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# Model Construction Of Basketball Passing Network And Analysis Of Success Factors Of Offensive Rounds

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***Abstract:****In the research of team sports such as ball games, the research method based on network science is in the stage of rapid development. Based on the data of 203 offensive rounds of Guangdong Dongguan bank basketball team in the second and third finals of China professional men's Basketball League (CBA) 2019-2020 season, this paper establishes a passing network model sequence with offensive rounds as the time axis, and discusses the relationship between the topology index of passing network and the success or failure of offensive rounds by using Logistic regression method. The results show that the average clustering coefficient and efficiency value in the passing network have significant influence on the success of offensive round. The probability of success of the offensive round will decrease with the increase of the clustering coefficient in the passing network, and the higher the efficiency value of the player handling the ball at the end of the round, the higher the success rate of the offensive round. Considering the unpredictability of the game, the result was reasonable.*
***Key Word****: basketball offensive round; passing network; topology index; Logistic regression; factor analysis*.

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## I. Introduction

The research method of network science usually abstracts the entities in the complex system of the real world into nodes, The relationship between entities is abstracted into edges, so that the study of the system is transformed into a network with complex topological structure characteristics, in the language of mathematics, that is, the study of graphs[1]. If the object of research is a social unit (individual, group, or subject), it belongs to the category of social network. The research of social networks is an important part of the field of network science research, And it has formed a unique theory and method of "structure-relationship" research in social network analysis[2], A series of results have been achieved in social, trade, cooperation, counter-terrorism, communication and other fields[3].

In sports science research, social network analysis involves earlier related research on players' social network[2], and in recent years it has developed into the study of team sports performance such as ball games[4]. Team sports can be mapped to a player as a node, The interconnection between players is a network structure of edges, so as to conduct research on the relationship between player interaction and team performance[4-5]. The research objects have involved football, volleyball, cricket, basketball and other sports, and the research on football is the most in-depth[5].

In the field of basketball, research results based on social network analysis are still very limited. Fewell uses the data from the first round of the 2009-2010 season playoffs of the National Basketball Association (NBA) to build a network with players as nodes and the trajectory of the ball as connected edges, and explores the team's offensive strategy through changes in the network structure The difference[6], this is the earliest document that social network analysis is applied to basketball performance research[5]. Clemente et al. analyzed the differences in the level of network centrality between different competitive levels and tactical positions in basketball[4]. In [7], the author establishes a player relationship network through the social media connection between NBA teammates on Twitter in the 2014-2015 season, and studies the relationship between the team's season performance and the interactive activity of star players on social media with their teammates. And impact. XIN L et al. included the basketball game stage into the research scope, and used continuous time random block model to cluster the players' game style and performance[8]. Among domestic scholars, Liao Bin's research team used the big data graph analysis framework GraphX software to model the passing data into a graph[9], and on this basis, conducted a quantitative analysis of the pass quality, and proposed a pass quality evaluation method PESV (Pass Expectation Score Value)[10].

During the basketball game, there are 5 players on both sides of the game, representing 5 positions in the basketball field[6](point guard, shooting guard, small forward, power forward, center), playing against the same team The process includes offensive rounds and defensive rounds, and each round takes no more than 24 seconds, and the winner of the game is finally determined based on the score. In the network built around basketball, "individuals" (nodes in the network) are mainly based on the players or players' positions on the court, and some also attach the result of the offensive round as a node[6]. "Relationship" mainly considers two types: social relations between players in daily life, such as social media attention, comments and other interactive behaviors; During the game, the most direct interactive relationship is passing the ball. In terms of research objects, most of the NBA teams and their games are studied[6-10], and domestic basketball games are rarely involved. The article[4] recruited 40 volunteers of different age groups to participate in the live competition in 4 groups. In terms of the data source of the pass data, the article[4]records the game process and related data by the expert group, the article [6,8]records the relevant data through the game video observation, and the article[9-10]studies the extraction of the pass from the game video. Technical means of ball data. In terms of passing network modeling and result analysis, in [6], Fewell et al. constructed the passing network based on the position level rather than the individual level. The resulting network is a summary of the data of all positions during the game, so it cannot reflect Differences at the individual level are taken out, and time dynamics are not considered. The continuous-time random block model proposed by XIN L et al.[8]is based on real-time dynamics to describe player differences, but it is mainly a cluster analysis of players' game styles. Liao Bin's research team studied the extraction of passing data from the perspective of computer science, and discussed the application scenarios of the passing network. It also modeled the summary of the passing data of each season and did not analyze the passing situation of each offensive round. For modeling, the study of the passing network is based on the analysis of the static properties of the network, and the dynamic properties of the passing network structure are not discussed[11-12].

