

Using Topological Clustering to Identify Emerging Positions and Strategies in NCAA Men's Basketball

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ABSTRACT

College basketball represents a rich context in which human resources are critical. Team success depends upon numerous factors, including talent acquisition and development. In the NCAA, teams are restricted on the number of players allowed on a roster. Consequently, coaches must make difficult decisions about which players to recruit, often attempting to match specific players with strategic styles of play.

There are five traditional positions in basketball—point guard, shooting guard, small forward, power forward, and center. These positions are often defined by a player's physical qualities (i.e., height and weight). As the game of basketball has evolved, however, new positions (e.g., point-forward or stretch 4) have emerged. Consequently, coaches have begun to adopt new strategies. This study examines how coaches must utilize resources more effectively by embracing emerging positionality to maximize strategic advantage. This research asks the question “What positions are NCAA Division I men's basketball teams using in the 2016-2017 season based on performance metrics?”

Performance metrics were used to identify positions to avoid any preconceived notions of what positions a player might be. The basic box score statistics Field Goal Percentage, Three Point Field Goal Percentage, Free Throw Percentage, Points per Minute, Total Rebounds per Minute, Assists per Minute, Turnovers per Minute, Steals per Minute, and Blocks per Minute were used in this research. Topological mapping was used to identify clusters in this data. Topological mapping was effective for two reasons. First, topological mapping clustered data points based on data similarities, allowing the researcher to identify statistical averages for each cluster. Second, topological mapping simplified data points that were affected by many different variables.

Eight positions were identified in this research from the NCAA Division I men's basketball 2016-2017 season. The Bench Warmer, Role Player, Rebounding Shot Blocker, Ball Handling Defender, Three Point Scoring Ball Handler, Three Point Scoring Rebounder, Close Range Dominator, and Point Producer each showed performance metrics that separated themselves from the other positions. This research can be used to assist coaches in better understanding the styles of play and positions being used in college basketball today.

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CHAPTER ONE

INTRODUCTION

When basketball was invented in 1891 in a Springfield, Massachusetts it was a very simple game. Dr. James Naismith created the game to create a pastime for YMCA children that was less violent than football and could be played indoors during the winter months (Grasso, 2011) (Krause, 1991).

Naismith created only thirteen basic rules for the game when it was first created (Anderson & Albeck, 1964). A year later, both Vanderbilt University and Geneva College both played against local YMCA teams in what are considered to be the first college basketball games (Kirschman, 2014). From then college basketball began to grow in popularity across the United States, and many colleges and universities began to add basketball teams within their athletic departments, and in 1939 Oregon was crowned as the first NCAA Division I champion as they won the NCAA Basketball Tournament in Evanston, Illinois (Grassi, 2011).

From this first championship game basketball continued to grow in cultural and collegiate popularity. As the sport continued to grow, it evolved from the game that Dr. Naismith had originally invented. Unlimited substitutions were made legal, while defensive and offensive goaltending were made illegal. Also, the foul lane was widened from 6 to 12 feet (Official 2007 NCAA Men's Basketball Records Book, 2007). The 1980s was another age of renaissance for NCAA basketball. In 1985 the shot clock was added to NCAA basketball games, and a year later the three-point line was first introduced to college basketball.

These two additions were significant in increasing pace and scoring to the game of college basketball (Grundy, Nelson, Dyreson, 2014; Newnham, 1995; Stephens, 2015). Also, during this time, coaches began implementing unique playing styles like the dribble drive and Princeton offense. At Princeton, coach Pete Carril's offense required that all his players be able to dribble, pass, and shoot at a high level (Wallace, 1991). Around the same time, a high school coach named Vance Walberg was creating the dribble drive motion. This offense required four players to be able to dribble, score, and pass well, while one bigger player was expected to rebound and score near the basket (Wahl, 2008). These offenses, as well as other styles of play being implemented at the time, required players with different skillsets depending on which system they were playing in.

These unique offenses and the players they required began to redefine how coaches viewed basketball positions. When basketball was first invented, nine or more players would compete for a team at a time. These players were divided into three general positions: guards, forwards, and centers (Grassi, 2011). When basketball was played at the collegiate level the number of players was limited to five for each team. As the game developed these five players were given more specific positions: point guard, shooting guard, small forward, power forward, and center. Since the growth of college basketball in the 1980s, the more unique playing styles led to the development of hybrid positions like a point-forward, swingman, and stretch four (Aschbruner, 2010; Hayes, 2013; Trninić & Dizdar, 2000).

Problem Statement

The positions of college basketball have evolved along with the game over since the first games in 1892. Traditionally, point guards were expected to handle the basketball, set up the offense, and be good passers. They were also considered to be smaller and quicker players. The shooting guard was expected to be a team's scorer, shoot outside jump shots, and share ballhandling responsibilities with the point guard. The small forward was expected to bridge the gap between guards and post players by scoring from midrange, rebounding, and doing some ballhandling. Power forwards were considered some of the taller and stronger players on the team and were expected to score from inside and midrange while rebounding as well. Finally, centers were the tallest players on a team who were expected to block shots defensively, rebound, and score near the basket (Grasso, 2011). While positions have become more specific and nuanced over the years, there has been no quantitative method for coaches to differentiate which position their players fit into. Because of this, coaches must use their best judgement in defining positions and roles for their players. This research uses quantitative performance metrics to cluster players with similar statistical performances. These clusters create a quantitative way to define the current positions used in NCAA Division I basketball.

Purpose

The purpose of this study was to identify the positions currently used in NCAA Division I men's basketball. These positions were identified by grouping college basketball players into clusters based on their season statistical performances. Once these positions were identified, this research investigated roster construction, how a team uses the different positions together, of NCAA Division I teams. Specifically, this research looked to find relationships between roster construction and winning percentage as well as trends in roster construction across NCAA Division I conferences. To this end, this study asked the following research questions:

1. What positions are NCAA Division I men's basketball teams using in the 2016-2017 season based on performance metrics?
2. Is there a relationship between the positions found in this research and team's winning percentage?

Significance of Study

This study is significant because of the current lack of research that examines the positions of NCAA Division I men's basketball. This study provided quantitative insight into the current positions used in college basketball and is one of the first studies of its kind. The results of this study can assist collegiate coaches in recruiting and developing players more effectively. Currently, the NCAA is bringing in over \$770 million in revenue from the NCAA Tournament

each year (Revenue) and recruits are worth tens to hundreds of thousands of dollars to their university (Borghesi, 2018). Also, the rise of “positionless” basketball has become the fad within college basketball over the past few years (Marshall, 2014). With the current competitive and financial landscape of NCAA Division I basketball, it is vital that teams are maximizing the potential and ability of each player and role on their team.

Limitations

There were a few limitations to this study. The first limitation was the ability to collect more in depth historical data. Collecting data from seasons before the 2016-2017 season was considered, but there was not a database that had complete statistics for these seasons. The NCAA website provided statistics for earlier seasons, but there were many missing variables in this database which made the data set unrepresentative. Also, collecting more advanced performance statistics was considered (e.g., efficiency statistics or plus/minus player ratings), but again there are no easily accessible databases that provided these statistics comprehensively for every NCAA Division I player. Although some databases report having this information, they were prohibitively expensive for this study. The second limitation was the level of statistical analysis software used for this study. Software such as R and SPSS were used for this study. Although this software was capable of producing robust results, there are other software programs that could provide more in-depth analysis and visualizations

of the data. However, this more advanced software was either unavailable or, again, prohibitively expensive for this study.

This study strictly spoke about the positions in NCAA Division I men's college basketball, however one could argue that the results have identified roles for players on a team rather than their positions. For the sake of consistency throughout the paper, the term positions has been used for both the traditional positions and the positions found in this research. The differentiation between positions and roles and which best describes the results of this research have not been discussed in this paper.

Delimitations

The main delimitation of this study is the simplicity of the performance statistics used in identifying the positions used in college basketball. This study used the season average of a player's box score statistics to identify their position. These statistics did not represent as detailed of a description of a player's performance compared to advanced statistics such as plus/minus, win shares, and efficiency ratings. The decision to exclude these statistics was partially based on the inability to find these statistics for every NCAA Division I player. However, it was also decided that initial focus on simple statistics that are easy to comprehend would be best for this study. Also, it is important to note a player's position or role on their team could change within a season, or even

within a game. While season statistics provide an overall representation of a player's abilities, it does not intricately represent how a player may be used differently within their team based on different scenarios. Finally, this study is attempting to use quantitative methods to identify the positions that are currently being used in NCAA Division I men's basketball. Although positions may be given new names over the course of this research to accurately attribute the statistics that significantly characterize each position, it should be noted that the purpose of this study is not to create new positions, per se, but rather to highlight how quantitative clustering brings clarity and insight into the positionality in college basketball today.

