zone for incoming passes also had zone 15 as the most prominent region for passes performed. It suggests that certain right sided centre-backs tend to dribble with the ball forward into more advanced areas of the pitch, thus, potentially trying to disbalance the opponent's defensive shape and facilitate own team's build-up play.

The average within degree scores revealed that zones 11 and 15 were the most active regions for passes performed inside the same zone. It signifies that the right centre-backs also tended to interchange passes with a nearby teammate whether it be a right-back, a holding midfielder or left centre-back. Generally, it was evident that zones 11 and 15 were the most active zones for all three degree centralities in the right-centre corridor. These findings go in line with the same study by Gama et al. (2016) who found zone 11 and zone 15 to be the areas with the most successful within passes performed. Both these zones belong to the middle third of the right-centre corridor.

4.5 Active zones of right-wing corridor

The analysis of the most active zones in the right-wing corridor revealed some interesting results. Zones 16 and 20 were the most used for incoming passes implying the right-backs' tendency to operate in those areas. Being positioned in the zones that are closer to the opponent's penalty area indicate an attacking nature of right-backs. Receiving the ball in advanced areas provides a better attacking input and force the opposition into deeper defensive positions. Consequently, there are more chances to create danger when having additional support from the right-back in advanced pitch regions. Adams, Morgans, Sacramento, Morgan and Williams (2013) claimed that full-backs play a significant role in a team's offensive strategy contributing to the passing sequences in all zones of the pitch.

The highest average out-degree values were also associated with regions 16 and 20. Relating this to the previously discussed in-degree metric, it can be stated that the right-backs tend to pick one of three scenarios. Either performing a pass from the zone where the ball was received or dribbling back into a lower zone (from 20 to 16) or carrying the ball into a more advanced zone (from 16 to 20) and then performing a pass. This is evident with teams like Man City or Chelsea following the second scenario or Besiktas that used scenario number three. The remaining teams (their right-backs) tended to perform a pass from the same zone where it was received. Returning to a lower zone (from 20 to 16) may indicate that the passing lanes are blocked and it is hard to progress forward in that area, likewise moving into a higher zone (from 16 to 20) may imply that there is free space up front and the right-back can make additional ground before making a pass. Additionally, receiving and performing passes from the same zone can denote that the right-back is combining with nearby players and his position is more rigid. Brooks et al. (2016) found that a pass from the right-wing of the attacking third (equivalent to zone 20 in this study) to the central zone in front of the opponent's penalty box (equivalent to zone 18 and 19 in this study) is positively associated with shooting opportunities.

The average within degree scores went in hand with the scores of other two degree metrics and had zones 16 and 20 as the most active regions for within performed passes. It can be repeated that receiving and performing passes from more advanced regions indicates a more attacking nature of right-backs in this case. Overall, zones 16 and 20 were the most prominent areas in the right-wing corridor where the right-backs are usually positioned.

4.6 Pitch-player connectivity by position

The last part of analysis looked at the pitch-player connectivity where the most connected zones for each defensive position were investigated. Starting with the goalkeeper, the most occurring passing pathway (10 teams) was having either zone 2 or 3 as start zone and one of the four zones (zone 5; 6; 7 or 8) as ending zone. It indicates an attempt to play out from the back using short distance passes being either short vertical or short diagonal passes. The fact that most of goalkeepers' passing routes occurred in the nearby zones in the defensive third signifies that the opposition team was applying a fairly high press. What is more, it can indicate that the goalkeepers of those teams are good on the ball and do not panic under pressure, thus, continue to play out from the back in short distance passes. Nevertheless, there were a few teams whose goalkeepers used either zone 2 or 3 as starting zone but the end destination was either zone 13 or 14 which is already in the middle third of the opponent's half. It may indicate that those goalkeepers were either given instructions to play long as part of a game plan or they are not comfortable on the ball and struggle when being pressed by the opposition's strikers. The latter usually results in high risk passing options as stated by Adams et al. (2013) that can be interpreted as long direct passes.

The results showed by the right-back position lead to different considerations than the ones outlined for the goalkeeper's position. The right-backs of eleven clubs had either zone 16 or 20 as its starting point for outgoing passes and a mixture of zones in lower and higher regions as a final destination. Teams like Bayern, Porto, and Roma had their right-backs spreading the passes from either zones 16 or 20 to zone 23. It denotes that these right-backs had the tendency to make quite a few crosses into the opposition's box. Teams like Liverpool, Tottenham, and Besiktas had their right-backs choosing the backwards passing pathway (from zone 20 to either 16 or 15). It implies that right-backs for these teams were used in other ways such as maintaining ball possession and combining in certain triangles not intending to deliver crosses into the penalty area. A key thing to note here is that a high number of passing routes chosen by right-backs were in advanced areas of the opposition half. It indicates that full-backs, in general, are the ones who provide width to the team in order to stretch the opposition's defence.

The right centre-backs also showed some varying results regarding pitch-player connectivity. The passing routes usually originated from zones 7, 11, and 15; however, the destination zones varied from team to team. The right centre-backs of Juventus, Sevilla, Roma, Barcelona, Shakhtar and Liverpool tended to play loads of sideways passes to nearby horizontal zones (zone 6 and 10 respectively). It indicates that their main objective might have been to retain ball possession and wait for the right opportunity to progress the ball into more advanced areas. Either it being sideways or forwards passes, the general view is that most right centre-backs tended to play short distance passes. According to Adams et al. (2013), defenders that possess superior technical qualities have higher tendency of maintaining ball possession via short successful passes. In addition, it helps to manoeuvre the opponents around the pitch until an attacking option emerges (Adams et al., 2013). In this case, the only exception was Man United's right centre-back who's most favoured passing route was from zone 7 to zone 16. It implies that longer distance passes were used trying to bypass the opponent's press with little risk or following a more direct playing approach on purpose.

The left centre-backs aimed to progress the build-up with short distance vertical passes as results have revealed. The most common passing route for them was from zone 10 to either zone 14 or 13. Additionally, there were a few teams like Basel, Man United or Porto whose left centre-backs preferred sideways passes. In this case, the aforementioned centre-backs may have been a lit bit more cautious and did not force the play in vertical directions. None of the left centre-backs went for the passing route including more than two zones further away from each other. It implies that short distance passes connecting certain zones were favoured by the left centre-backs. The same argument from Adams et al. (2013) can be used stating that defenders with better technical skills opt for short passing options to unbalance the opposition and find the gaps to progress the ball further.

The left-backs revealed to use diverse passing routes down the left-wing. A mixture of short distance vertical passes, long distance passes down the channel and crosses into the box was prevalent for the left-backs. Teams like Juventus, Chelsea, Liverpool and Roma all had their left-backs connecting zone 17 with one of the zones in the opponent's penalty area suggesting delivery of crosses. Moreover, the left-backs of Bayern, Barcelona, PSG and Shakhtar favoured the passing route within the same zone. However, Bayern's and Barcelona's left-backs were a lot more attacking minded sending passes from zone 17 to another player in zone 17. The left-backs of PSG and Shakhtar were more reserved (connection zone 9 to zone 9) perhaps due to the opposition pressing higher up the pitch or using the left-back as an additional player to form a back three, thus, allowing the right-back on the other side to push forward. In addition, teams like Man United and Basel had left-backs who favoured direct passing route involving long distance passes. It can be argued that this type of left-back is not so efficient going forward or the team's plan is to play in behind the opponent's defence, thus, having its left-back sending long balls over the top. This can be also explained by the lack of technical quality of the player forcing him to distribute the ball forward directly when the opposition adopts a high-press strategy (Adams et al., 2013).

CONCLUSIONS

Ball possession and positional play have become major features when talking about modern football. The most successful and even less successful teams tend to follow this modern playing concept. However, the research in this area has not yet been able to fully explore the modern football phenomena. Most of the research studies tend to focus on how the team works as a complete mechanism neglecting the analysis of separate entities and their contribution to the overall mechanism.

In order to tackle the aforementioned issue, the present study looked into specific playing positions to better understand how certain players contribute to the team's possession play. In most instances, the possession play starts in the defensive third or initial part of midfield third. These are the areas where defensive players most often operate in, therefore, the decision to analyse only them seemed logical. To the best of our knowledge, this is the first study that investigated purely one set of players to determine their impact on the team and playing characteristics.

A network theory concept was applied to investigate the effectiveness of defensive players' passing sequences. So far, research in football passing networks only revolved around overall passing data. However, it does not explain whether the players are equally effective with their passing in different passages of play. For this reason, the overall passes were compared to passes of passing sequences that entered the opponent's penalty box to investigate whether the effectiveness of defensive players participation in specific passing plays increases or decreases. Additionally, possession tracking using pitch zones' analysis with network metrics has not been renown so far, therefore, the present thesis also investigated the distribution of passes by defensive players over the zones of the pitch determining the zones with highest incoming and outgoing passing activities as well as the best connected zones. All of that contributed to the formation of defensive players' tactical profiles.

The main aim of this study was to evaluate the effectiveness of defensive players' participation in different passing sequences as well as examining the tactical profile of defensive players in regard to their passing networks and pitch zones' connectivity. The findings of this thesis revealed the following:

1) The average scores of in and out-degree centralities overall were not affected by the passing condition. The defensive players as an entity were not less effective for receiving and

performing passes in passing sequences that entered the opposition's penalty area compared to overall passes.

2) The average score of betweenness centrality overall was affected by the passing condition. It was higher for passes of passing sequences that ended up in the opposite penalty area. It means that on average defensive players were more effective at linking with others which meant they had more influence on the ball flow between other players in passing sequences that reached the penalty box.

3) The average score of closeness centrality overall was also affected by the passing condition. This time it was higher for overall passes. It denotes that on average it required more passes until the ball reached defensive players in passing sequences that reached the opposition's penalty area.