The Chinese Basketball Association (Chinese Basketball Association), referred to as the CBA (CBA), is a multi-year home and away basketball league hosted by the Chinese Basketball Association, the highest level of basketball league in China. The current CBA format includes summer league, preseason, regular season, and playoffs. As of the 2020-2021 season, the CBA is composed of 19 teams.The current league organization divides the 19 teams into two divisions, including 9 teams in the north and 10 teams in the south. Guangdong Hongyuan Basketball Club, which belongs to the Guangdong Dongguan Bank Team, was established in 1993. As of the 2020-2021 season, the team has won 11 CBA championships and is the CBA team with the most championships.

Different from the previous research on the passing network, this article takes the CBA game as the research object and the Guangdong Dongguan Bank team as the research team. By recording the CBA 2019-2020 season finals, the Guangdong Dongguan Bank team and the Liaoning Bengang team are the first. The passing situation of all the Guangdong Dongguan Bank team's offensive rounds in the second and third games has constructed a passing network sequence based on the offensive round. Furthermore, the relationship between the interaction formed by passing between players in each offensive round and the effectiveness of that round is studied. For the passing network of these offensive rounds, four indicators of the number of sides, reciprocal sides, three cycles, and average clustering coefficient are selected, and the efficiency value of each network is defined according to the efficiency value of the player. After index screening and elimination, 4 kinds of indexes are retained. The logistic regression method was used to explore the relationship between these index values and the combined loss of offensive rebounds, and find the index values that have a more significant relationship with the combined power of offensive rebounds. The structure of the full text is as follows: Section 1 introduces the data sources, model construction and network visualization; Section 2 introduces the research methods of this article, the selection of network index values, and the analysis of logistic regression results; Section 3 shows the conclusions of this article.

## II. Network construction and visualization

**data collection**

In a basketball game, the team will score as many points as possible in each offensive round in order to win the game. Passing is the most commonly used technique in basketball games. It is a specific means to achieve tactical coordination and is the basis for all organizations to attack. How about the passing and receiving of the players in each offensive round? What factors affect the passing and receiving of a successful offensive round?

In basketball games, conventional technical statistics include: points, rebounds, assists, steals, blocks, turnovers, fouls, shooting percentage, playing time, etc. After the game, fans can check regular technical statistics through major sports websites or forums. The official NBA website (http://www.nba.com) has provided unconventional technical statistics including passing, defensive influence, movement speed and distance[9], which facilitates the construction of passing networks and related research. At present, China's CBA is still blank in the acquisition of passing data, statistical analysis, and the use of tactics and training around passing data[9].

This article selects the Guangdong Dongguan Bank Team in the fourth round of the CBA 2019-2020 season playoffs, that is, the last two games of the season finals (the second and third games of the fourth round) as the research sample. The final game is the most important game in each season. The 2019-2020 season CBA finals adopts 3 games of 2 wins to determine the final championship team. The other team that entered the finals was the Liaoning Bengang team. Due to the disparity between the results of the two teams in the first game of the finals (the score was 110:88), the two teams had entered the garbage time before the end of the game. Therefore, the first game is not considered in this article. In the results of the last two games, the two teams have their own winners and losers (the scores are 123:115; 113:115 respectively), so that analysis errors will not be caused by only selecting the winner of the game; In addition, in these two games, there was no one-sided situation in which the main players were replaced prematurely. The result of the game was a regular result of winning or losing in basketball.

By watching the live video of the two games of the Guangdong Dongguan Bank team, the team's offensive round pass data was recorded. The specific method is to observe the number on the jersey, that is, the player's number, record the passing route between the players during each offensive round of the team, and map the player's number to the network node (see Table 1). The passing line establishes the directional relationship between the nodes, which is mapped to a directed edge of the network, and is saved in the .net format file of the network analysis software Pajek. Since each team has only 5 players on the court in the basketball game, the total number of nodes in each offensive round network is 5. According to statistics, in the two games watched, the Guangdong Dongguan Bank team had a total of 203 attacks and established 203 .net files.

On the other hand, the performance of a team game depends on the contribution of each player. The performance of players in the game can be reflected through technical statistical indicators, Table 1 lists the average technical data of the relevant players of the Guangdong Dongguan Bank team involved in the basketball data website www.basketball.reference.com in the 2019-2020 season[1]. Note that the average number of missed shots per game (*FGM*) and number of free throws (*FTM*) in the table are based on the number of field goal attempts (*FGA*), number of field goal attempts (*FG*), number of free throw attempts (*FTA*), and number of free throw attempts (*FT*) based on online data. It is obtained by converting the relation $FGM = FGA\text{-}FG$, $FTM = FTA\text{-}FT$.