CHAPTER TWO

LITERATURE REVIEW

Historical Basketball Positionality

In the past twenty years there have been a few published articles on positions and roster construction of basketball teams, specifically NBA and professional European teams. These articles researched the roles of players based on the traditional five positions, the tasks that players must perform during a basketball game, the effect a player's teammates may have on their performance, how teammates can complement or take away from team success based on roster construction, and a topological analysis of NBA positions.

In 2000, Slavko Trninić analyzed the roles of players based on the traditional five positions. Although Trninić admitted that positions and roles in modern basketball are defined variedly, he still believed that using the traditional five positions was still the most effective way to divide positions (Trninić & Dizdar, 2000). Seven criteria for defensive performance (level of defensive pressure, defensive help, blocking shots, ball possession gained, defensive rebounding efficiency, transition defense efficiency, and playing multiple positions of defense) and twelve criteria for offensive performance (ball control, passing skills, dribble penetration, outside shots, inside shots, free throws, drawing fouls and three point plays, efficiency of screening, offense without the ball, offensive rebounding efficiency, transition offensive efficiency, playing multiple positions on offense) were created by the researchers in this study. Ten basketball experts, defined as

players or coaches who had won a medal at the European or World Championships or at the Olympic Games; the first place in a European club competition; or a National Championship, were asked to rate the importance of these roles for each position. From their responses, the researchers found that the following performance criteria was considered important for each position:

Point Guard – level of defensive pressure, transition defense efficiency, ball control, passing skills, dribble penetration, outside shots, and transition offense efficiency

Shooting Guard – level of defensive pressure, transition defense efficiency, outside shots, dribble penetration, offense without the ball, and transition offense efficiency

Small Forward – transition defense efficiency, outside shots, dribble penetration, offense without the ball, free throws, and transition offense efficiency

Power Forward – defensive and offensive rebounding efficiency, inside shots, dribble penetration, efficiency of screening, and free throws

Center – defensive and offensive rebounding efficiency, inside shots, dribble penetration, efficiency of screening, drawing fouls and three-point plays, and free throws (Trninić & Dizdar, 2000)

This research provided a qualitative baseline for the expectations of roles for traditional positions. However, it did not consider the changing landscape of positionality in basketball. Also, it did not provide quantitative standards for how these criteria should be measured.

Trninić again researched the roles of basketball players in 2010. This research focused on an extensive list of 79 tasks that were completed consistently throughout the course of a basketball game (Trninić, Karalejić, Jakovljević, Jelaska, 2010). Roles were assigned to two groups of players, inside players and outside players, within different aspects of the game; half court offense, half court defense, full court offense, full court defense, transition offense, and transition defense (Trninić et al., 2010). Basketball experts, defined as players and coaches who had won the first place on some European club contest, won one of medals on a European championship, or won a World championship or the Olympic Games, were then interviewed and asked to assign these tasks to a player grouping within one of the aspects of the game. These answers were analyzed to create lists of tasks for players in different parts of a basketball game. For example, inside players in half court offense had a list of thirteen tasks that included “playing at a low post position when the offense player is held by a shorter defense player” and “positioning for inside position for offensive rebound” (Trninić et al., 2010). While this research recognized a less structured version of positioning, dividing players into inside and outside players, it still only created a list of qualitative tasks that players should achieve.

In 2011, research was presented at the MIT Sloan Sports Analytics Conference that attempted to measure a player’s performance adjusting for interaction effects by their teammates. The research used offensive, defensive, and total efficiency ratings to understand how important a player was relative to

their teammates playing with them and how well that player performed statistically in that role (Piette et al., 2011). This research sheds light onto the understanding that a player's role can change depending on the lineup they are playing with and the game situation they are in. Although this research used play by play data for its analysis, the research in this paper will focus on season long statistics. Although the season long statistics may lack a detailed explanation of a player's role in every moment of their season, they should provide a broad explanation of their general role over the course of the entire year.

The 2012 MIT Sloan Sports Analytics Conference produced more research on roster construction and roles in basketball. This research considered how an NBA team's top two or three players together affected their team's winning percentage. First, NBA players were clustered based on their level of play and statistical similarity (Ayer, 2012). There were fourteen clusters of players that included limited role-playing centers, high scoring dynamic guards that aren't elite three-point shooters, somewhat limited role-playing backcourt players, wing three-point shooters, etc. Then regression was used to find possible correlations between a team's best two player pairings with their winning percentage. It was found that five pairings of clustered positions were positively significantly correlated with winning, while only one pairing was negatively significantly correlated with winning. When the same regression was run with team's top three players there were four groupings that had a positive significant correlation with winning, while three groupings had a negative significant

correlation with winning (Ayer, 2012). This reinforced the notion that roster construction could play both a positive and negative role in a team's winning percentage. According to this research, it is vital for NBA teams to construct their roster with complimentary players to increase their chances of winning.

Also, in 2012, research was done that attempted to categorize NBA players into new positions, different than the traditional five positions. This research used topological methods to clusters NBA players by their box score statistics. Many of these statistics that would be affected by a player's playing time were adjusted to per minute statistics. This leveled the playing field in effort to cluster players solely by their statistical similarity, not their level of play or time of play. This research found thirteen clusters that were labeled based on the statistical similarities within the cluster: Offensive Ball-Handler, Defensive Ball-Handler, Combo Ball-Handler, Shooting Ball-Handler, Role-Playing Ball Handler, 3-Point Rebounder, Scoring Rebounder, Paint Protector, Scoring Paint Protector, Role Player, NBA 1st-Team, NBA 2nd-Team, and One-of-a-Kind (Alagappan, 2012). No regression analysis was done, but there were visual similarities between the roster construction of teams with higher winning percentages when their players were highlighted across all clusters. Also, this research stated that these new positions could be used to help recognize undervalued players who had the potential to be a high-level player. This could be done by comparing statistics and salaries among players within a given position cluster (Alagappan, 2012). This research was groundbreaking because it quantitatively categorized

players into positions. Roles of the traditional five positions and physical characteristics like height and weight were not used in the creation of these new positions, which revealed the actual positions and roles that NBA players have in the modern game of basketball.

Current State of Basketball Positionality

Basketball has continued to evolve at both the professional and collegiate level over the past few years. Throughout this evolution the traditional five positions of point guard, shooting guard, small forward, power forward, and center have become continuously more outdated. In contrast, coaches are looking for players with more versatility who they can give freedom to play in different roles on the court (Medcalf, 2013). This desired versatility has limited the use of specialists, players who are highly skilled in one area of the game, and has arguably decreased players' skill levels (Medcalf, 2013). This means that while players may have more skills at different parts of the game of basketball, they might not be as highly skilled in each area as they once were. One example of this is three-point shooting. Since the introduction of the three-point line in the 1980s the average player has shot over 38% from three-point range. However, in 2013 the average three-point shooting percentage was 34% across all NCAA Division I players, a significant dip from 38% (Medcalf, 2013). Another important note is that the increased versatility required by basketball players has lessened the importance of physical characteristics in defining a certain player's position or role on a team. Many smaller players are required to defend and rebound in the

post, a role traditionally given to taller and bigger players. Also, taller players are being given the opportunity to handle the basketball and shoot more jump shots, a role traditionally given to smaller players (Medcalf, 2013).

Defining positions and roles as players have become more versatile has been a difficult task for basketball coaches, and there have been different ways that positions are being identified. Brad Stevens, currently the coach of the Boston Celtics and formerly the coach of the Butler Bulldogs, used three position groups for his teams. These position groups are divided as ball handlers, wings, and bigs (Belden, 2017). While three positions sound simpler than the traditional five positions, Stevens claims that there is versatility required within the three groupings that his teams use.

The most popular phrase used to describe the versatility required in modern basketball is “positionless basketball”. Positionless basketball at its purest form is exactly what its name implies; a team would play five players who are adequate at every part of the game. Although this level of positionless basketball is not the case for many teams at lower levels, this level of versatility has become the goal for most professional teams (Tjarks, 2015). “Tweeners”, players that did not fit into one of the traditional five positions, were once looked upon negatively in NBA basketball, but now their versatility has made them some of the most sought-after players by teams. Players are beginning to market themselves as versatile; Markelle Fultz, the 1st pick in the 2017 NBA draft was

quoted as saying he that he did not believe he had a certain position (Reynolds, 2017).