4) There was a significant effect of playing position on all four network metrics for both passing conditions combined. Both centre-backs (right and left) showed the highest average scores for in-degree, betweenness and closeness centralities. An exception was the out-degree metric that recorded only the right centre-back to have the highest average score. It indicates that both centre-backs are the most important players among all defensive players in terms of the contribution to the team's possession play with passes. In contrast, the goalkeeper showed the lowest average scores for all four degree centralities. It means that the goalkeeper contributes the least to the possession play of the team.

5) A significant interaction between the defensive position and passing condition was observed. Firstly, both centre-backs and the goalkeeper showed higher average in-degree scores for passes of passing sequences that entered the opponent's box. Other players showed higher in-degree score for overall passes. Secondly, both full-backs possessed a higher average out-degree score for passes of passing sequences that reached the opposite penalty area. Other players showed higher out-degree scores for overall passes. Thirdly, both centre-backs showed the highest average betweenness scores for passes of passing sequences that entered the opponent's box. The goalkeeper was the only player who had his score decreased. Fourthly, every defensive player showed lower average closeness scores for passes of passing sequences that reached the opposite penalty box.

6) The most active pitch regions of the left-wing corridor for in, out and within degree centralities were zones 9, 13 and 17.

7) The most active pitch regions of the left-centre corridor for in, out and within degree centralities were zones 6, 10 and 14.

8) The most active pitch regions of the right-centre corridor for in, out and within degree centralities were zones 11 and 15.

9) The most active pitch regions of the right-wing corridor for in, out and within degree centralities were zones 16 and 20.

10) Pitch-player connectivity for goalkeepers revealed the following passing routes indicating the connectivity between the zones via short vertical or short diagonal passes.
Zone 2 and 3 → Zone 5, 6, 7 and 8. Additionally, long vertical or slightly diagonal long passes were also present in some of the goalkeepers' passing routes. Zone 2, 3 and 6 → Zone 13 and 14.

11) Pitch-player connectivity for right-backs revealed mainly two passing routes: backwards or within via short passes and crosses into the penalty box. Zone 20 → Zone 20, 16 and 15; Zone 16 and 20 → Zone 23.

12) Pitch-player connectivity for right centre-backs revealed mainly two passing routes: short vertical and short sideways passes. Zone 11 → Zone 10, 11, 15; Zone 15 → Zone 15 and 20.

13) Pitch-player connectivity for left centre-backs revealed mainly three passing routes: short vertical, short sideways and short diagonal passes. Zone 10 → Zone 13 and 14; Zone 14 → Zone 13 and 14.

14) Pitch-player connectivity for left-backs revealed a mixture of passing routes from passes within the same region, crosses into the box, long vertical passes and short vertical passes. Zone 9 → Zone 9; Zone 13 → Zone 13; Zone 17 → Zone 17; Zone 17 → Zone 22 and 23; Zone 5 and 9 → Zone 21; Zone 13 → Zone 17.

From the results observed it can be stated that defensive players certainly play an important role in the team's possession play. In most cases, their contribution to specific passing plays when the team is trying to enter the opponent's penalty area compared to overall passing distribution did not decrease implying that defensive players are integral to the team's offensive network.

Additionally, it can be said that the goalkeepers mostly started the play or contributed to the build-up while being positioned in their own penalty box and usually used short vertical and short diagonal passes to connect with players in nearby zones. Some goalkeepers also chose to play long balls into the opponent's half bypassing the high press. What is more, both full-backs were the most attacking minded out of all defensive players. They tended to perform passing routines in relatively advanced zones whether it would be crosses into the box, short backwards passes into lower zones or within the same zone. Finally, both centre-backs were usually involved in passing routines while being situated in the middle third of their own half or on occasion the opponent's half of the middle third area. Short vertical and sideways passes were the preferred passing route most of the time with some centre-backs playing long distance passes as well.

RECOMMENDATIONS

The present study tried to band together notational, video and network analyses in order to develop a better understanding of how certain entities within a team operate. Nevertheless, just like any study, it has its limitations that can be used to advise the future research in this area. Adding to that, general recommendations can also be added.

1) The passing sequences to penalty area criteria could be reconsidered for assessing players' passing effectiveness. Even if a passing sequence does end up in the opponent's penalty area, it does not guarantee that a pass performed by a certain defensive player was effective. Contrarily, a passing sequence may not necessarily enter the opponent's penalty box but a pass performed by a player was still effective in breaking the opposition's lines and reaching a teammate in a dangerous position.

2) The difficulty of a pass could be measured by creating a specific profile that defines different types of passes and ranks them based on criteria of difficulty. For instance, a pass that plays away the opponent's forward and midfield lines would be worth more than a simple sideways pass with no opponents around.

3) Other groups of players such as midfielders and attackers could also be investigated as a separate entity in the same study. The overall comparison between defenders, midfielders and attackers can then be done to determine which entity contributes the most to the team's possession play.

4) A larger sample size in terms of matches analysed is needed to fully assess the validity of results. Additionally, selecting only a few teams, which level of performance differed significantly (champions team and relegated team), rather than a large group of teams could be preferred. It may allow to determine on a deeper level how players of the same entity (defenders, midfielders or attackers) operate differently in best and worst teams.

5) Research studies that use pitch zones for tracking ball possession could reach a consensus for using the same pitch division method. If a pitch is divided into a different number of zones, it is hard to compare your findings with the findings of other researchers because of the difference of how the pitch was divided.

6) Lastly, the opposition players could be incorporated into analysis when passing sequences are analysed. Positions taken up on the pitch by the opposition players partly determine the actions of the team that is in possession. For this reason, having this information discarded makes it a one-way analysis.

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ANNEXES

Comparison of best and worst teams passing networks

Real Madrid were the winners of the 2017/18 Champions League season, thus can be declared as the best team of the knockout stage. Besiktas lost the tie in an aggregate score of 1-8 and can be declared as the worst team of the knockout stage.

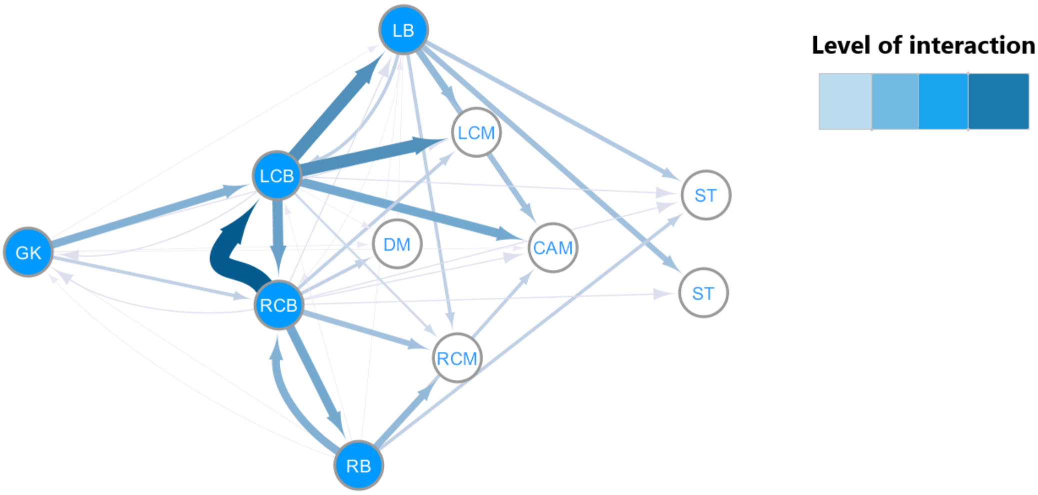

Figure 5. Real Madrid's overall passing network combined from seven matches containing only passes performed by defensive players (blue nodes)

From a visual network we can observe that left-sided defenders were more actively involved in the possession play. The left centre-back (LCB) and left-back (LB) had stronger passing connections with the left central-midfielder (LCM) and the central attacking-midfielder (CAM). Additionally, the left-back was also strongly involved in interactions with both strikers. On the opposite side, both right-sided defenders were less engaging with forward passes and tended more to shift the ball across the back-line. The goalkeeper also favoured the distribution to the left rather than the right side. All of this may indicate that Real Madrid had a tactic to use right-sided defenders for ball-retention trying to invite the opponent on that side before swiftly switching the ball to the left. On the left side, defenders with better ball-playing and passing ability tended to forward the play into more advanced areas, especially the left-back who looks very attacking-minded.

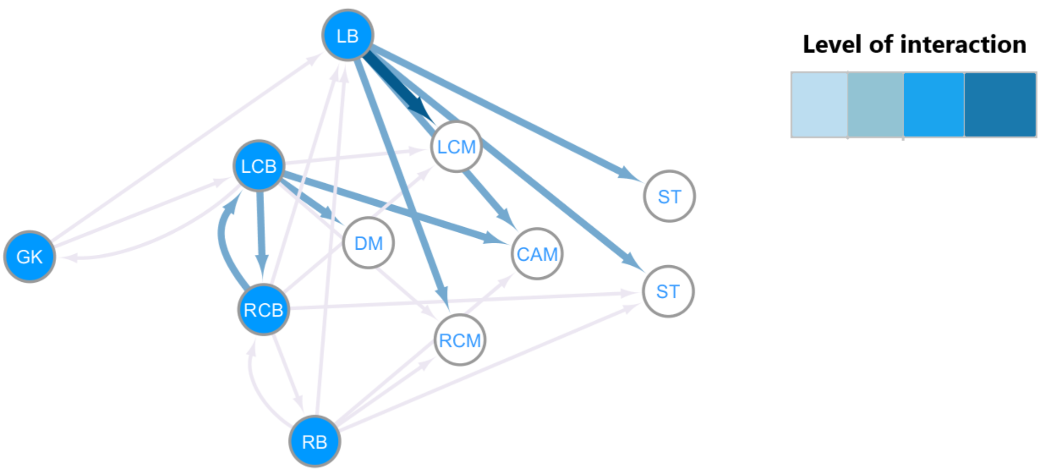

Figure 6. Real Madrid's passing network of all passing sequences combined from seven matches that entered the opposition's penalty area containing only passes performed by defensive players (blue nodes)

Real Madrid's preference to utilise the left-sided defenders in passing sequences that entered the opposite penalty area is even more noticeable in the above displayed network graph. Right-sided defenders were even less engaged in interactions with players in more advanced positions indicating a low level of involvement. It can be stated that the left-sided defenders contributed the most to the team's build-up in passing sequences that reached the opposite penalty box.