**Table no 1 :** Shows metabolic parameters of patients of the three groups before treatment.

| Player name (node serial number) | number | Points(PTS) | Assists (AST) | Total Rebounds(TRB) | Steals (STL) | Blocks (BLK) | Miss shots (FGM) | Miss throw (FTM) | turnover(TOV) | efficiency(EFF) |
|---|---|---|---|---|---|---|---|---|---|---|
| Yi Jianlian($v_1$) | 9 | 20.1 | 1.3 | 10.4 | 1.3 | 1.5 | 6 | 1.3 | 1.2 | 26.1 |
| Zhou Peng($v_2$) | 11 | 12.1 | 2.4 | 3.9 | 1.6 | 0.8 | 4.4 | 1.7 | 1.4 | 13.3 |
| Ren Junfei($v_3$) | 20 | 12.9 | 2.4 | 5.8 | 1.4 | 0.8 | 3.6 | 1 | 1.5 | 17.2 |
| Weems($v_4$) | 13 | 20.7 | 6.2 | 5.8 | 1.6 | 0.4 | 7.2 | 0.6 | 2.9 | 24 |
| Zhao Rui($v_5$) | 10 | 13.7 | 4.4 | 4.5 | 2 | 0.3 | 5.7 | 0.6 | 1.8 | 16.8 |
| Su Wei($v_6$) | 12 | 4.5 | 0 | 3.4 | 0.4 | 0.4 | 1.1 | 0.6 | 1.2 | 5.8 |
| Wan Shengwei($v_7$) | 51 | 1.8 | 0.5 | 2 | 0.3 | 0.1 | 0.9 | 0.2 | 0.7 | 2.9 |
| Wang Xinkai($v_8$) | 5 | 5.9 | 0.6 | 1.6 | 0.3 | 0 | 2.3 | 0.1 | 0.7 | 5.3 |
| Du Runwang($v_9$) | 18 | 7.8 | 0.8 | 2.9 | 0.4 | 0.2 | 2.8 | 0.3 | 0.9 | 8.1 |
| Xu Jie($v_{10}$) | 2 | 5 | 2.1 | 1.6 | 1.1 | 0 | 2.5 | 0 | 0.6 | 6.7 |
| Hu Mingxuan($v_{11}$) | 3 | 11.3 | 2.8 | 2.9 | 1.2 | 0.1 | 3.2 | 0.3 | 1.1 | 13.7 |
| Zeng Fanri($v_{12}$) | 22 | 3.5 | 0.4 | 2.8 | 0.3 | 0.4 | 0.7 | 0.4 | 0.5 | 5.8 |

**Model building**

Based on basketball offensive rounds, the passing relationship between players and players can be modeled as a passing network. The nodes in the network represent the players, the edge represents the passing

[1] https://www.basketball-reference.com/international/teams/guangdong/2020.html

relationship between the two players during the game, the arrow represents the direction of the pass, and the number on the edge represents the weight, that is, the number of passes between the players.

Use $V$ to represent the collection of players from the Guangdong Dongguan Bank team in the game, $V=\{v_1,v_2,\cdots,v_{12}\}$, Define the passing network of the $j$ th offensive round as, $G_j=(V_j,E_j,\omega_j)$, Among them, the node set $V_j$ represents the set of players on the field in the offensive round, $V_j=\{v_{j_1},v_{j_2},\cdots,v_{j_5}\}$ and there is $V_j \subset V$. If $v_{j_s}$ passes the ball to $v_{j_t}$ during this round, there is a directed edge $(v_{j_s},v_{j_t})\in E_j$, $E_j$ represents the set of directed edges formed by the passing relationship in the $j$ th offensive round, and $\omega_j$ represents the edge weight.

A dynamic network can be seen as a network composed of time-varying relationships (edges) between nodes [11]. For an offensive round of the game, the formation of the passing network is actually a dynamic process, and the time is continuous [8], The number of nodes is fixed, and the edges increase with time, and the changes of the edges can be expanded with different time steps, thus containing time information (not covered in this article). This dynamic passing network can be approximately explained by the Markov process [12], that is, at any point in time, the current state of the network determines its next evolution, and is not affected by the past, All relevant information is contained in the current state [13]; the player who owns the ball controls their output link, According to their specific position in the actual game process and their views on other players in the network, make the judgment and realization of the passing relationship [14]. The shot result of each offensive round depends only on the player who shot the ball, that is, the last receiver; When an offensive round ends, the formed passing network $G_j=(V_j,E_j,\omega_j)$ can be regarded as a snapshot of the passing network of the round [15].

Figure 1 illustrates the dynamic generation process of the passing network of the 87th offensive round of the third game of the 2019-2020 season finals of the Guangdong Dongguan Bank Team and a snapshot of the passing network of that round, In this offensive round, there were more players participating in the pass, and the number of passes was also relatively large, which is representative.