Positionless basketball has become more popular in college basketball as well. More and more college coaches are attempting to find ways to put their best five players on the court at one time. Often this leads to having to ignore the traditional position labels that might be used (Marshall, 2014). Mike Krzyzewski, the head coach at Duke, claims that basketball has always been a positionless sport. "Our game doesn't have a position," Krzyzewski said. "You have five guys working together trying to stop the other five guys from creating a shot. The fact that a big guy is going to play closer — what if you didn't have a big guy?" (Marshall, 2014). While this evolution of positionless basketball continues, some coaches believe that there is still a need for positions when it comes to role definition for their players. Herb Sendek, the head coach at Arizona State said, "When you're talking about positions, you're creating labels to help you organize your team and communicate to your team about roles and responsibilities. From that standpoint, it may be important." (Marshall, 2014). As a result, a complete move toward positionless basketball is unlikely, even if trends toward more versatile players with a variety of skills gains momentum.

Financial Outlook on NCAA Basketball

NCAA Division I men's basketball is one of the most important aspect of the NCAA and NCAA institution's financial success. Specifically, the NCAA Tournament is one of the largest revenue streams for the NCAA, and most of

that revenue is directed to member institutions. In 2010 the NCAA signed a 14-year, \$10.8 billion media rights deal with CBS Sports and Turner Broadcasting (Revenue). This deal that mostly consists of the right to air NCAA tournament basketball contests made up around 81% of the NCAA's revenue in 2011-2012 (Revenue). In 2025 this deal will be reworked, so the NCAA will bring in \$1.1 billion annually from their media rights contracts (Gaines & Yukari, 2017).

Because most of this revenue is distributed among NCAA Division I institutions, the continued media rights success and profitability of the NCAA tournament is vital to these athletic departments. Being successful in the NCAA Tournament is also important for basketball teams and their conferences because of how the NCAA distributes some of the NCAA tournament revenues. In 2010-2011, the NCAA's Basketball Fund distributed \$202 million, which was 40% of total NCAA distributions (Distributions). The Basketball Fund rewards conferences for having teams making, and succeeding, in the NCAA Tournament. In short, each NCAA Tournament game is a unit; in 2018 each unit will be worth \$273,200. A conference will receive an amount equal to the sum of their team's units over a six-year rolling period (Hobson, 2014). This means that Power 5 conferences with multiple teams in the tournament have the opportunity to bring in millions of dollars to distribute to their conference members if they have successful basketball programs. Even small conferences receive benefit from receiving a unit or two worth of money to distribute to their conference

members from their conference champion appearing in the NCAA Tournament (Hobson, 2014).

Research was done to calculate the financial value of NCAA Division I basketball players to their institutions. Forms of revenue including an institution's revenue distribution from the NCAA Tournament, donations to the university, and other forms of revenue significantly related to the success of an institution's basketball team were measured in relation the recruiting star-value assigned to players on the team. It was found, if the NCAA split revenues 50/50 between institutions and players like the NBA, that players should receive the following annual wages: five-star players \$613,000; four-star players \$166,000; three-star players \$91,000; and low star players \$50,000 (Borghesi, 2018). Although players are not currently compensated, this shows the financial value that each player has for their team and school. Managing these players to maximize their potential and ability has effects both on and off the court.

Scarce Resources

The resource-based view of a firm was first popularized by Jay Barney in 1991. Barney claimed that resources could be defined as "all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness" (Barney, 2001). It is important to note that every resource a firm uses is scarce, meaning that there is a higher demand than supply for it. Firms that use their resources in a way that

maximize their efficiency and effectively create a competitive advantage for themselves under the resource-based view of the firm (Barney, Wright, Ketchen Jr., 2001). It is also vital for companies to be able to maintain this competitive advantage by adapting their use of resources in a dynamic market (Barney et al., 2001).

In NCAA Division I basketball two of the most important resources are human (e.g., talented players) and time; both resources are incredibly scarce as well. Currently NCAA Division I men's basketball teams are allowed thirteen scholarship players to be on a team each year. Coaches can bring in high school graduates or transfers from other college programs to fill these thirteen roster spots. Time is the other main resource coaches must manage efficiently and effectively. Teams are allowed a limited number of practices and hours practicing throughout and season and offseason. This means there is limited opportunity for coaches to develop their players that they must maximize to achieve success.

The human resource aspect of college basketball has been proven to be highly related with a team's success. Coaches tend to recruit players that they believe have the physical skill that will fit within their coaching strategy for their team (Wright, Smart, McMahan, 1995). It is important that players are recruited that fit their coach's strategy. If players do not have the required skills to play a certain system or coach must adjust his system to fit his players' skillsets, it has been found that the team's performance will suffer. In contrast, when a team is

filled with many players who play well within their coach's strategy, the team's performance is maximized (Wright et al., 1995).

Positionality in Other Sports

Other sports can be an example of versatile approaches that can be taken when it comes to positionality. Baseball, football, and soccer all have different examples of the evolution of positionality and the importance of having different roles within a team's system.

Football

In football there are eleven players on the field at one time for each team, and a handful of general positions for both offense and defense. On offense, quarterback, running back, full back, tight end, wide receiver, and offensive lineman are the main positions. On defense, linemen, linebackers, and defensive backs are the general positions groups (Hall, 2015). There are many different offensive and defensive systems and strategies used in the game of football.

Offensively, pro-style, west coast, spread, air raid, and option styles are used within high school, college, and professional football. Each of these systems use a range of unique formations that require different player groupings to be on the field. For example, the spread offense uses many wide receivers in most formations, while rarely using tight ends or fullbacks (Potak, 2017).

Defensively, 4-3, 3-4, 3-3-5, dime, nickel, and prevent defensive formations are all used at different levels of football. Teams will use multiple defensive formations within the course of a single game in different scenarios. The 4-3 and 3-4 defenses tend to be base defenses for teams; dime and nickel defenses tend to be used only in situations when the offensive team is likely to throw the ball and has many wide receivers and running backs on the field (Cosmell, 2011).

Soccer

In soccer there are eleven players on the field at one time, and there are four general groups of positions: goalkeepers, defenders, midfielders, and attackers. Each of these positions have their basic roles: goalkeepers protect their goal from opposing team's shots, defenders stay back near their goal to make it more difficult for opposing teams to get shots, midfielders attempt to control the middle of the field and move the ball towards the opposing team's goal, attackers play near their opponent's goal and attempt to score. Within these position groupings there are unique roles. Defenders tend to be either central or outside defenders. Midfielders can be defensive, central, attacking, or outside midfielders. Attackers are usually center forwards or wingers.

Different formations are used in soccer as teams use different strategies throughout the course of a game and season. The 4-4-2, 4-3-3, 4-5-1, and 5-3-2 are all popular formations used by soccer teams. A 4-4-2 formation means that a team plays four defenders, four midfielders, and two attackers. Teams will

change formations throughout the game depending on if they are attempting to be more offensive or defensive minded, which requires not only a formation change, but often a different approach to the game by players on the field. For example, an attacking defender on a team in a 4-4-2 formation will transform that 4-4-2 formation into an aggressive 3-4-3 as quickly as a player can run the length of the field. Teams will also change formations game by game to best fit their personnel for each game (Tighe, 2012). Of course, these changes are dependent on the abilities and skills of versatile players, and modern coaches are taking more and more advantage of this flexibility.

Baseball

In baseball there are nine players competing for each team. Defensively, there is a pitcher, catcher, first baseman, second baseman, short stop, third baseman, left fielder, center fielder, and right fielder (Spatz, 2012). Although these positions have remained the same for most of the history of baseball, recently defensive shifts have become more popular. Defensive shifts, which were first used against Ted Williams in the 1920s, are used when the opponent's batter statistically hits the baseball to a certain part of the field a high percentage of the time. For example, if a batter tends to hit the ball to right side of the field, the infield defenders will shift that way. The second baseman will move to short right field, the short stop will move directly behind second base, and the third baseman will shift to the short stop's normal position (Paine, 2016). Offensively, some teams have changed the way they arrange their batting order.