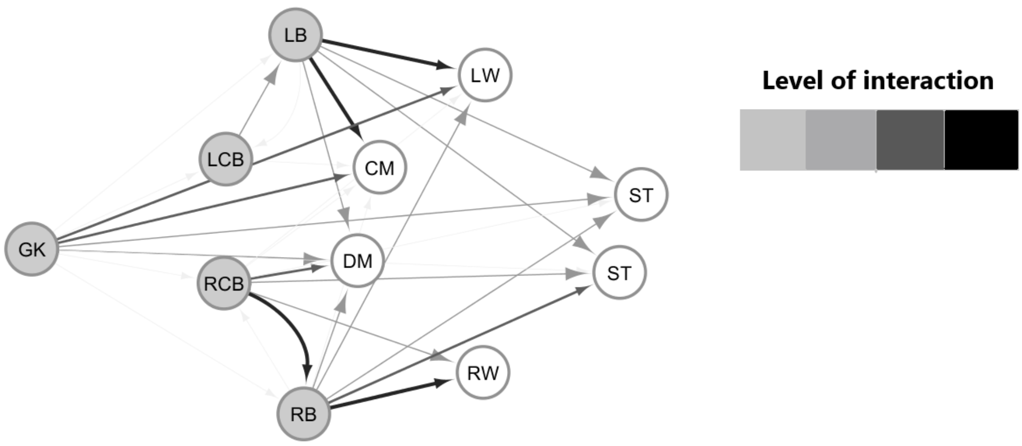

Figure 7. Besiktas' overall passing network combined from two matches containing only passes performed by defensive players (grey nodes)

From a visual network we can see that defensive players of Besiktas tended to prefer direct and longer distance passes. The goalkeeper was especially inclined to distribute long balls to the left-winger and the striker. It indicates that Besiktas back-line was pressed deep into their own defensive third by the opponent. Consequently, the goalkeeper had to opt for more direct passing routes due to lack of technical and passing ability. In general, the most active defensive players were both full-backs (RB and LB) implying Besiktas' intention to build-up from defence down the sides. This would again mean that both centre-backs (RCB and LCB) were heavily pressed by the opposition's strikers forcing them to play the ball out-wide to the full-backs. Overall, the centre-backs were seldom engaged in passing interactions suggesting their poor ability on the ball when pressed by the opponents.

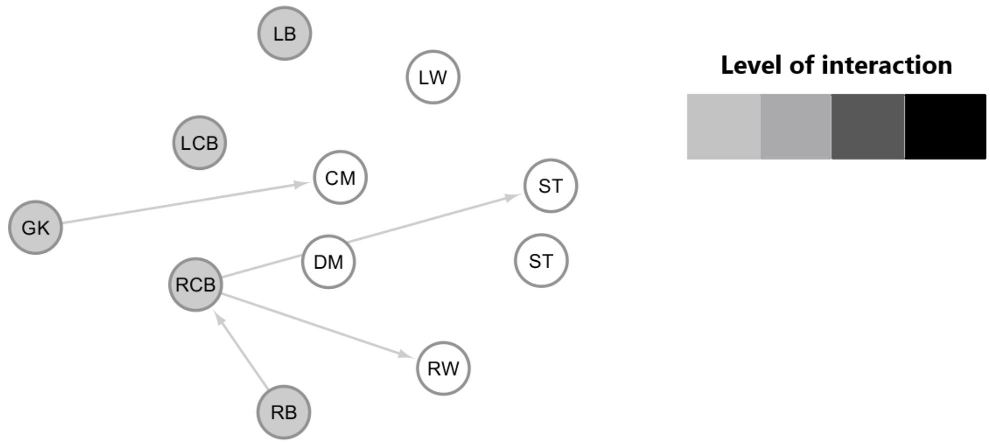

Figure 8. Besiktas' passing network of all passing sequences combined from two matches that entered the opposition's penalty area containing only passes performed by defensive players (grey nodes)

The defensive players of Besiktas had even less impact on the team's build-up play in passing sequences that reached the opposite penalty area. The right-sided defenders took part in a few passing plays that ended up in the penalty box but the level of participation was very low. It denotes that defensive players of weak teams are less capable on the ball and struggle to significantly contribute to the team's possession play.

SCIENTIFIC ARTICLE

INVESTIGATING THE TACTICAL PROFILE OF DEFENSIVE PLAYERS IN ELITE FOOTBALL. A NETWORK THEORY ANALYSIS

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Abstract

In the present study, a network theory analysis method was applied to examine the effectiveness of defensive players' contribution to the team's possession play and determine their tactical profile. The overall passing data-set was compared to passing data of passing sequences that entered the opposite penalty area. The player, pitch and pitch-player passing networks were investigated. The degree centralities of in, out, betweenness and closeness were used for player networks analysis. The degree centralities of in, out and within were applied to examine the most prominent pitch zones. There were statistically significant differences for degree centrality metrics when considering each defensive player position and passing condition. The main results revealed that the centre-backs were the most integral players to the team's possession play, whereas the goalkeeper contributed the least. For the in-degree metric, the goalkeeper and both centre-backs had a higher effectiveness ratio in the passing sequences that ended up in the opponent's penalty box compared to overall passing sequences. For the out-degree metric, both full-backs possessed a higher effectiveness ratio in the passing sequences that entered the opposite penalty area. For the betweenness centrality, everyone except from the goalkeeper made a greater impact on passing plays that reached the opponent's penalty area. For the closeness centrality, every single defensive player had less influence on the team's passing plays that ended up in the rivals penalty box. The most active pitch zones of the left-wing channel were zone 9, 13 and 17 with zones 16 and 20 on the opposite wing. The left-centre channel had zones 10 and 14 as the most active areas, whereas zones 11 and 15 were the most prominent regions in the right-centre channel. The goalkeepers tended to connect the zones via a mixture of short and long passes. The full-backs were usually positioned higher up the pitch and opted for short backwards or forwards passes or crosses into the box. Both centre-backs preferred to retain ball-possession via short sideways, vertical and backwards passes.

Introduction

Football is a team sport where all four entities including the goalkeeper, defenders, midfielders and forwards have to work in synchronization to operate efficiently as a unit (Lusher et al., 2010 as cited in Clemente et al., 2016). However, it can be argued that some entities or some parts of the entity used to be treated or are treated as having more responsibility in certain phases of play than others. According to Wallace and Norton (2014), football has experienced some major changes over the past four or five decades in terms of its structure, game speed and playing patterns. It is safe to say that all these changes were only possible due to improved technical, tactical and physical abilities of players. As stated by Wallace and Norton (2014), the passing rate has shown the most significant changes increasing by 35% overall from 1966 to 2010. It denotes that the most influenced area of the game has been the utilisation of ball-possession.

Since a big part of a modern game is based around possession style of play (Collet, 2012), it can be argued that some entities were more prone to experience a need to broaden their playing profile. The goalkeeper and defenders can be described as the two entities of a football team that seem to have come to the fore when talking about their importance in the possession-based game. The reason for that is simple as the goalkeeper and the defenders are the pivotal players in the build-up process when the ball is in the team's defensive third (Williams, n.d.). Consequently, it is possible to create the tactical profile of defensive players using passing distribution data and assess how effective or ineffective the tactical profile might be.

Traditionally, the most common tool used to investigate the passing distribution has been notational analysis (Hughes & Bartlett, 2002). However, using this approach to analyse passing distributions on its own usually lacks contextual information (Rein & Memmert, 2016). For this reason, a complementary tool that would compensate for the scarcity of contextual information when applying a traditional notational analysis concept has to be used.

Social network analysis can be regarded as such a tool that provides contextual information to the passing distribution data set (Clemente et al., 2016). In a field of team sports, a concept of social network analysis refers to the interactions between the players via passing links (passes received and performed) that define the organisation of a team (Buldu et al., 2018). The main advantage of using the social network concept in football is that it permits the incorporation of social hierarchy to individual level measures (Lusher, Robins & Kremer, 2010). Some players are more influential than others and social network analysis considers that rather than assuming that each player contributes equally to the team (Lusher et al., 2010).

Nevertheless, just like any theoretical concept, social network analysis is susceptible to having limitations. So far, research studies on network analysis in football used the overall passing data-set as a way to investigate individual players' metrics (Clemente et al., 2015; Mendes, Clemente & Mauricio, 2018; Gama et al., 2014; Gama et al., 2016). Unfortunately, the problem with such an approach is that majority of situational information is discarded since the passes are not split into different categories that eventually fails to consider the varying importance of them in different passages of play. Adding to that, the contextual element regarding overall passing distribution is not the only issue in network analysis research. McLean, Salmon, Gorman, Stevens and Solomon (2018) further criticise football research due to lack of match context in respect of pitch zones where possession can be tracked.