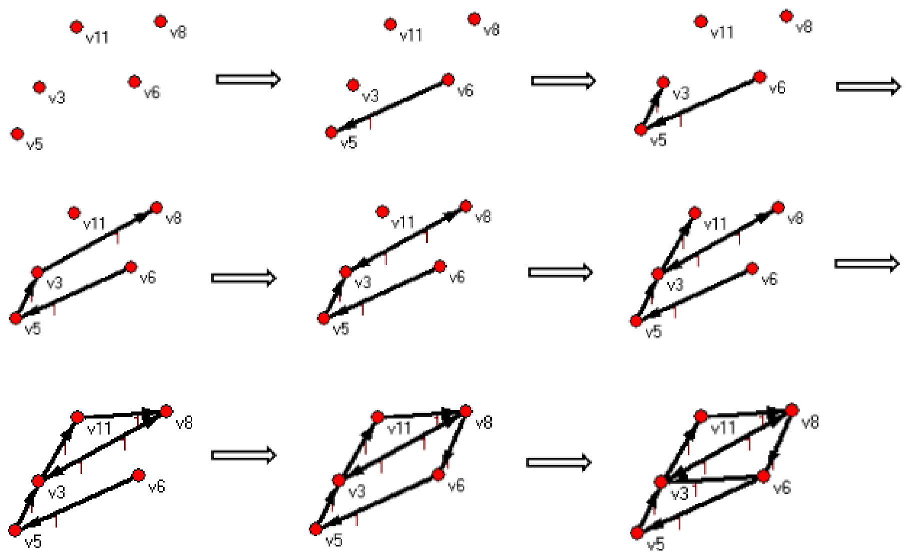

**Figure no 1:** The construction process of guangdong Dongguan Bank's passing network on its 87th offensive round in Game 3 of the 2019-2020 CBA Finals

The players participating in the offensive round are Ren Junfei $v_3$; Zhao Rui, $v_5$ Su Wei $v_6$; Wang Xinkai $v_8$; Hu Mingxuan $v_{11}$, In the beginning, the five players were in a discrete state, and then after the player Su Wei obtained the ball, he passed the ball to Zhao Rui, so a directed connection was formed between Su Wei and Zhao Rui $(v_6,v_5)$, After the player Zhao Rui got the ball, he passed it to Ren Junfei to create a tie $(v_5,v_3)$, Then Ren Junfei passed it to Wang Xinkai to create a connection $(v_3,v_8)$, After Wang Xinkai got the ball, he passed the ball to Ren Junfei to create a tie $(v_8,v_3)$, The two players pass the ball to each other, which is presented in a bidirectional (reciprocal) manner on the network map. Ren Junfei, who has regained the ball, passes the ball to Hu Mingxuan to create a connection $(v_3, v_{11})$, After receiving the ball, Hu Mingxuan passed to Wang Xinkai to create a connection $(v_{11}, v_8)$, Then Wang Xinkai passed the ball to Su Wei to create a tie $(v_8, v_6)$, After Su Wei received the ball, he passed it to Ren Junfei to have an edge $(v_6, v_3)$. Finally, Ren Junfei made a shot and the round ended. The pass line is:

$$v_6 \to v_5 \to v_3 \to v_8 \to v_3 \to v_{11} \to v_8 \to v_6 \to v_3$$

Thus, the passing network map of the 87th offensive round of the third game of the Guangdong Dongguan Bank team was obtained. Defined by the passing network, the passing network $G_{87} = (V_{87}, E_{87}, \omega_{87})$, where

$$V_{87} = \{v_3, v_5, v_6, v_8, v_{11}\}$$

$$E_{87} = \{(v_6, v_5), (v_5, v_3), (v_3, v_8), (v_8, v_3), (v_3, v_{11}), (v_{11}, v_8), (v_8, v_6), (v_6, v_3)\}$$

And the weight of each side is 1.

For all the games studied, the passing network based on offensive rounds can be expressed as the network sequence of the snapshots of the passing network formed in each offensive round. Denote by $G = \{G_j\}_{j \in J}$, where $G_j = (V_j, E_j, \omega_j)$ is the passing network for the $j$ th round.

According to the above method, the pass network sequence of 203 offensive rounds in the two games of the Guangdong team can be obtained. Figure 2 shows part of the passing network of the Guangdong Dongguan Bank Team in the third game of the 2019-2020 season finals against Liaoning Bengang. In order to have a clearer understanding of how multiple players cooperate to complete the pass in each offensive round, only 56 passing networks with a passing relationship greater than or equal to 3 are selected for display.