Traditionally, teams would have their highest percentage hitters hit early in the order, their best overall and power hitters hit in the middle of the order, and their worst hitters hit at the end of the order. However, some teams have moved their best hitters up in the batting order, and other teams have let power hitters hit early in the batting order instead of high percentage hitters (Kram, 2017).

In summary, previous literature has clearly shown the evolution of positionality in the modern game of basketball, as well as other sports. The traditional positions created decades ago no longer accurately represent the roles that players perform in the game today. It is important that the positions of basketball be redefined using performance based metrics. Research has shown that having a well-developed understanding of positions, roles that players fill, and roster construction can be correlated with winning a higher percentage of games (Wright et al., 1995). Also, when compared to other sports, one can see the value in the versatility of implementing different strategies throughout a game or season. In NCAA Division I basketball, winning is important for many reasons. One of these reasons is the financial affects that basketball can have on a university and athletic department. The millions of dollars that can be gained for an NCAA institution from men's basketball success makes any research in this area worthwhile. Finally, coaches must create a team that will achieve this success with a limited number of players on their team. Effectively and efficiently using these scarce human resources to create a team that fits into the coach's system to be successful is a difficult, but necessary task. These reasons make a

new, performance based understanding of the positions of NCAA Division I men's basketball valuable to the collegiate athletic field.

CHAPTER THREE

METHODS

The purpose of this research was to identify the positions that were used by NCAA Division I men's basketball teams during the 2016-2017 season solely using performance metrics. There was no intent to create "new" positions throughout this research. It is expected that using performance metrics to define positionality in basketball may lead to more accurate understandings of the positionality in college basketball, rather than using the traditional metrics of physical characteristics (i.e., height and weight) and oversimplified roles of traditional positions.

This research used only quantitative in-game performance data to identify the positions being used in college basketball today. The aim of the quantitative data was to accurately represent a player's skills and role on their team without any outside influence that could affect how someone viewed their performance over the course of an entire season. The specific performance metrics used will be discussed in more detail below. Players were then grouped together based on their box score statistics using the method of topological clustering. The process of utilizing topological clustering will also be discussed in more detail in the following sections. These clusters were used to then identify positions that characterized player performance across NCAA Division I men's basketball.

Sample

Initially, all NCAA Division I men's basketball players' season box score statistics were collected for this research. Each player's box score statistics was found at the NCAA.com. These box score statistics included the following individual statistics: Year (Yr), Position (Pos), Height (Ht), Games Played (GP), Games Started (GS), Minutes Played (MP), Field Goals Made (FGM), Field Goals Attempted (FGA), Field Goal Percentage (FG%), 3-Point Field Goals Made (3FG), 3-Point Field Goals Attempted (3FGA), 3-Point Field Goal Percentage (3FG%), Free Throws Made (FT), Free Throws Attempted (FTA), Free Throw Percentage (FT%), Points (PTS), Average Points (Avg), Offensive Rebounds (OREbs), Defensive Rebounds (DREbs), Total Rebounds (Tot Reb), Average Rebounds (Avg), Assists (AST), Turnovers, (TO), Steals (STL), Blocks (BLK), Fouls, Double Doubles (Dbl Dbl), Triple Doubles (Trpl Dbl), and Disqualifications (DQ) You can see an example of a team's roster with the above statistics in Appendix A. Each player's team, conference, win/loss record, and winning percentage for the 2016-2017 basketball season was collected as part of the sample for this research.

Data Collection

The data set was completed once box score statistics were compiled for each individual NCAA Division I men's basketball player. There were many players who had blank statistics within their box score, and those players were individually reviewed to fill in those statistics accurately. The data set was then

dissected to see how many players had enough box score statistics to be used in the data analysis for this research. Using SPSS Statistics version 25, a histogram of all players' Minutes Played was created to find if there was normal distribution, or if the data set skewed in one direction. You can see the histogram of all NCAA Division I Men's Basketball players my Minutes Played in Appendix B. The histogram showed that the data skewed hard to the right. Also, the largest bin the histogram was players who had played less than 50 minutes throughout the entire season. Because the skew was so severe and the under 50 minute bin was so large, each player who played under 50 minutes was individually examined to see if they produced statistics robust enough to be included in the data set. For example, a player who played five minutes during the entire season, scored three points, rebounded the ball twice, and was 1-1 from three-point range, would identify as an elite scorer and rebounder. In reality, they did not play enough minutes to have a sample size significant enough to determine their performance levels. Therefore, it was decided that every player should be removed. Removing players who had played fewer than 50 minutes in the season significantly normalized the data set. In Appendix C, you can see the histogram of NCAA Division I Men's Basketball players by Minutes Played once players who played fewer than 50 minutes were removed

After removing players based on their significantly low minutes played, the data set was also checked for how many games players had played throughout the 2016-2017 season. Again, a histogram was created with the remaining data

by Games Played. In Appendix D, you can see a histogram of the players remaining in the data set by Games Played. The histogram was severely skewed to the left, meaning many players played 30 or more games throughout the season, but there were also many players that played in as few as 1-5 games throughout the course of the season. The mean Games Played was 28.3 games with a standard deviation of 6.977 games. To normalize the data by Games Played, it was decided that players 2.5 standard deviations below the mean of 28.3 games would be removed from the data set. This meant that any player that competed in less than 11 total games throughout the season was removed. While removing these players did not perfectly normalize the data, it made it much more normalized. In Appendix E, you can see a histogram of the players in the data set once players who competed in less than 11 total games were removed. These steps were taken to remove players whose playing time was so insignificant that they would inaccurately cluster the data later in research.

Finally, it was decided to only include players within this research that fit the above criteria and played for a team within a conference that had multiple teams selected to compete in the NCAA Tournament during the 2016-2017 season. While reviewing literature, it was found that the financial benefits of this research would affect teams from larger conferences that had multiple teams making the NCAA Tournament each year. As mentioned before, this was because of the financial rewards of making and being successful in the NCAA Tournament. Also, these teams tended to recruit more highly related recruits,

who had a larger financial impact on these athletic departments. Also, decreasing the size of the data set allowed for clearer clustering of the data in the topological mapping which allowed for better interpretations of the positions of NCAA Division I men's basketball. These decisions decreased the total data set from 4,772 players to 1,162 players that would be used for this research.

The box score statistics taken from the NCAA.com were also examined to decide if all statistics were going to be included in the topological clustering process. First, Field Goals Made, Field Goals Attempted, 3-Point Field Goals Made, 3-Point Field Goals Attempted, Free Throws Made, Free Throws Attempted, Points, Offensive Rebounds, Defensive Rebounds, Total Rebounds, Assists, Turnovers, Steals, Blocks, and Fouls were all adjusted to be "per Minute" statistics. This means that each of these statistics was divided by the player's total minutes. This was done to ensure that clustering would not be affected by how many minutes a player played, but solely by their performance while they had playing time. Also, it was decided that Year, Position, Height, Games Played, Games Started, Double Doubles, Triple Doubles, and Disqualifications would not be used as statistics affecting the topological clustering. Correlations were then run to see if any statistics highly correlated with each other. The following statistics were correlated with each other an R-rating of higher than 0.7, meaning they were very highly correlated: Field Goals Attempted & Field Goals Made, Field Goals Made & Points, Field Goals Attempted & Points, 3-Point Field Goals Attempted & 3-Point Field Goals Made, Free Throws Attempted & Free

Throws Made, Free Throws Made & Points, Total Rebounds & Defensive Rebounds, and Total Rebounds & Offensive Rebounds. You can see the regression analysis of the above statistics that were deemed highly correlated in Appendix F. Because many of the shots attempted and shots made statistics correlated highly with each other and with points, it was decided that only Field Goal Percentage, 3-Point Field Goal Percentage, Free Throw Percentage, and Points per Minute would be kept as scoring statistics. Also, because Total Rebounds highly correlated with both Offensive and Defensive Rebounds, it was decided that only Total Rebounds per Minute would be kept of those three statistics. The final statistics that were used in the topological clustering of the data were Field Goal Percentage, 3-Point Field Goal Percentage, Free Throw Percentage, Points per Minute, Total Rebounds per Minute, Assists per Minute, Turnovers per Minute, Steals per Minute, and Blocks per Minute. This decision was made to create a leaner process for the topological clustering software to sift through and to remove any unneeded statistics that may inaccurately affect the topological clustering.