Passing sequences that end up in the opposition's penalty box can be regarded as a category of passes of a specific passage of play. A number of studies found that shots taken from inside the penalty box are more effective than those taken from outside (Acar et al., 2009; Bergier, Soroka, & Buraczewski, 2008; Grant, Williams & Reilly, 1999 as cited in Ruiz-Ruiz, Fradua, Fernandez-Garcia & Zubillaga, 2013). Hence, it indicates that entering the penalty area is one of the key objectives when having ball possession since it has the potential to end up in a shot and eventually a goal. However, even though the key performance indicator of penalty area entries is a valid measurement for the effectiveness of offensive actions, only counting the number of times the team enters the opposition's penalty box can miss important contextual information. For this reason, the strategy used for this research was to accompany the entries into the penalty area with network theory.

Considering the reasons outlined in the earlier sections, the main aim of this study was to evaluate the effectiveness of defensive players' participation in the team's passing sequences concerning their passing networks and pitch zones' connectivity that overall determines the tactical profile of defensive players. The analysis is two-folded: 1) Comparing the defensive players' overall passing data with the data of passing sequences that ended up in the opponent's penalty area using degree centralities of networks. 2) Investigating the distribution of passes by defensive players over the zones of the pitch determining the zones with highest incoming and outgoing passing activities as well as the best-connected zones.

Research methodology

Sample

Twenty-nine official matches of the 2017/18 UEFA Champions League knockout stage were analysed in this study. These were the matches of 16 teams that progressed from the group stage to the knockout stage which consisted of round-of-16, quarterfinals, semi-finals, and the final. As a result, a total of 58 player adjacency matrices were generated from the coded passing sequences that entered the opponent's penalty area. Moreover, the overall passing distribution data from all 29 matches were obtained from the official UEFA website. Consequently, another 58 player adjacency matrices were generated from the overall passing data. The analysed defensive players were the goalkeeper, the right centre-back, the left centre-back and the left-back. The centre-defender in a back three system was excluded from the analysis since only two teams played with a back three system making it a disproportionate analysis.

In addition to player adjacency matrices, a total of 58 pitch zone adjacency matrices were generated using the data retrieved from the passing sequences that ended up in the penalty box. On top of that, 58 goalkeeper adjacency matrices, 58 right-back adjacency matrices, 58 right centre-back adjacency matrices, 58 left centre-back adjacency matrices, and 58 left-back adjacency matrices were generated as well making it a total of 288 adjacency matrices specifically for defensive players. All in all, a total of 98 defensive players (80 defenders and 18 goalkeepers) were analysed.

Procedures

For the purpose of this study, the overall passes and passes of sequences that entered the opponent's penalty area were investigated. According to Ruiz-Ruiz et al. (2013), an entry into the penalty area is defined as an action that takes place when the team having possession of the ball passes the ball into the opposition's penalty area having a teammate receiving the ball there (taking a touch and controlling it) or if a player carried the ball into the opponent's penalty area (the last action was not a pass). A key thing to note is that if a pass that reached the penalty area was not received by the team's own player inside the opponent's penalty box (the ball went through the area with no one stopping it or it was cleared away by the opponent), such passing sequence was discarded. Additionally, in cases when the ball was delivered straight into the box, for example, from a free-kick or a corner-kick, these passing sequences were also discarded.

In order to carry out the analysis of passing networks, an adjacency matrix that represents the connection between the node (player) and an adjacency node (teammate) has to be built (Clemente, Martins, Kalamaras, Wong & Mendes, 2015). In the case of football network analysis, the connection between the nodes is defined as a pass (Clemente et al., 2015). Every time the player performs a successful pass to his teammate, it is codified as 1 (Clemente, Martins, Kalamaras, Oliveira, Oliveira & Mendes, 2015). If more than one pass is performed to the same teammate, it is codified based on the number of passes performed (Clemente et al., 2015). If no passes are performed between the players, it is codified as 0 (Clemente et al., 2015). Consequently, each interaction between the teammates contributes to the unit of attack that is described as a passing sequence starting with a successful pass and ending when the team loses ball possession (Clemente et al., 2015). An example of a passing sequence until the ball is lost can be seen in Figure 1.

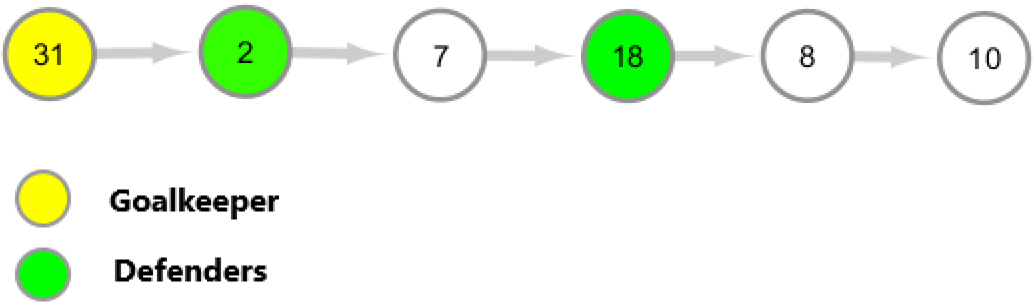

Figure 1. Example of data collecting. Passing sequence that entered the penalty area involving defensive players

Once all the passing sequences are coded, an overall adjacency matrix summing up all of them is generated (Clemente et al., 2015). In respect to this paper, an overall adjacency matrix based on overall passing data-set for each team was already generated by the UEFA in their post-match reports. However, an overall adjacency matrix for each team based on passing data of sequences that only entered the penalty area had to be generated manually using the above mentioned technique. An example of an overall adjacency matrix can be seen in Table 1.

Table 1. Example of data coding representing an overall adjacency matrix of passing sequences that entered the penalty area involving defensive players (highlighted in bold)

	P31	**P2**	**P4**	**P7**	**P8**	**P10**	**P17**	**P18**	**P20**	**P25**	**P30**
P31	-	0	0	0	**1**	0	0	0	0	**1**	0
P2	0	-	**1**	0	0	**1**	0	0	**2**	**1**	**1**
P4	**1**	**1**	-	0	0	0	0	0	0	0	**3**
P7	0	0	0	-	0	0	0	0	0	0	0
P8	0	0	0	0	-	0	0	0	0	0	0
P10	0	0	0	0	0	-	0	0	0	0	0
P17	0	0	0	0	0	0	-	0	0	0	0
P18	0	**1**	0	0	0	0	**1**	-	0	**1**	**2**
P20	0	0	0	0	0	0	0	0	-	0	0
P25	0	0	0	0	0	0	0	0	0	-	0
P30	0	0	**1**	**2**	**1**	0	0	**3**	0	0	-

Along with the players' adjacency matrix, an overall pitch zone adjacency matrix for each team was generated based only on passing data of sequences that entered the opponent's penalty area. Additionally, a pitch-player adjacency matrix for each defensive player position was also generated based on the data of passing sequences that ended up in the opposition's penalty area. The same codification method as for player adjacency matrix was used to generate pitch zone adjacency matrices. A pass from one zone to another or within the same zone was codified as 1, with no passes between certain zones or within the same zone codified as 0. If there was more than one interaction between different zones or within the same zone, the number of interactions were codified. An important thing to note is that a pass between zones was codified only if a player received the ball and fully controlled it. A pass that only travelled through the zone but did not stop in the zone was not considered.

Continuing a theme of pitch zones' networks, the playing football field was divided into 24 zones to carry out the analysis of pitch zones' and pitch-player connectivity (Figures 3 and 4). Zones 1; 5; 9; 13; 17 and 21 belong to left-wing. Zones 2; 6; 10; 14; 18 and 22 belong to left-centre corridor. Zones 3; 7; 11; 15; 19 and 23 belong to right-centre corridor. Zones 4; 8; 12; 16; 20 and 24 belong to right-wing. Additionally, zones from 1 to 8 belong to the defensive third, zones from 9 to 16 to the middle third, and 17 to 24 to the attacking third.

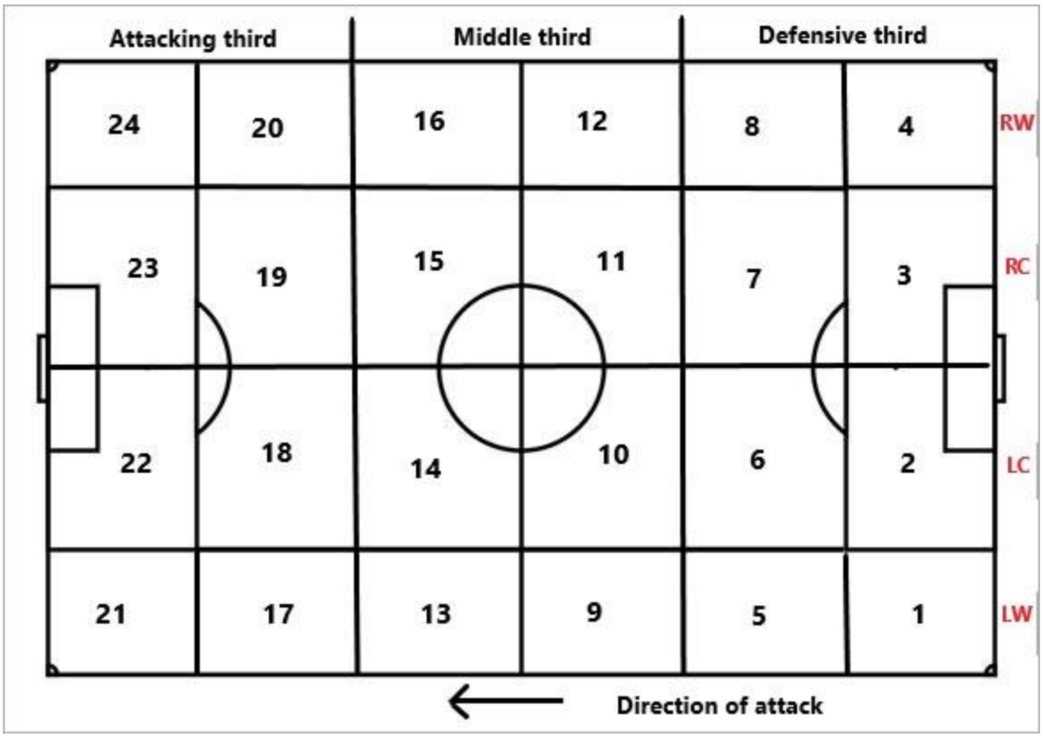

Figure 2. Football field divided into 24 zones. Direction of attack: from right to left. Adapted from Gama et al. (2014)