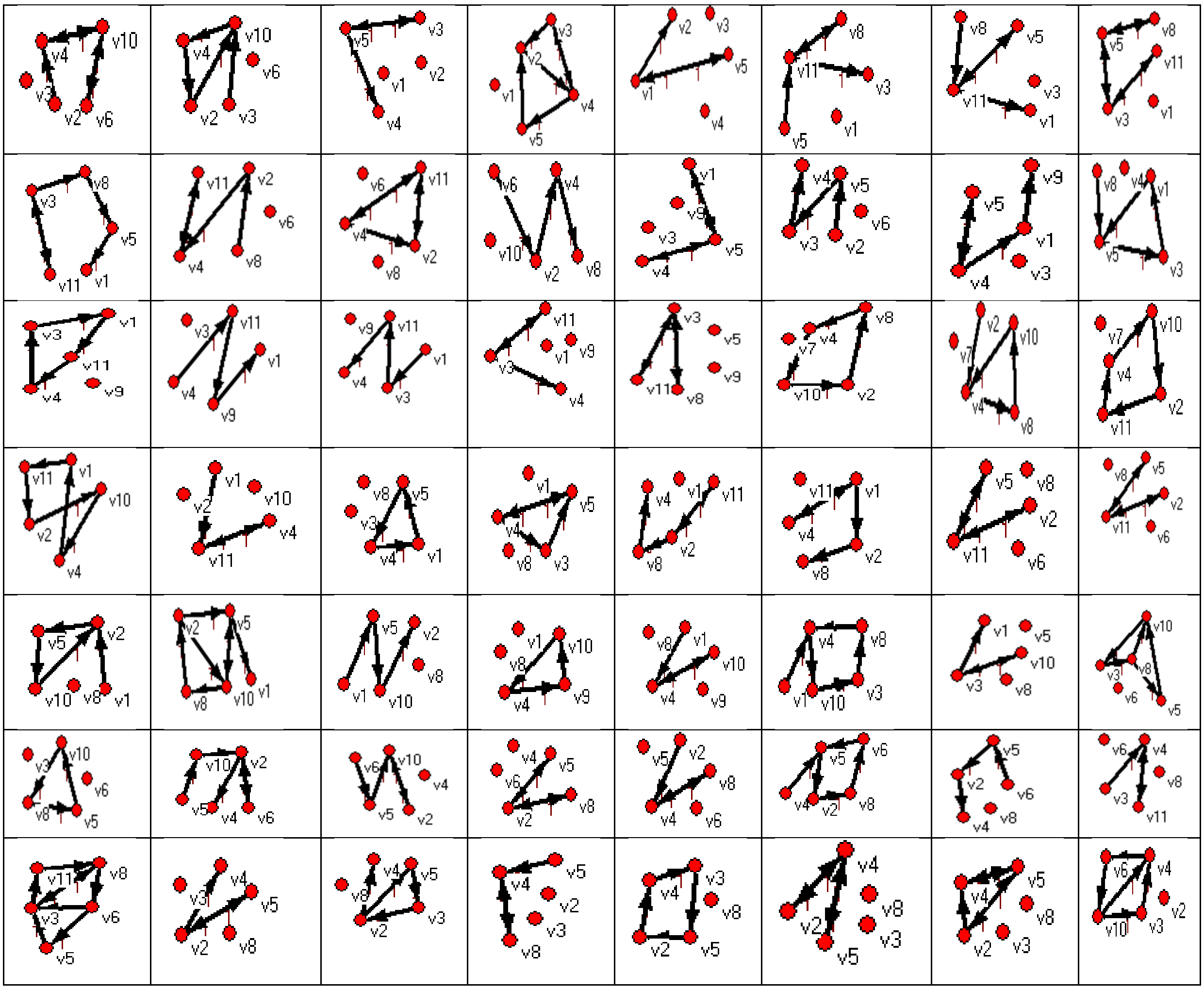

**Figure no 2:** Network diagram of partial offensive rounds in Game 3 of the 2019-2020 CBA Finals of Guangdong Dongguan Bank team

## III. Research methods and results analysis

**Research methods**

Consider an attacking round in a basketball game and denote the result by $Y$, which can be divided into two situations: success and failure. Definition of this article: A successful shot and a foul caused by the offense are regarded as a successful round, and the $Y$ value is 1; Failed shots, offensive fouls, and turnovers are considered a round failure, and the $Y$ value is 0. $Y$ is a 0-1 type variable. Consider using the Logistic regression model to quantitatively analyze the factors that affect the failure of the attack round. The form is:

$$\ln\left(\frac{p}{1-p}\right)=\sum\beta_i x_i+\beta_0 \qquad (1)$$

where, $x_i$ , $i=1,2,\cdots,k$ represents a deterministic variable related to $Y$, $p$ is the probability that the attacking round is a successful round under the action of $k$ independent variables, that is, $p=P(Y=1|x_1,x_2,\cdots,x_k)$; $\beta_0$ is a constant term; $\beta_i,(i=1,2,...,k)$ is the partial regression coefficient of logistic regression, indicating the influence of variable $x_i$ on $Y$. After transformation, the following formula can be obtained to calculate the probability of an event happening:

$$p=\frac{e^{\sum\beta_i x_i+\beta_0}}{1+e^{\sum\beta_i x_i+\beta_0}} \qquad (2)$$