Data Analysis

Data for this research were analyzed in R Studio and SPSS Statistics version 25. To answer the research question “What positions are NCAA Division I men’s basketball teams using in the 2016-2017 season based on performance metrics?”, topological mapping was used within R Studio. Throughout the topological mapping process, the data was valued, binned, and then clustered

based on the statistics for each player. You can see an image showing the process of topological mapping in Appendix G. This example uses a hand to show how the data is filtered, binned, and clustered. First, a principal component analysis (PCA) was run with all the players included in the research. The purpose of this analysis was to create one value to filter data when mapping it later. This filter value combined all nine of the statistics used for each player. The PCA process weighted each of these statistics by which were most influential in differentiating the players statistically. From this process, the one filter value was created for each player to be used in topological mapping. The PCA filter value for each player can be seen in the PCA scatterplot. You can see the PCA scatterplot in Appendix H. Once PCA values were found for each player, the data was run through topological data analysis (TDA) in R Studio. Topological mapping is a form of math that attempts to find the shape of data (Lum et al., 2013). Using the filter values created in the principal component analysis, the data was binned and then clustered. This means that players that had similar statistics were clustered together. A map of these clusters was then created; players with the most similar statistics were placed in the same bins and bins with similar players were placed closely together. You can see the topological map in Appendix I. After the topological mapping was completed, the researcher identified clusters and bins as different positions based on their statistics. The process of identifying the eight positions found in this research from the sixty clusters created in the topological mapping was a mixture of

quantitative and qualitative based decision making. The average of each statistic for each cluster was reviewed and compared to clusters connected to it within the topological map. When clusters had similar statistical averages, they were grouped together within the same position. The researcher determined when the statistical averages were not similar enough to be considered the same position through quantitative analysis and qualitative comparison based on the researcher's own understanding of college basketball and basketball statistics.

After positions were created, the second research question "Is there a relationship between the positions found in this research and team winning percentage?" was answered using a one-way ANOVA test with SPSS Statistics version 25. Each position grouping of players was run with team winning percentage. The results were analyzed by the researcher and compared across all positions.

CHAPTER FOUR

RESULTS

Positions

The first research question asked was, “What positions are NCAA Division I men’s basketball teams using in the 2016-2017 season based on performance metrics?”. The results of the data analysis give insight into finding the positions and roles used within NCAA Division I men’s basketball. There were 60 clusters found during the topological mapping analysis. Each of these clusters were examined individually and grouped by statistical similarities. Eight positions were identified and named based on their statistics: Bench Warmer, Role Player, Rebounding Shot Blocker, Ball Handling Defender, Three Point Scoring Ball Handler, Three Point Scoring Rebounder, Close Range Dominator, and Point Producer. There were four clusters that did not connect to any other clusters within the data; those clusters were also examined individually and added to the most appropriate position. For the entire data set of 1,161 players the average Field Goal Percentage was 44.86% with a standard deviation of 9.07%. The average 3-Point Field Goal Percentage was 27.28% with a standard deviation of 17.13%. This distribution was heavily influenced by a high number of players that shot 0% from 3-point range. Any player that did not attempt a 3-point shot was listed as a 0% 3-point shooter for the purpose of topological mapping. The average Free Throw Percentage was 66.95% with a standard deviation of 16.44%. The average Points per Minute was .337 with a standard deviation of

.118. The average Rebounds per Minute was .168 with a standard deviation of .072. The average Assists per Minute was .062 with a standard deviation of .04. The average Turnovers per Minute was .059 with a standard deviation of .02. The average Steals per Minute was .029 with a standard deviation of .148. The average Blocks per Minute was .022 with a standard deviation of .024. This distribution was skewed to the right because of the high number of players who averaged almost no blocks per minute, while some players averaged over .1 blocks per minute. Also, the average minutes per game for the entire data set was 20 minutes. The statistics for every position as well as the average of the entire data set can be found in Appendix J.

Bench Warmer

The Bench Warmer was the first position identified. Clusters 6,7,8,9,13,14,15, and 16 combined to create the position. The clusters that created the Bench Warmer can be seen within the topological map in Appendix K. There were 163 players that fit into the Bench Warmer position. The statistics for the Bench Warmer can be found in Appendix J. The Bench Warmer was below average in Field Goal Percentage, Free Throw Percentage, Points per Minute, Total Rebounds per Minute, Assists per Minute, Steals per Minute, and Blocks per Minute. However, they were above average in Three Point Field Goal Percentage and Turnovers per Minute. If this data was extrapolated to 20 minutes of playing time, the Bench Warmer would average the following statistics per game: 4.5 points, 2.37 rebounds, 1.05 assists, .88 turnovers, .50 steals, and

.14 blocks. One can see that the Bench Warmer was given this title because of the of their consistent statistical underperforming in most of the performance metrics.

Role Player

The Role Player was the next position identified. Clusters 20,21,27, and 28 combined to create the position. The clusters that created the Role Player can be seen within the topological map in Appendix L. There were 88 players that fit into the Role Player position. The statistics for the Role Player can be found in Appendix J. The Role Player was average in Field Goal Percentage, Free Throw Percentage, Total Rebounds per Minute, and Steals per Minute. They were above average in Three Point Field Goal Percentage, and Turnovers per Minute and were below average in Points per Minute, Assists per Minute, and Blocks per Minute. If this data was extrapolated to 20 minutes of playing time, the Role Player would average the following statistics per game: 6.05 points, 3.20 rebounds, 1.00 assists, 1.08 turnovers, .57 steals, and .31 blocks. The Role Player was given its title because this position was average in many categories, but not exceptional in any statistical categories.

Rebounding Shot Blocker

The Rebounding Shot Blocker was the next position identified. Clusters 3,4,5,10,11,12,17,18,19,24, and 25 combined to create the position. The clusters that created the Rebounding Shot Blocker can be seen within the

topological map in Appendix M. There were 185 players that fit into the Rebounding Shot Blocker position. The statistics for the Rebounding Shot Blocker can be found in Appendix J. The Rebounding Shot Blocker was above average in Field Goal Percentage, Total Rebounds per Minute, Turnovers per Minute, and Blocks per Minute. However, they were below average in every other statistical category. If this data was extrapolated to 20 minutes of playing time, the Rebounding Shot Blocker would average the following statistics per game: 4.66 points, 4.42 rebounds, .54 assists, 1.1 turnovers, .42 steals, and .89 blocks. The Rebounding Shot Blocker was named this because of their high-level rebounding and shot blocking abilities. However, the rest of their statistics imply that this position is quite limited offensively.

Ball Handling Defender

The Ball Handling Defender was the next position identified. Clusters 22,23,29, and 30 combined to create the position. The clusters that created the Ball Handling Defender position can be seen within the topological map in Appendix N. There were 161 players that fit into the Ball Handling Defender position. The statistics for the Ball Handling Defender can be found in Appendix J. The Ball Handling Defender was above average at Three Point Field Goal Percentage, Free Throw Percentage, Assists per Minute, Turnovers per Minute, and Steals per Minute. However, they were below average at Field Goal Percentage, Points per Minutes, Total Rebounds per Minute, and Blocks per Minute. If this data was extrapolated to 20 minutes of playing time, the Ball

Handling Defender would average the following statistics per game: 6.25 points, 2.09 rebounds, 1.61 assists, 1.00 turnovers, .67 steals, and .12 blocks. The three most influential statistics in defining the Ball Handling Defender were their assists, turnovers, and steals.

Three Point Scoring Ball Handler

The Three Point Scoring Ball Handler was the next position identified. Clusters 36,37,45,56, and 60 combined to create the position. The clusters that created the Three Point Scoring Ball Handler position can be seen within the topological map in Appendix O. There were 156 players that fit into the Three Point Scoring Ball Handler position. The statistics for the Three Point Scoring Ball Handler can be found in Appendix J. The Three Point Scoring Ball Handler was above average in Three Point Field Goal Percentage, Free Throw Percentage, Points per Minute, Assists per Minute, and Steals per Minute. They were below average in Field Goal Percentage, Total Rebounds per Minute, Turnovers per Minute, and Blocks per Minute. If this data was extrapolated to 20 minutes of playing time, the Ball Handling Defender would average the following statistics per game: 7.88 points, 2.16 rebounds, 2.02 assists, 1.31 turnovers, .73 steals, and .13 blocks. As the position name implies, scoring and ball handling statistics like Three Point Field Goal Percentage, Points per Minute, and Assists per Minute were most influential in defining this position.