In respect to player metrics, four centralities were selected to evaluate defensive players' performance. Firstly, the centrality of in-degree was measured that looks at the passes received by a player (Trequattrini, Lombardi & Battista, 2015). It determines the popularity of a player with a higher number of passes received meaning a more popular figure (Trequattrini et al., 2015). Secondly, an out-degree variable was computed that measures the passes performed by a player (Trequattrini et al., 2015). The more important the player is for distributing the ball, the higher the out-degree value (Trequattrini et al., 2015). Thirdly, the betweenness centrality was looked at to determine how often a player is situated between teammates, thus showing players who act as a link (Mendes et al., 2018). A higher betweenness score indicates that a particular player is key for connecting other players in a team (Clemente et al., 2016). Fourthly, the closeness score allows to determine how easy it is to reach a player in a team in terms of passes (Pena & Touchette, 2012). A player possessing higher closeness score is easier to access via passes (requires fewer passes to be reached by teammates) than a player with a lower score (Pena & Touchette, 2012).

For the pitch zone analysis, the zones represent the nodes allowing the analysis of passes in, out and within the zone (Mclean et al., 2018). In this case, degree centrality metrics were measured to evaluate zone importance. Firstly, an in-degree metric was computed that counts the number of incoming passes to the zone (Mclean et al., 2018). A higher number of passes entering a certain zone denotes that to be a target zone (Mclean et al., 2018). If very few passes reach a specific zone, it can be described as a neglected or ignored region of the pitch where the play does not take place very often (Mclean et al., 2018). Secondly, an out-degree centrality computed the outgoing passes from one zone to another (Mclean et al., 2018). A pitch region that records more outgoing passes automatically holds a higher out-degree score indicating a prominent zone for distributing the ball to other zones (Mclean et al., 2018). Lastly, a within degree centrality was measured to identify the most prominent intra-zones (Mclean et al., 2018). It means that the passes performed within the same zone were taken into consideration. A large within score suggests slower ball movement and progression of play since more than one player is positioned in the same zone (Mclean et al., 2018).

The data-set containing the mean values of degree centrality metrics for each passing condition and player position were analysed using the Two-Way Mixed ANOVA after validating the normality and homogeneity assumptions. The independent variable of the passing condition was assigned to the *within-subjects* factor and had two levels: overall passes and passes of passing sequences that entered the opposite penalty area. The independent variable of player position was assigned to the *between-subjects* factor and had five levels: the goalkeeper, the right-back, the right centre-back, the left centre-back and the left-back. The dependent variable of this study was the degree centrality metric (in, out, closeness and betweenness).

The procedures were performed using IBM SPSS Statistics package (version 25.0, Chicago, Illinois, USA). Statistical significance was set at $p < 0.05$. The descriptive analysis was performed for the pitch zones and pitch-player connectivity.

Results

Overall passes vs Passing sequences to penalty area

The findings revealed statistically significant interaction between the player position and passing condition for the in-degree metric ($F(4, 75) = 5.144$, $p = 0.001$, $n_p^2 = 0.215$). The right centre-back (*M* = 0.269, *SD* = 0.153) and left centre-back (*M* = 0.284, *SD* = 0.097) both showed higher average in-degree scores for passes of passing sequences that entered the opponent's penalty area compared to in-degree scores of overall passes (right centre-back *M* = 0.218, *SD* = 0.038; left centre-back *M* = 0.232, *SD* = 0.036). The goalkeeper also showed a higher average in-degree score for passes received in passing sequences that ended up in the penalty box (*M* = 0.098, *SD* = 0.082) compared to overall passes (*M* = 0.086, *SD* = 0.037). However, both full-backs possessed higher average in-degree values for overall passes (right-back *M* = 0.224, *SD* = 0.053; left-back *M* = 0.240, *SD* = 0.043) than passes of passing sequences that entered the penalty area (right-back *M* = 0.178, *SD* = 0.073; left-back *M* = 0.172, *SD* = 0.107).

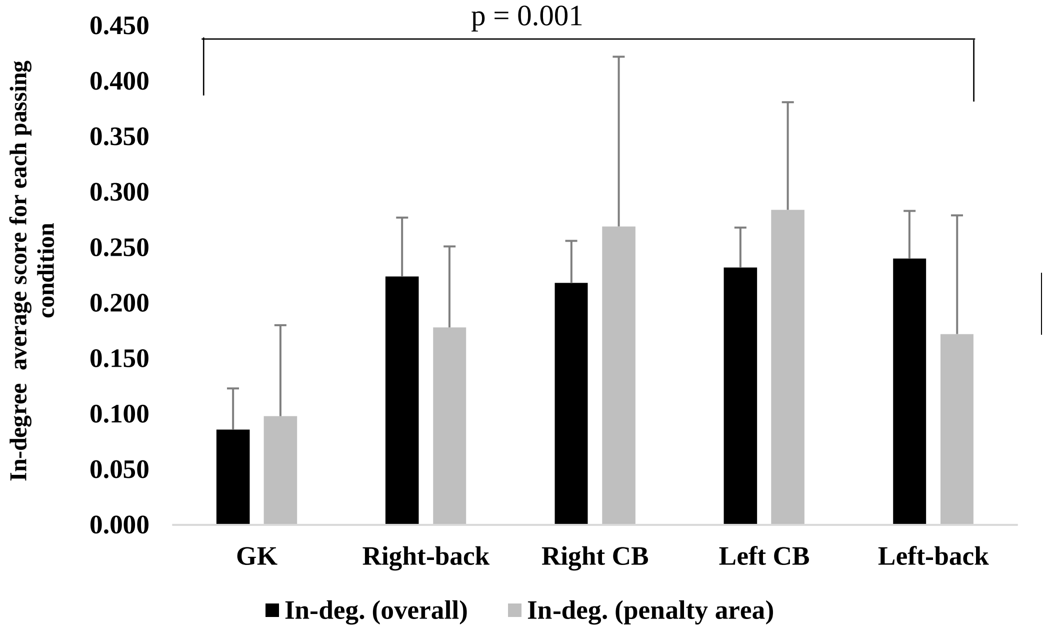

Figure 3. Two-Way Mixed ANOVA values for the in-degree centrality metric

There was also a statistically significant interaction between the player position and passing condition for the out-degree variable ($F(4, 75) = 12.647$, $p < 0.001$, $n_p^2 = 0.403$). The descriptive statistics revealed that the goalkeeper (*M* = 0.121, *SD* = 0.034), right centre-back (*M* = 0.234, *SD* = 0.042) and left centre-back (*M* = 0.247, *SD* = 0.038) possessed higher average out-degree scores for overall passes compared to passes of passing sequences that entered the penalty area (goalkeeper *M* = 0.074, *SD* = 0.061; right centre-back *M* = 0.216, *SD* = 0.067; left centre-back *M* = 0.216, *SD* = 0.050). In contrast, the right-back (*M* = 0.231, *SD* = 0.075) and left-back (*M* = 0.263, *SD* = 0.075) showed higher average out-degree scores for passes performed in sequences that entered the opponent's penalty box than overall passes (right-back *M* = 0.193, *SD* = 0.042; left-back *M* = 0.203, *SD* = 0.033).

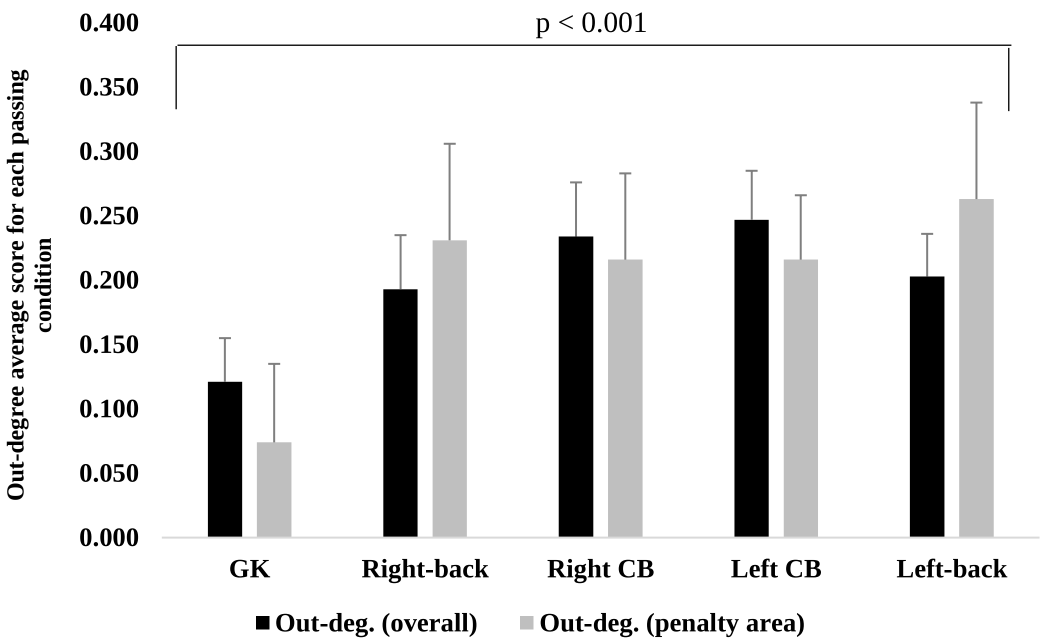

Figure 4. Two-Way Mixed ANOVA values for the out-degree centrality metric

In addition, there was also statistically significant interaction between the player position and passing condition for the betweenness centrality ($F(4, 75) = 6.543$, $p < 0.001$, $n_p^2 = 0.259$). All defensive players, apart from the goalkeeper, showed higher average betweenness scores for passes of passing sequences that entered the opponent's penalty area (right-back *M* = 0.043, *SD* = 0.023; right centre-back *M* = 0.071, *SD* = 0.041; left centre-back *M* = 0.085, *SD* = 0.045; left-back *M* = 0.049, *SD* = 0.028). The goalkeeper was the only defensive player who possessed a higher average betweenness score for overall passes (*M* = 0.024, *SD* = 0.021) compared to passes of passing sequences that reached the opposite penalty box (*M* = 0.015, *SD* = 0.021).