Using the maximum likelihood method, it is possible to estimate the probability of success of the attacking round given the influencing factors, and to estimate whether the attacking round is successful according to this probability. If $p$ is greater than 0.5, the round is considered a success, $y=1$; if $p$ is less than or equal to 0.5, the round is considered a failure, $y=0$. That is:

$$y=\begin{cases}1, p>0.5\\ 0, p\le 0.5\end{cases} \qquad (3)$$

**factor selection**

From the perspective of network science and basketball technology, the following factors that may affect the success of the round are initially selected:

**number of edges**

The number of players passing the ball in each offensive round in a basketball game reflects the team's playing style, and the average number of passes is relatively high, indicating that the team may tend to pass the ball many times to find opportunities for attacking; If the number of passes is low, the team may be more inclined to use star players to close the game. The number of passes thus becomes an indicator to consider. For the network $G_j=(V_j,E_j,\omega_j)$ of the $j$ th attacking round, use $link_j$ to represent the total number of edges in the network (the multiple edges are counted according to the multiples), in the network $G_{87}=(V_{87},E_{87},\omega_{87})$ demonstrated in Figure 1, $link_{87}=8$.

**reciprocal side**

In a basketball game, two players pass the ball to each other, which can control the rhythm of the game and then seek opportunities to play tactical offense. A reciprocal edge is formed between two nodes representing players in the pass network, As shown in Figure 1, there is a reciprocal edge between nodes $v_3$ and $v_8$. For the network $G_j=(V_j,E_j,\omega_j)$ of the $j$-th attacking round, use $recip_j$ to represent the value of the network reciprocal edge index in this round, which is defined as the total number of network reciprocal edges (regardless of multiple edges), that is, $recip_j=\sum_{v_i,v_k\in V_j}\delta(v_i,v_k)$, where $\delta(v_i,v_k)=1$ if and only if $v_i,v_k$ satisfies $(v_i,v_k)\in E_j$ and $(v_k,v_i)\in E_j$ at the same time, and $\delta(v_i,v_k)=0$ in other cases. In the network shown in Figure 1, $recip_{87}=1$.

**Three cycle**

Figure 3 shows a three-cycle network structure composed of three nodes in a directed graph [12]. This graphic corresponds to the passing coordination and transfer between the three players. If player 1 passes the ball to teammate 2, teammate 2 passes the ball to teammate 3, and teammate 3 passes the ball back to player 1, it constitutes a this image. For the network $G_j = (V_j, E_j, \omega_j)$ of the $j$ th attacking round, use $tc_j$ to represent the number of three cycles of the network. In the network $G_{87} = (V_{87}, E_{87}, \omega_{87})$ demonstrated in Figure 1, $tc_{87} = 1$.

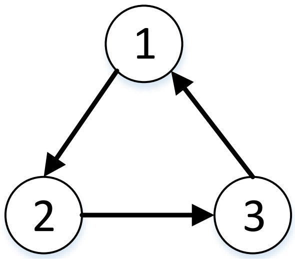


**Figure no 3:** Three cycle

Average clustering coefficient

In basketball, triangle passing is a basic passing method, and the triangle offensive tactic is also a common offensive tactic during the game [17]. Abstracted into a network, the three diagonals and the number of triangles in the network reflect the smoothness of passing between players to a certain extent, and have a potential impact on the success or failure of an attacking round. The related network index is the average clustering coefficient of the network. For network $G_j = (V_j, E_j, \omega_j), j \in J$ , consider the network as an undirected and weightless network, and obtain network $\tilde{G}_j = (V_j, \tilde{E}_j)$ ,The value obtained according to the usual definition method of the average clustering coefficient of an undirected and unweighted network is taken as the value of the average clustering coefficient of the directed network $G_j$ . That is, the agglomeration coefficient of the node $v_{j_i} \in V_j$ is expressed as:

$$C_j(j_i) = \frac{2edge_j(j_i)}{k_j(j_i)(k_j(j_i)-1)} \tag{4}$$

Where $k_j(j_i)$ represents the degree value of node $v_{j_i}$ , that is, the number of connected edges of $v_{j_i}$ in $\tilde{G}_j$ . $edge(j_i)$ represents the number of links between $k_j(j_i)$ adjacent points of node $v_{j_i}$ , and the average clustering coefficient of network $G_j$ is expressed as:

$$\langle C_j \rangle = \frac{1}{5}\sum_{i=1}^{5} C_j(i) \tag{5}$$

For the network shown in Figure 1, there is $\langle C_{87} \rangle = 0.51$.