Three Point Scoring Rebounder

The Three Point Scoring Rebounder was the next position identified. Clusters 26,33, and 34 combined to create the position. The clusters that created the Three Point Scoring Rebounder can be seen within the topological map in Appendix P. There were 56 players that fit into the Three Point Scoring Rebounder position. The statistics for the Three Point Scoring Rebounder can be found in Appendix J. The Three Point Scoring Rebounder was above average at Field Goal Percentage, Three Point Field Goal Percentage, Total Rebounds per Minute, and Blocks per Minute and below average in Assists per Minute and Steals per Minute. They were average at Free Throw Percentage, Points per Minute, and Turnovers per Minute. If this data was extrapolated to 20 minutes of playing time, the Ball Handling Defender would average the following statistics per game: 6.87 points, 4.38 rebounds, .89 assists, 1.22 turnovers, .53 steals, and .57 blocks. The Three Point Scoring Rebounder was a position that shot well from all areas, but specifically from three-point range, while rebounding and blocking shots at a high rate.

Close Range Dominator

The Close Range Dominator was the next position identified. Clusters 31,32,38,39,40,41,46,47,48, and 49 combined to create the position. The clusters that created the Close Range Dominator can be seen within the topological map in Appendix Q. There were 197 players that fit into the Close Range Dominator position. The statistics for the Close Range Dominator can be

found in Appendix J. The Close Range Dominator was above average in Field Goal Percentage, Points per Minute, Total Rebounds per Minute, and Blocks per Minute and below average at Three Point Field Goal Percentage, Assists per Minute, Turnovers per Minute, and Steals per Minute. They were average at Free Throw Percentage. If this data was extrapolated to 20 minutes of playing time, the Ball Handling Defender would average the following statistics per game: 8.44 points, 5.21 rebounds, .84 assists, 1.42 turnovers, .50 steals, and .91 blocks. The Close Range Dominator separated themselves by shooting a high percentage and scoring at a high rate while rebounding and blocking shots well too.

Point Producer

The Point Producer was the final position identified. Clusters 31,32,38,39,40,41,46,47,48, and 49 combined to create the position. The clusters that created the Point Producer position can be seen within the topological cluster in Appendix R. There were 148 players that fit into the Point Producer position. The statistics for the Point Producer can be found in Appendix J. The Point Producer was above average at Three Point Field Goal Percentage, Free Throw Percentage, Points per Minute, Assists per Minute, and Steals per Minute and below average in Total Rebounds per Minute, Turnovers per Minute, and Blocks per Minute. They were average at Field Goal Percentage. If this data was extrapolated to 20 minutes of playing time, the Ball Handling Defender would average the following statistics per game: 9.30 points,

2.97 rebounds, 1.92 assists, 1.48 turnovers, .78 steals, and .23 blocks. The Point Producer was a player who scored efficiently, especially from three-point range, and scored at a high rate as well. They also created scoring opportunities for their teammates with their high assists.

Other Clusters

There were four clusters that were not connected to any other clusters within the topological mapping of the data. These clusters were 1,2,43, and 59. The clusters listed here can be seen within the topological map in Appendix S. Cluster 1 contained two players, while Clusters 2, 43, and 59 each only contained one player. Clusters 1 and 2 both had significantly low 3-Point Field Goal and Free Throw Percentages which separated them from any other clusters. When examined, both clusters were added to the Bench Warmer position because most of their statistics were below average. Cluster 43 had a 100% 3-Point Three Point Field Goal Percentage which separated it from the other clusters. However, when examining deeper, this was because the player in this cluster was 1-1 from 3-point range during the season. However, the player in Cluster 43 had statistics that fit within the Close Range Dominator position, so he was added there. Finally, Cluster 59 had no clear statistic that separated the cluster from others. However, when examined closer, it was found that the player in Cluster 59 was most like the players within the Point Producer position, so he was categorized as such.

Team Winning Percentage

The second research question was “Is there a relationship between the positions found in this research and team winning percentage?”. A one-way ANOVA test was run to compare the mean team winning percentage of each position, and a comparative box plot was created to show this comparison. Because there was a difference in the number of players at each position, it was important to test for the homogeneity of variance within the data for the ANOVA test. The Levene’s Test showed a significance level of .391. The results of the Levene’s Test can be seen in Appendix T. This was above the significance level of .05, showing that there was homogeneity of variance for this data. The one-way ANOVA showed the team winning percentages by position ranged from 53.29% to 61.04%, with the Bench Warmer having the lowest team winning percentage and the Close Range Dominator having the highest team winning percentage. The maximum and minimum winning percentages, standard deviations, and 95% confidence intervals were also displayed for each position. The comparison of team winning percentage by position can be seen in Appendix U. The one-way ANOVA comparison of means showed that most positions team winning percentages were not statistically significantly different from each other. However, the Close Range Dominator, with a mean team winning percentage of 61.04% was significantly different than both the 53.29% team winning percentage of the Bench Warmer and the 54.12% team winning percentage of the Rebounding Shot Blocker. The results of the one-way ANOVA

test can be seen in Appendix V. The box plot of each position's team winning percentage shows the difference in means as well as the range of team winning percentages that each position contained. The box plot comparison of team winning percentage by position can be seen in Appendix W. Although there were significant differences between some position's team winning percentages, it is important to note that each position had a player with a team winning percentage of 25% or lower. Also, each position had a player with a team winning percentage of 86.11% or higher, meaning that each position had an incredibly wide range of players that experienced different levels of team success.

CHAPTER FIVE

DISCUSSION & CONCLUSION

The purpose of this study was to identify the positions being used in NCAA Division I men's basketball by using performance metrics. The performance metrics used in this study were statistics found in a NCAA Division I basketball game box score. Once these positions were identified using topological mapping, the importance of these positions and roster construction were examined. The importance of each position was found by comparing the average team winning percentages of each position. Nine positions were found in this research: Bench Warmer, Role Player, Rebounding Shot Blocker, Ball Handling Defender, Three Point Scoring Ball Handler, Three Point Scoring Rebounder, Close Range Dominator, and Point Producer. These positions each had statistical differences that separated themselves from the other positions.

Positions

Bench Warmer

The Bench Warmer was arguably the least important position found in this research. The bench warmer was at, or below, average at each of the box score statistics used to identify positions. Over half of the players in this position grouping were Freshman or Sophomores. This is important because these young players could develop into different, more important, positions during their college basketball career. Also, this position had players that were listed as both guards and forwards by their teams. This is not surprising considering that each

player in this position has done nothing statistically to differentiate themselves into a specific performance metric. Along with this diversity in position, there was a large diversity in height in this position. Players ranged from 5'11" to 6'9" in the Bench Warmer position. It is important that a player in the Bench Warmer position identifies skills that will allow to develop out of the Bench Warmer position into a different position during their career. Some players that were listed in the Bench Warmer position during the 2016-2017 season were Hassani Gravett (South Carolina), Rex Pflueger (Notre Dame), Kenny Williams (North Carolina), and Keith Stone (Florida). These underclassmen all played a role on high major basketball teams during the 2016-2017 season. However, they played even larger roles during the 2017-2018 season, and gave themselves the opportunity to move into different positions because of their improvement.

Role Player

The Role Player was around average in nearly all the statistical categories used in this research. This position grouping was evenly split across Freshman, Sophomores, Juniors, and Seniors. It seems that younger players could evolve from the Role Player position into a more skill specific position, but many older players have settled into the Role Player position as well. This position had players ranging from 6'0" to 6'11" in height, with the largest grouping of players between 6'6" and 6'9". Sam Houser (Marquette), Dean Wade (Kansas State), and Ahmed Hill (Virginia Tech) were all underclassmen who fit into the Role Player position during the 2016-2017 season. However, it was expected that

these players may have larger roles within their team during future positions that could lead to their position changing. On the other hand, V.J. Beachem (Notre Dame) was a senior who filled the Role Player position. He played significant minutes for his 26-win team within the Role Player position.