The right-back (M = 0.020, SD = 0.014), right centre-back (M = 0.030, SD = 0.021), left centre-back (M = 0.030, SD = 0.013) and left-back (M = 0.023, SD = 0.011) all showed lower average betweenness values for overall passes.

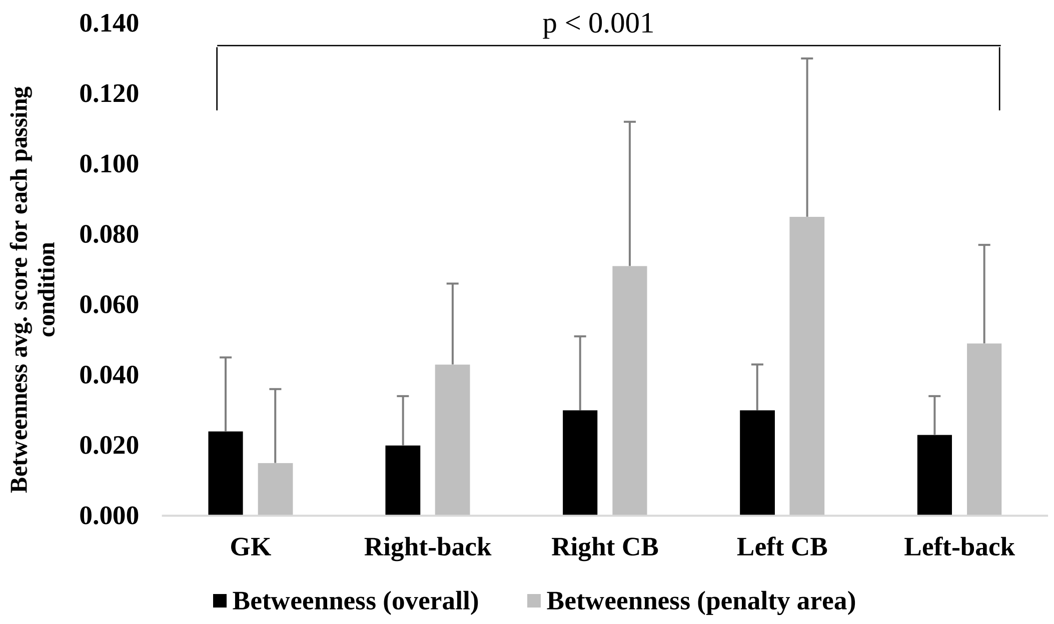

Figure 5. Two-Way Mixed ANOVA values for the betweenness centrality metric

In addition to that, there was also statistically significant interaction between the player position and passing condition for the closeness centrality ($F(4, 75) = 4.356$, $p = 0.003$, $n_p^2 = 0.189$). Every defensive player showed higher average closeness scores for overall passes with the left centre-back (M = 0.835, SD = 0.085) and right centre-back (M = 0.799, SD = 0.141) leading the way having the left-back (M = 0.773, SD = 0.126), right-back (M = 0.756, SD = 0.096) and goalkeeper (M = 0.754, SD = 0.065) slightly behind them. As a result, every defensive player had lower average closeness scores for passes of passing sequences that ended up in the penalty area (goalkeeper M = 0.528, SD = 0.156; right-back M = 0.695, SD = 0.145; right centre-back M = 0.705, SD = 0.106; left centre-back M = 0.711, SD = 0.162; left-back M = 0.698, SD = 0.177).

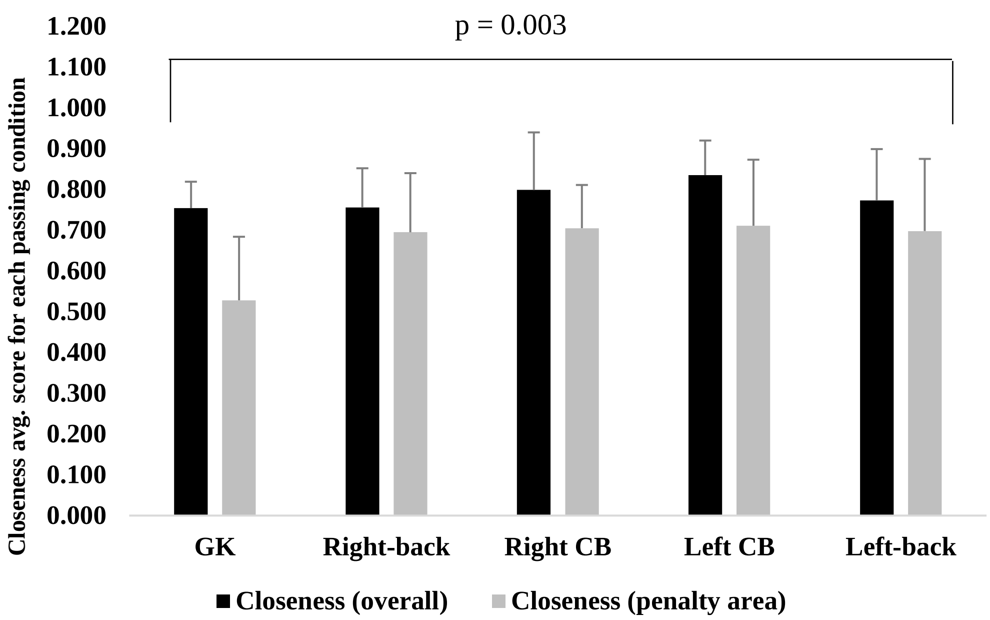

Figure 6. Two-Way Mixed ANOVA values for the closeness centrality metric

The most active pitch zones

The three images displayed below present the most actively used zones in four corridors of the pitch (left-wing corridor, left-centre corridor, right-centre corridor, right-wing corridor). The determination of the most active zones in four vertical strips can portray and describe the profile of the defensive player assigned to one of the four vertical strips since only passes performed by defensive players were coded. Hypothetically speaking, the left-wing corridor (zones 1; 5; 9; 13; 17; 21) belongs to the left-back, the left-centre corridor (zones 2; 6; 10;14; 18) to the left centre-back while his partner occupies the right-centre corridor (zones 3; 7; 11; 15; 19) with the right-back taking up the right-wing corridor (zones 4; 8; 12; 16; 20; 24).

The findings revealed that the most active pitch zones of the left-wing for the in-degree metric (incoming passes) were zone 9 (0.427) and zone 13 (0.514). The left-centre corridor had zones 10 (0.754) and 14 (0.590) as the most prominent regions. Adding to that, zone 11 (0.889) and zone 15 (0.516) had the highest number of incoming passes in the right-centre corridor with zones 16 (0.634) and 20 (0.534) receiving the most passes on the right-wing.

The most active regions for the out-degree centrality were practically the same compared to the in-degree. The zone 9 (0.269) and zone 13 (0.522) were the most functional areas for out-going passes on the left-wing. The zone 10 (1.218) was by far the most active region for passes performed in the left-centre channel with zone 6 (0.267) just behind it. The zones 11 (0.801) and 15 (0.565) in the midfield third of the right-centre corridor and zones 16 (0.738) and 20 (0.449) on the right-wing had the highest out-degree scores.

Lastly, very few changes occurred regarding a within-degree centrality as well. One of them was the prominence of zone 17 (0.137) on the left-wing for passes performed within the zone. However, the zone 9 (0.191) was the most functional of the two. The zone 10 (0.250) and 14 (0.117) had the most passes performed within the same region in the left-centre corridor. The right side of the pitch saw zone 11 (0.127) and zone 15 (0.369) as the most active areas of the right-centre channel with zones 16 (0.228) and 20 (0.353) of the right-wing.