Passing Network Efficiency Value

Converting a lot of data into a value through a mathematical formula can intuitively summarize the performance of a player in a game or a season by the size of the value. This value is called the basketball player's efficiency value, which is calculated by a variety of different methods, usually adding different weights to multiple indicators to add up the positive data and subtract the negative data [15]. In this paper, the method of Martin Manleys [15] is used to calculate the efficiency value of the players, the weight of each indicator is set to 1, and the formula is:

$$EFF = PTS + AST + TRB + STL + BLK - FGM - FTM - TOV \tag{6}$$

The specific meaning of each symbol in the formula is shown in Table 1.

For the network $G_j = (V_j, E_j, \omega_j), j \in J$ of the $j$ th attacking round, define the efficiency value of the end of the passing line, that is, the last player in possession of the ball in this round, as the passing network efficiency value of this round, denoted by $eff_j$ . In Figure 1, the last player to handle the ball is Ren Junfei, so $eff_{87} = 17.2$ .

**factor screening**

In order to ensure that there is no strong collinearity among the independent variables, and to achieve the precondition of using the logistic regression model, the independent variables are firstly analyzed for collinearity.

**Table no 2** Preliminary collinearity diagnosis

| variable | Collinearity Statistics | |
|---|---|---|
| | Tolerance | VIF |
| number of edges | 0.501 | 1.997 |
| reciprocal side | 0.619 | 1.616 |
| Three cycle | 0.100 | 10.006 |
| Average clustering coefficient | 0.107 | 9.389 |
| Efficiency Value | 0.974 | 1.027 |

After several times of collinearity diagnosis, it is found that there is a strong collinearity between the number of three cycles and the average clustering coefficient, which is defined by the average clustering coefficient and contains the information of the number of three cycles, so the factor of the number of three cycles is not considered in the model. Factors with strong collinearity are excluded, and finally it is found that there is no multicollinearity problem in the independent variables such as the number of connected edges ( $x_1$ ), reciprocal edges ( $x_2$ ), average clustering coefficient ( $x_3$ ), and efficiency value ( $x_4$ ). Table 3 shows the collinearity diagnosis and descriptive statistics of the above four independent variables.

**Table no 3** Collinear diagnosis and descriptive statistics

| variable | Collinearity Statistics | | average value | standard deviation | minimum | maximum |
|---|---|---|---|---|---|---|
| | Tolerance | VIF | | | | |
| number of edges | 0.535 | 1.869 | 3.241 | 1.769 | 1 | 10 |
| reciprocal side | 0.649 | 1.540 | 0.507 | 0.683 | 0 | 3 |
| Average clustering coefficient | 0.773 | 1.294 | 0.062 | 0.131 | 0 | 0.51 |
| Efficiency Value | 0.986 | 1.015 | 17.882 | 6.637 | 5.3 | 26.1 |

**Result analysis**

Logistic regression was performed on the sample data to further obtain significant variables in the process of identifying factors affecting the success of an attacking round, and the significance level was bounded by 0.1, and the results are shown in Table 4.

**Table no 4** Variables in equation

| statistical results / Equation variables | B | standard error | Wald | degrees of freedom | salience | EXP(B) | 95% confidence interval for EXP(B) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | lower limit | upper limit |
| number of edges | 0.160 | 0.115 | 1.944 | 1 | 0.163 | 1.174 | 0.937 | 1.470 |
| reciprocal side | -0.352 | 0.269 | 1.718 | 1 | 0.190 | 0.703 | 0.415 | 1.191 |
| Average clustering coefficient | -2.689 | 1.302 | 4.264 | 1 | 0.039 | 0.068 | 0.005 | 0.872 |
| Efficiency Value | 0.044 | 0.022 | 3.987 | 1 | 0.046 | 1.045 | 1.001 | 1.091 |
| constant | -0.705 | 0.503 | 1.965 | 1 | 0.161 | 0.494 | | |

Among the factors that affect the success of an attacking round, the average agglomeration coefficient ( $x_3$ ) and the efficiency value ( $x_4$ ) are significant, and the number of connected sides ( $x_1$ ) and reciprocal sides ( $x_2$ ) have a certain degree of influence. The number of connected edges and the efficiency value have a positive correlation with the probability of round success, and the reciprocal edges and the average clustering coefficient have a negative correlation with the probability of round success.