Rebounding Shot Blocker

The Rebounding Shot Blocker was known for rebounding and shot blocking at an above average rate while shooting at an above average field goal percentage. One of the interesting results about the Rebounding Shot Blocker was that this position had the second lowest team winning percentage to the Bench Warmer. This could be attributed to the fact that the Rebounding Shot Blocker seems like a limited player offensively. While they did shoot an above average field goal percentage, they did not shoot well from three-point range and scored below average points per minute as well. It seems that the natural progression for a Rebounding Shot Blocker would be to evolve into a Close Range Dominator, a player with similar rebounding and blocking statistics who scored at a higher rate. 133 of the 185 players in this position were listed as forwards or centers by their teams, meaning that this position seems to fit with these traditional positions. Also, almost all the players listed in the Rebounding Shot Blocker position were 6'7" or taller, with the tallest player in the position being 7'4". There were over 100 players in the position that were either Freshman or Sophomores, which could mean that this position is filled with players who play above average defense but are still trying to learn how to

develop their offensive game. Eric Paschall (Villanova), Dewan Huell (Miami), Wenyen Gabriel (Kentucky), Kyle Alexander (Tennessee), and Jack Salt (Virginia) were all underclassmen that fit into the Rebounding Shot Blocker position during the 2016-2017 season. Tyler Wideman (Butler) and Jo Lual-Acuil, Jr. (Baylor) were upperclassmen that fit into the position as well.

Ball Handling Defender

The Ball Handling Defender was known for being an above average assister and stealer while shooting above average from three-point range. However, the Ball Handling Defender seemed somewhat limited offensively as they were below average in field goal percentage and points per minute. 142 of the 161 players in this position were listed as guards by their team, which is not surprising considering their skillset. Also, the heights of the players in this position ranged from 5'10" to 6'8" with most players ranging from 6'2" to 6'5". The Ball Handling Defender was the first position found that slightly skewed towards older players. While the player grades were relatively evenly distributed, there were more Juniors and Seniors within this position. Lourawls "Tum" Nairn, Jr. (Michigan State), Payton Pritchard (Oregon), Parker Jackson-Cartwright (Arizona), Quentin Snyder (Louisville), and Nate Britt (North Carolina) were all players that played the Ball Handling Defender position. These players were considered traditional point guards whose roles were to distribute the basketball and manage the game offensively for their team. Also, Zak Irvin (Michigan) and Theo Pinson (North Carolina) were other players that fit into this position. These

players were larger wing players who were not known for being incredibly offensively skilled. Most of the time their role included defending the other team's best player, so they make sense in this position as well. Two surprise players in the Defending Ball Handler position were Kyle Guy (Virginia) and Bryce Alford (UCLA). These players were known for their scoring, specifically their three-point shooting. The fact that they were grouped in this position could mean that both Guy and Alford were better passers and defenders than a quick evaluation of their talents would indicate. In the case of Guy, this could also be an indication of a player's team's style of play. Virginia was known for their incredibly slow pace of play that would have limited Guy's chances to score in high enough volumes to be considered a Three Point Scoring Ball Handler or Point Producer.

Three Point Scoring Ball Handler

Three Point Scoring Ball Handlers were significantly above average three-point shooters who also had points, assists, and steals per minute that were above average. This position could be described as a seemingly more offensively capable version of the Defending Ball Handler. 140 of the 156 players in this position were listed as guards by their team, very similar to the Defending Ball Handler position as well. Players in this position ranged from 5'10" to 6'9" with most players evenly distributed between 6'0" and 6'5". This position also had an even distribution between Freshman, Sophomore, Junior, and Senior. Also, of these factors seem to show that the Three Point Scoring

Ball Handler had similar characteristics to a traditional Shooting Guard or Small Forward. Jordan McLaughlin (Southern California), J.P. Macura (Xavier), Joel Berry II (North Carolina), Grayson Allen (Duke), Matt Ferrell (Notre Dame), and Landry Shamet (Wichita State) were all players that played the Three Point Scoring Ball Handler position. However, Kris Jenkins (Villanova), Nathan Adrian (West Virginia), and Andrew Chrabascz (Butler) were also a part of this position. All these players would traditionally be considered post players, but they shot relatively well from three-point range. Also, it seems that they played a role within in their team that allowed them to handle the ball and assist to other players that would classify them as a ball handling player more so than a post player.

Three Point Scoring Rebounder

Three Point Scoring Rebounders were above average field goal percentage shooters, three-point percentage shooters, points per minute scorers, and rebounders. There were only 56 players identified in this position, and 38 of them were listed as forwards by their teams. This position was also well represented by each grade class. Players ranged from 6'4" to 7'0" tall in this position with most players being 6'6" to 6'10". The Three Point Scoring Rebounder seems like it is very similar to the "Stretch 4" position that has become more popular in the last decade. This position is simply defined as a traditional post player who can shoot three-point shots with high levels of success. Thomas Welsh (UCLA), Lauri Markkanen (Arizona), Nigel Hayes

(Wisconsin), Luke Kornet (Vanderbilt), and D.J. Wilson (Michigan) were all players listed in the Three Point Scoring Rebounder position, and all these players would have been called “Stretch 4” type players during the 2016-2017 season.

Close Range Dominator

The Close Range Dominator players shot an incredibly high field goal percentage while being above average points, rebounds, and blocks per minute. This position had the highest team winning percentage of any of the positions identified in this research. Because of this, one could argue the Close Range Dominator is the most important position in NCAA Division I basketball. Of the 197 players in this position, 182 of these players were listed as a forward or center by their team. This position was evenly distributed between Freshman, Sophomore, Junior, and Senior players. 163 of the 197 players in this position were between the heights of 6’7” and 7’0”. This player seems like it would fit with the traditional Power Forward or Center position and seems like a more offensively capable version of the Rebounding Shot Blocker. Moritz Wagner (Michigan), Yante Maten (Georgia), Caleb Swanigan (Purdue), Zach Collins (Gonzaga), Jordan Bell (Oregon), and Ethan Happ (Wisconsin) were all traditional post players that were identified as Close Range Dominators in this research. Some players that could be somewhat of a surprise at this position were Jayson Tatum (Duke), Miles Bridges (Michigan State), and Bonzie Colson (Notre Dame). These three players would traditionally be listed as Small

Forwards. However, they scored most of their points at the two-point level and rebounded at a high level, which led them to be grouped with the Close Range Dominators for the 2016-2017 season.

Point Producer

The Point Producer was an above average field goal percentage, three-point field goal percentage, and free throw percentage shooter while having high points and assists per minute. 119 of the 148 players in this position were listed as guards by their team, which is not surprising considering the high three-point shooting percentage and assist rate of this position. The position was relatively evenly distributed between grade levels, with a slight skew towards Senior players. There was a range of heights from 5'10" to 6'10", but over half of the Point Producers were between 6'3" and 6'5". This position seems like it could include Point Guards, Shooting Guards, and Small Forwards from the traditional positions of basketball. Many of the star players in college basketball fit into this position, which makes sense considering the high level of scoring that the Point Producer achieved. Jalen Brunson (Villanova), Frank Mason (Kansas), De'Aaron Fox (Kentucky), Nigel Williams-Goss (Gonzaga), Dennis Smith Jr. (NC State), and Lonzo Ball (UCLA) were all players that would traditionally fit into the Point Guard position that were listed as Point Producers during the 2016-2017 season. Donovan Mitchell (Louisville), Josh Hart (Villanova), Luke Kennard (Duke), and Markelle Fultz (Washington) were more prototypical Shooting Guards who also fit as Point Producers. Dillon Brooks (Oregon), Sindarius Thornwell (South

Carolina), and Kelan Martin (Butler) were bigger players listed as forwards by their team that also fit into the Point Producer position.

Roster Construction

To study the roster construction of NCAA Division I men's basketball teams the 2017 NCAA Tournament Final Four teams will be examined. North Carolina, Gonzaga, Oregon, and South Carolina were the four teams that advanced to this point in the tournament. Each team's roster will be examined using the nine positions found in this research, and these rosters will be compared with each other.

North Carolina

North Carolina, the 2017 NCAA Division I men's basketball National Champion, had a roster that included two Bench Warmers, three Ball Handling Defenders, one Three Point Shooting Ball Handler, four Close Range Dominators, and two Point Producers. North Carolina's starting five players were Joel Berry II (Three Point Shooting Ball Handler), Justin Jackson (Point Producer), Theo Pinson (Ball Handling Defender), Isaiah Hicks (Close Range Dominator), and Kennedy Meeks (Close Range Dominator). North Carolina had a diverse group of perimeter players. Along with Berry II, Jackson, and Pinson, North Carolina had Nate Britt (Ball Handling Defender), Seventh Woods (Point Producer), and Kenny Williams (Bench Warmer) that played significant minutes off the bench. However, North Carolina's team strength seemed to be their post

players. They started two Close Range Dominators and had two more coming off the bench.