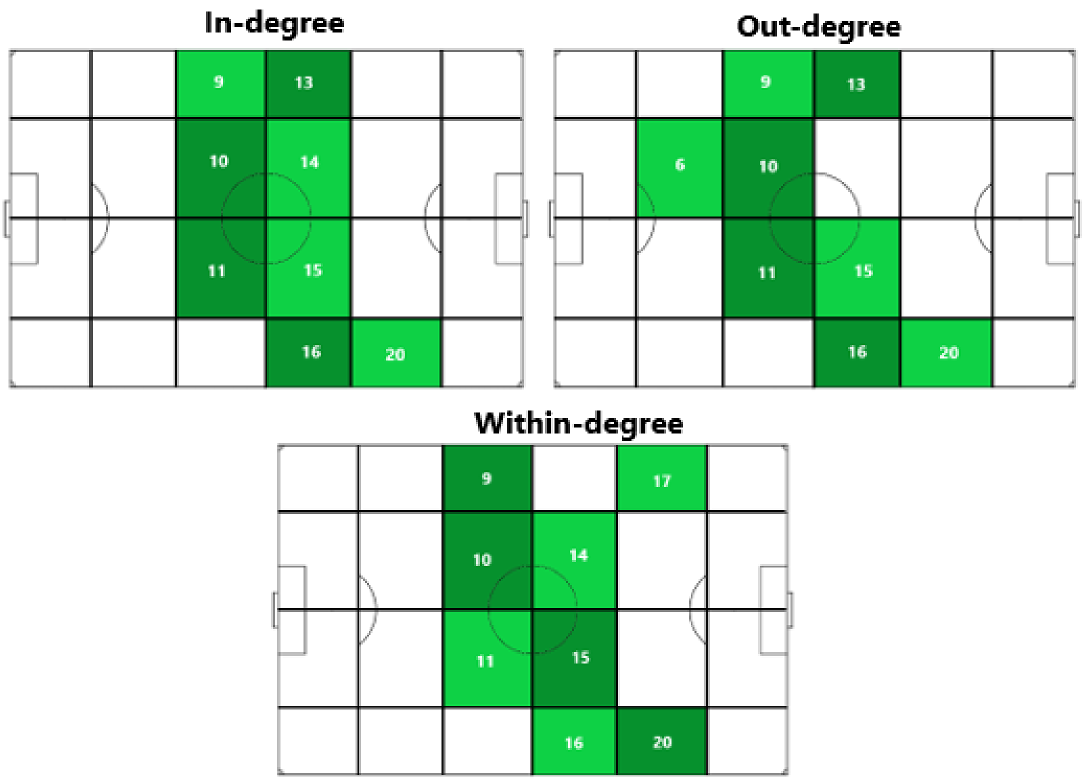

Figure 7. The most active pitch zones in four vertical channels for in, out and within degree centralities

* darker green = higher degree value; lighter green = lower degree value

Pitch-player connectivity by position

Further findings presented in the following figures dwelled into the analysis of the most connected pitch regions by position alluding to the pitch-player connectivity. Starting with Figure 8, the strongest interactions between the zones for the goalkeeper are presented. The results revealed that zones 2 and 3 were the most prominent regions for origins of passes with zones from 5 to 8 as the destination zones. The total degree score for it was 1.790. Additionally, the passing routes from zones 2, 3, 6 and 7 to zones 13, 14 and 16 were also popular among the goalkeepers with a total degree score of 1.530.

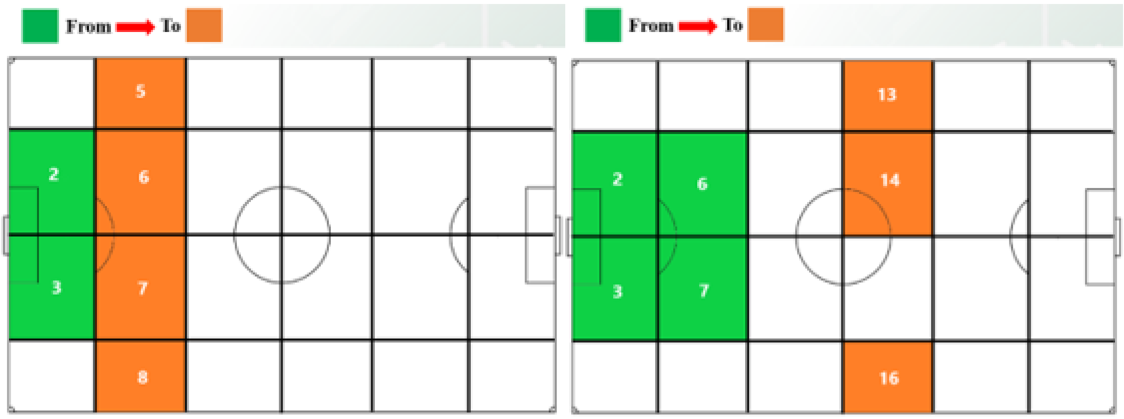

Figure 8. The most connected zones for the goalkeeper

The connectivity between pitch regions was also measured for the right-back position and is presented in Figure 9. Generally, the most popular pitch zones amongst all the right-backs for releasing the pass were zones 20 and 16. The destination zone, however, produced mixed results with a few zones located further back (zone 15 and 16) and in the opponent's penalty area (zone 23). The total degree score for passes from zone 20 to lower zones was 1.522. The other passing route of zone 16 or 20 to zone 23 showed a degree score of 0.908.

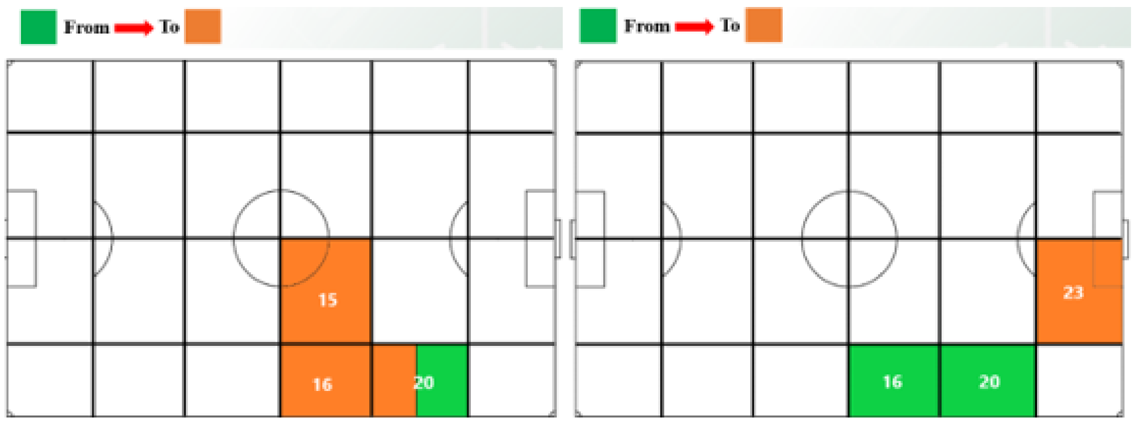

Figure 9. The most connected zones for the right-back

The best connected pitch zones for the right-centre back are presented in Figure 10. The findings revealed that zone 11 was the primary region for performing a pass with zones 10, 11 and 15 being the primary target zones. The total degree score for this passing route was 2.176. Additionally, the zone 15 was also an area where some of the right centre-backs' passes originated from and travelled to either zone 20 or stayed within the zone 15. The total degree score for this passing route was 1.024.

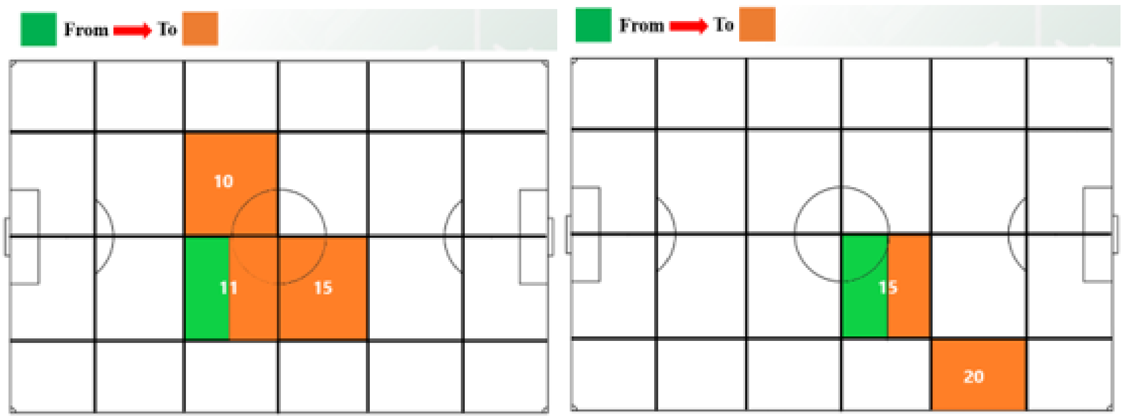

Figure 10. The most connected zones for the right centre-back

The strongest interactions between the pitch zones for the left centre-backs are shown in Figure 11. The results showed that the most prominent passing routes were from zone 10 to either zone 13 or 14. The total degree score for this passing route was 1.585.

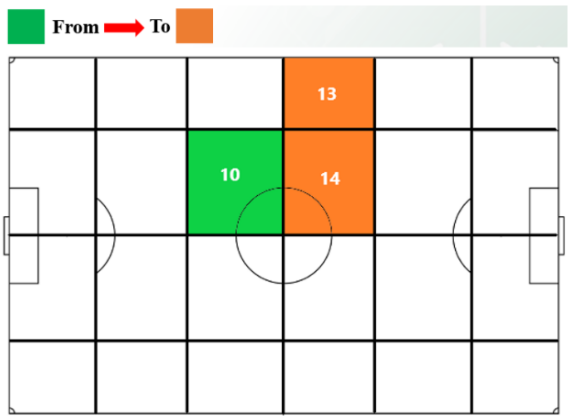

Figure 11. The most connected zones for the left centre-back

The best connected zones for the left-backs are displayed in Figure 12. The findings revealed that the left-backs mostly interacted with other players within the same zones. From zone 9 to zone 9, from zone 13 to zone 13 and from zone 17 to zone 17 were the most often occurring passing routes. The total degree score for these pitch-player interactions was 1.578. Additionally, the left-backs also tended to connect the zones 17 and 21 with the zones in the penalty area. The total degree score for those connections was 1.304.