According to the relevant variables in the regression results, a recognition model for the success of basketball offensive rounds can be constructed. The results are shown in the following formula:

$$p = \frac{e^{0.160x_1 - 0.352x_2 - 2.689x_3 + 0.044x_4 - 0.705}}{1 + e^{0.160x_1 - 0.352x_2 - 2.689x_3 + 0.044x_4 - 0.705}} \tag{7}$$

$$y = \begin{cases} 1, p > 0.5 \\ 0, p \leq 0.5 \end{cases}$$

It can be seen that the effect of the average agglomeration coefficient and efficiency value on the success of the round is significant. The average clustering coefficient is used to describe the degree of interconnection between adjacent points of a point. In a basketball network, the team as a whole conducts the ball more widely, and the connection between players becomes redundant, which may increase the probability of passing mistakes. Secondly, the player efficiency value is the index value of the comprehensive quality evaluation of the basketball player itself, which represents the strength of the player. At the end of the round, the efficiency value of the last player the ball passed by represents the efficiency value of the entire network, and that player determines where the basketball will ultimately go: fielded, missed, and stolen. Therefore, the player is closely related to the success of the round. When the player's efficiency value is high, the shooting rate is relatively high, and the probability of being truncated and not scoring is relatively low, The success rate of the round is higher than that of players with lower efficiency values. If the ball can be transferred to a player with a higher efficiency value in time, it will have a positive effect on the team's attack success rate, so the team sometimes needs star players to dominate the game.

Although the number of connected sides and reciprocal sides do not have a particularly significant effect on the success of the round, they also have a certain effect. When faced with defense in an offensive round, the attacker will adopt some tactics to resolve, and then achieve the purpose of the success of the round. In order to create offensive opportunities, players need a cooperative method composed of reasonable use of technology, that is, basic offensive coordination, including: breaking the ball, passing and cutting, supporting, and screening. In order to get out of the defense, the offensive player will use these tactics, passing the ball to other players, so that the number of sides of the basketball transfer increases. For example, Lu Qinlongwen [17] pointed out that the joint defense attack of the world's top teams usually launches the attack in the form of quick transfer of the ball outside the line and breakthrough of the ball. Whether the success of this round can be achieved after adopting tactics also depends on the influence of other comprehensive factors such as coping strategies adopted by the defender, so the influence of these two indicators is not particularly obvious.

In order to test the overall fitting effect of the model, the Hosmer Lemeshaw method was used to test, It can be seen from Table 5 that the significance is 0.536, Hosmer's null hypothesis $p$ value is greater than 0.05, the null hypothesis is accepted, and the chi-square value is less than the critical value, Therefore, the Hosmer Lemeshaw test is passed, and the model established this time has a good fit with the real data.

**Table no 5** Hosmer Lemeshaw test results

| step | Chi-square | degrees of freedom | salience |
|---|---|---|---|
| 1 | 7.009 | 8 | 0.536 |

From Table 6, although the prediction accuracy for the failure of the round is relatively low, the prediction for the success of the round reaches 79.8%, Since a game often focuses on the success of the attacking round, and the situation in the actual game is complicated, and the influence of human factors and accidental factors cannot be ruled out, the fitting of this model is desirable.

**Table no 6** Model judgment accuracy

| observations / Validation results | The actual attacking round was successful | The actual attacking round was fail | total |
|---|---|---|---|
| Judging the success of the offensive round | 30 | 23 | 53 |

| | | | |
|---|---|---|---|
| Judging the fail of the offensive round | 59 | 91 | 150 |
| total | 89 | 114 | 203 |
| Correct rate | 33.7% | 79.8% | |

## IV. Conclusion

This paper uses the CBA 2019-2020 season finals Guangdong Dongguan Bank team in the second and third games of the offensive round pass data to construct a pass network and analyze the network indicators, According to the social network statistics idea, the regression analysis was carried out on the network index data, and it was found that the average clustering coefficient and the efficiency value had a significant impact on the success of the round, Although the number of links and the reciprocal side have no significant effect on the attacking round, However, the impact of these two variables on the attacking round reflects that when a player transmits the ball more often when attacking, they can mobilize the opponent's defensive formation and disrupt the opponent's defensive rhythm. In this paper, the player's efficiency value at the end of each round is used to represent the efficiency value of the whole round. The player's efficiency value is positively related to the success of the attacking round, The results also show that when the player in the final round is very capable, the probability of the successful attacking round is greatly increased, This also shows that in a team system, although the overall coordination of play is beneficial to the team's offense, But more importantly, there are players with high ability to guarantee, which means that the team needs star players to win, so star players are what the team needs. The passing network has a certain effect on the team's victory, and in the actual game, the tactics arranged by the coach are linked between the running and passing of the players, Basketball game tactics should also be expressed in the form of network, and quantitative analysis of it, which will be the content of extended research in the future.

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