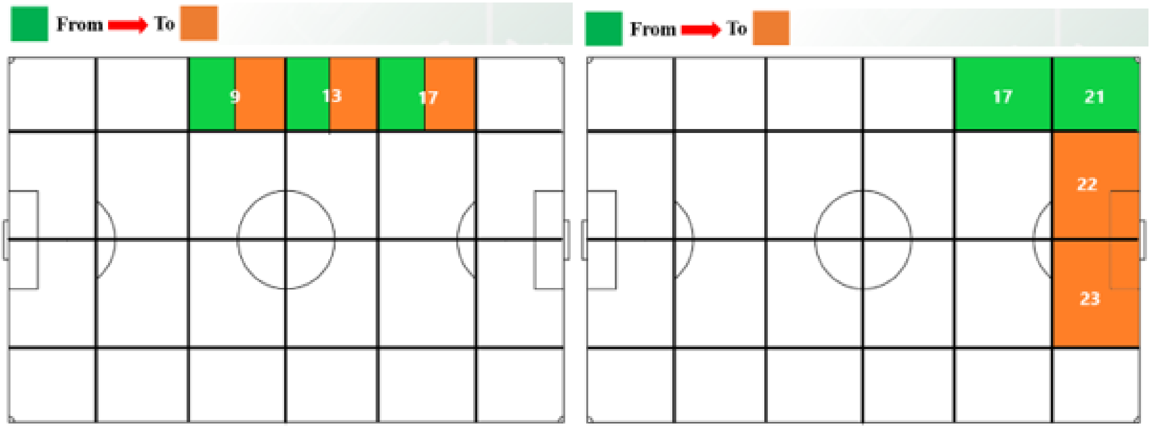

Figure 12. The most connected zones for the left-back

Discussion

The aim of the present study was to examine the effectiveness of the defensive players' participation in a team's passing sequences as well as to determine the tactical profile in regard to their passing networks and pitch zones' connectivity. The first part of analysis compared the defensive players' overall passing data with the passing data of passing sequences that entered the opponent's penalty area using degree centralities.

Both centre-backs and the goalkeeper showed higher average in-degree scores for passes received in passing sequences that entered the opposite penalty area compared to overall passes. It denotes that these players were more integral to the team's mechanism by receiving more passes and retaining ball possession in passing sequences that ended up in the opponent's box when compared to all other passing sequences that fit into an overall passes criteria. Adding to that, both centre-backs showed the highest average in-degree score compared to other defensive positions for both overall passes and passes of passing sequences that entered the opponent's penalty area. These results are in line with those of Clemente et al. (2016) and Mendes et al. (2018) who also found that central defenders on average receive the most passes among defensive players.

Both full-backs showed higher average out-degree scores for passes performed in passing sequences that ended up in the opponent's penalty box compared to overall passing sequences. It signifies that the full-backs were more important in distributing the ball and contributing to the attacking play in passing sequences that entered the box. It can be suggested that when the ball is delivered by other players to more advanced zones higher up the pitch, the full-backs become integral to the team's attacking network due to the license they have to situate themselves in those advanced positions. Consequently, the full-backs are in good positions to deliver crosses into the box or combine with wide-forwards that usually tend to move inside to overload the opposition’s defenders and create space on the wings for overlapping full-backs. Gomez, Gomez-Lopez, Lago and Sampaio (2012) found that majority of crosses into the box are delivered from side areas in the offensive third which are predominantly occupied by full-backs when they join the attack. What is more, it may indicate teams’ tendency to attack down the wings rather than the central areas.

In addition to that, both centre-backs showed the highest average betweenness scores. They were more effective in bridging other players in passing plays that reached the opponent’s box when compared to overall passing plays. On the other hand, the goalkeeper was the only one who had his average betweenness score decreased. It can be said that most of the possession play originates in higher zones of the defensive third with connection to the middle third and due to goalkeeper’s positioning, he becomes less involved in a set of passing plays that end up in the penalty area. Brooks, Kerr and Guttag (2016) analysed the 2012/13 Spanish La Liga season and discovered that most of the attempted passes originated from the central and wing zones in the middle third. It shows that most of the passing interactions occur higher up the pitch where the goalkeeper is usually absent.

The average closeness scores were also significantly affected by the passing condition. This time, the higher values belonged to overall passes. It denotes that on average it was harder to reach defensive players in terms of passes in passing sequences that reached the opposition’s penalty area. Despite that, both centre-backs dominated the closeness centrality metric by showing the highest average scores among all defensive players in both passing conditions. It goes in line with the findings of betweenness scores where both centre-backs were on top as well. It indicates that both centre-backs were very well connected and could be reached by other players via the shortest possible route. In the study conducted by Clemente et al. (2015), the central defensive position shared similar closeness values with the full-backs. Contrarily, the goalkeeper’s position possessed the lowest average closeness score for both passing conditions. It went in line with the findings of Clemente et al. (2015) who recorded the lowest closeness score for goalkeeper’s position. It denotes that it takes on average more passes to reach the goalkeeper in a passing sequence and they are not so well connected to the rest of the team.

The most active zones in every vertical pitch corridor were investigated in the second part of analysis. Zones 9, 13 and 17 were evidently the most active regions in the left-wing corridor where the left-back normally operates. Receiving and performing passes in the higher areas of the opposition half may indicate an attacking nature of left-backs. Conversely, having a left-back operating in his team's own-half may imply the manager's preference to form a back three while the full-back on the other side joins the attack. Interestingly, the study by Gama et al. (2014) revealed that left-back was the centroid player implying that he received and performed the most passes in a team. On average, he tended to occupy both zones in the middle third of the left-wing corridor that corresponds to zones 9 and 13 of this study.

Zones 6, 10 and 14 were the most functional regions in the left-centre corridor usually occupied by the left centre-back. Receiving and performing passes in the zones of the team's own half may indicate that the opposition's strikers were pressing the centre-backs in possession. Conversely, having a left centre-back operating in the zone in the opponent's half implies that the opposition retrieved deeper into their own half and its strikers did not press the centre-backs. Gama et al. (2016), who used the same pitch division concept as this study, had zone 10 as the most active region in the left-centre channel.

Zones 11 and 15 were the most active areas of the pitch in the right-centre corridor. A similar implication about receiving and performing passes in these areas can be made as to the previous one. The more active higher zone would imply that the opposition tended to drop deeper into their own half allowing the centre-back to operate in a higher zone. The more active lower zone suggests that the opposition tended to push out and had the strikers applying pressure on the centre-backs in possession. These findings go in line with the same study by Gama et al. (2016) who found zone 11 and zone 15 to be the key areas for ball retention in the right-centre channel.

Zones 16 and 20 dominated the activity charts of the right-wing channel. Being positioned in the zones that are closer to the opponent's penalty area indicate an attacking nature of right-backs. Receiving the ball in advanced areas provides a better attacking input and force the opposition into deeper defensive positions. Consequently, there are more chances to create dangerous plays in the final third when having additional support from the right-back in advanced pitch zones. Adams, Morgans, Sacramento, Morgan and Williams (2013) claimed that full-backs play a significant role in a team's offensive strategy contributing to the passing sequences in all zones of the pitch.

The last part of analysis looked at the pitch-player connectivity where the most-connected zones for each defensive position were investigated. The first group of best connected zones suggested a possession-based approach. It indicates an attempt to play out from the back using short distance passes being it either short vertical or short diagonal passes. The fact that most of goalkeepers' passing routes occurred in the nearby zones in the defensive third signifies that the opposition teams were applying a fairly high press. What is more, it can indicate that the goalkeepers of those teams are good on the ball and do not panic under pressure, thus, continuing to play out from the back in short distance passes.

The second group of best-connected zones implied a direct playing approach. It may indicate that those goalkeepers were either given instructions to play long as part of a game plan or they are not comfortable on the ball and struggle when being pressed by the opposition's strikers. The latter usually results in high risk passing options as stated by Adams et al. (2013) that can be interpreted as long direct passes.

The results showed by the right-back position lead to different considerations than the ones outlined for the goalkeeper's position. A number of right-backs had the tendency to make quite a few crosses into the opposition's box, whereas other right-backs were used in other ways such as maintaining ball possession and combining in certain triangles not intending to deliver crosses into the penalty area.

The left-backs revealed to use diverse passing routes down the left-wing. A mixture of short distance vertical passes, long distance passes down the channel and crosses into the box was prevalent for the left-backs. This can be supported with the statement of Adams et al. (2013) who claimed that full-backs contribute to the team's offensive player everywhere on the pitch depending on their skill-set.

Finally, both centre-backs had similar tendencies for best-connected pitch zones. Either it being sideways or forwards passes, the general view is that most centre-backs tended to play short distance passes. According to Adams et al. (2013), defenders that possess superior technical qualities have higher tendency of maintaining ball possession via short successful passes. In addition, it helps to manoeuvre the opponents around the pitch until an attacking option emerges (Adams et al., 2013).

Conclusion

From the results observed it can be stated that defensive players certainly play an important role in the team's possession play. In most cases, their contribution to specific passing plays when the team is trying to enter the opponent's penalty area compared to overall passing distribution did not decrease implying that defensive players are integral to the team's possession play.

Additionally, it can be said that the goalkeepers mostly started the play or contributed to the build-up while being positioned in their own penalty box and usually used short vertical and short diagonal passes to connect with players in nearby zones. Some goalkeepers also chose to play long balls into the opponent's half bypassing the high press. What is more, both full-backs were the most attacking minded out of all defensive players. They tended to perform passing routines in relatively advanced zones whether it would be crosses into the box, short backwards passes into lower zones or within the same zone. Finally, both centre-backs were usually involved in passing routines while being situated in the middle third of their own half or on occasion the opponent's half of the middle third area. Short vertical and sideways passes were the preferred passing route most of the time.

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