Gonzaga

Gonzaga, who lost in the National Championship game, had one Bench Warmer, one Rebounding Shot Blocker, four Ball Handling Defenders, five Close Range Dominators, and one Point Producer. Their starting lineup included Nigel Williams-Goss (Point Producer), Jordan Mathews (Ball Handling Defender), Josh Perkins (Ball Handling Defender), Johnathan Williams (Close Range Dominator), and Przemek Karnowski (Close Range Dominator). Gonzaga also had two Close Range Dominators in Zach Collins and Killian Tillie that played significant minutes off the bench. Silas Melson (Ball Handling Defender) also played for the Bulldogs. Again, it seems that Gonzaga's success could be attributed to their depth at the Close Range Dominator position. Also, it could be important that their primary ball handler, Nigel Williams-Goss, was a Point Producer for their team.

Oregon

Oregon lost to North Carolina in the National semi-final game in 2017. Their roster included one Role Player, one Rebounding Shot Blocker, two Ball Handling Defenders, one Three Point Scoring Rebounder, one Three Point Scoring Ball Handler, two Close Range Dominators, and two Point Producers. Their starting lineup included Payton Pritchard (Ball Handling Defender), Dylan

Ennis (Three Point Scoring Ball Handler), Tyler Dorsey (Point Producer), Dillon Brooks (Point Producer), and Jordan Bell (Close Range Dominator). It is important to note that Chris Boucher (Close Range Dominator) was a starter for most of the season, but he was injured during the NCAA Tournament. Kavell Bigby-Williams (Rebounding Shot Blocker) and Casey Benson (Ball Handling Defender) played significant minutes for Oregon as well. While Oregon had two Close Range Dominators throughout most of the season, it seems like they might have relied on a more diverse roster. Also, having two Point Producers in the starting lineup was a large part of Oregon's success during the 2016-2017 season.

South Carolina

South Carolina was defeated by Gonzaga in the 2017 National semi-finals. Their roster included five Bench Warmers, four Rebounding Shot Blockers, one Close Range Dominator, and three Point Producers. Sindarius Thornwell (Point Producer), Duane Notice (Bench Warmer), P.J. Dozier (Point Producer), Maik Kotsar (Rebounding Shot Blocker), and Chris Silva (Close Range Dominator) started for South Carolina. Justin McKie (Bench Warmer), Rakym Felder (Point Producer), and Hassani Gravett (Bench Warmer) all played for South Carolina as well. South Carolina had by far the most Bench Warmers on their team, a position you would not expect to see much of on a Final Four team. However, South Carolina was a 7 seed in the NCAA Tournament and made a surprise run to the Final Four. The amount of Bench Warmers on their

roster could explain their performance in the regular season that led to a lower seed. However, South Carolina also had three Point Producers in their lineup, which could make up for the large amount of Bench Warmers. This was the most Point Producers on any of the Final Four rosters. South Carolina only had one Close Range Dominator, which they could have used more of compared to the other teams examined.

Comparison

Unsurprisingly, it looks like the Close Range Dominator and Point Producer were the two most important positions on the 2017 NCAA Tournament Final Four rosters, as these positions were also had the highest correlated with team winning percentage. It looked like having multiple Point Producers that played for a team was a recipe for success in the 2016-2017 season and having multiple of these players could make up for a less than impressive roster overall. However, North Carolina and Gonzaga showed that having incredible depth at the Close Range Dominator position was arguably the most important roster component to competing for an NCAA Tournament Championship. While many pundits claim that college basketball is a guard's game, it seems as if having a multitude of post players was key for success in the 2016-2017 season.

Practical Applications

The practical applications of this research begin and end with the on-court success college basketball teams must achieve in such a competitive

environment and the financial returns that come from that success. Coaches must win consistently to maintain their jobs and make themselves intriguing candidates for jobs at larger programs. In today's college basketball landscape, there is not much patience from fan bases and administration. This means that coaches must be able to immediately and consistently recruit players that will fit into their system. With players being a scarce resource, based on the limited number of players with the ability to play at the NCAA Division I level and the limited number of scholarships a team has each year, means that coaches do not have much room for error when constructing their team (Wright et al., 1995).

Administrators are aware of the financial implications of men's basketball success in the NCAA Tournament, and each want the largest possible piece of the over \$200 million NCAA Basketball Fund distributions that are directly related to their tournament success (Distributions). For smaller conferences, the possibility of producing multiple NCAA Tournament teams could drastically change the financial outlook of all their conference members because of the impact extra Basketball Fund distributions could have on their smaller athletic budgets (Hobson, 2014). Below are specific ways that coaches and administrators can use this research to efficiently and effectively manage their teams to succeed on the court and financially.

Coaches

College basketball coaches could use this research for multiple purposes. Understanding styles of play, recruiting, and player development could all be

improved by viewing positionality from a performance metrics viewpoint.

Coaches could have a better understanding of their style of play as well as the style of play of their opponents. When looking to understand their own style of play, coaches could see which positions most often used and which positions were most important to their success. Also, coaches could look at the roster construction of other teams with similar playing styles to compare their players. This could lead to coaches having a better understanding of the best ways to maximize the potential of their roster. Coaches could also study their opponents roster construction. It could be possible for coaches to find positions that were consistently difficult for their team to defend and adjust accordingly.

From their understanding of their roster construction based on the positions identified in this research, coaches could be more efficient with their recruiting as well. Coaches would have a more in depth understanding of the types of players they should be recruiting. Instead of strictly recruiting based on a player's individual talent, coaches would be able to pursue players that fit into positions that were used within their style of play.

Finally, coaches would be able to better develop their players throughout their collegiate careers. Having performance metrics defining positions would allow coaches to more clearly explain their expectations to players. Also, it would be easier for coaches to see what their players needed to improve on. For example, a player could be a Rebounding Shot Blocker, and their coach would prefer that they improve to be a Close Range Dominator. A coach would know

that a player would need to improve their scoring while maintaining their rebounding and block rates to do this. Coaches could plan practices and individual workouts with this goal in mind.

Administrators

Administrators could use this research to both hire coaches and promote NCAA Tournament success within their programs. Hiring coaches can be a very difficult process within the world of basketball. Administrators often attempt to choose between many qualified candidates who have had similar levels of success in previous seasons. Administrators could check to see what style of play and positions a potential coaching candidate used to see if that style was successful across college basketball. Also, administrators could encourage their coaches to schedule games that help improve their NCAA Tournament resume but are still winnable games based on the matchup of positions on each team. It is important for administrators and coaches to balance scheduling difficult out of conference opponents while maximizing the possibility to win those games. Using the positionality in this research could assist in finding opponents that help find the proper balance.

Future Research

This research could be improved and advanced in three ways with future research. More advanced analytics could be used to identify positions, positions

could be tracked historically if this research was done each season, and line ups could be analyzed with the positions found in this research.

In this research basic box score statistics were used as performance metrics. However, there are more advanced statistics that could be used. Efficiency ratings, plus/minus statistics, win shares, value over replacement player, and advanced offensive and defensive statistics could all be used to measure a player's performance. Many independent statisticians like Ken Pomeroy and Bart Torvik are continuously creating new statistics to analyze player performance in college basketball. It would be interesting to compare the positions found in topological mapping with these more advanced statistics compared to the positions found only using box score statistics. This could provide a more detailed and nuanced identification of positions within NCAA Division I men's college basketball, which is likely to then produce greater insight for coaches and administrators as well. Also, these statistics would assist in describing what separates each position from others and give a better picture of what skills are important for a player to be successful within a position.

Performing this research in past seasons and continuing to perform this research each season in the future would allow for a historical perspective of the positions in college basketball. First, this historical analysis would provide a story of how the game of college basketball has evolved throughout its history. One would be able to see how positions have stood the test of time, and which positions have faded in and out of the game as it has grown. This research could

be paired with other historical college basketball research to help show how playing styles have changed in college basketball.

Second, it could be beneficial for coaches to have a historical perspective of the positions used in college basketball, and more specifically which positions they have utilized throughout their coaching career. Coaches would be able to see which positions are most valuable during their career while comparing that to positions that have become less important. Also, having this historical analysis would help them better understand what positions are most important to their style of play's success. They would be able to understand if certain positions and position groupings have consistently worked within their system throughout their career. They would also be able to compare their rosters throughout multiple seasons to compare them. It would be possible that they could find trends in their rosters or correlations between their roster construction and success on the court.

While this research looked specifically at individual positions, one could use the positions found in this research to analyze line ups in college basketball. Coaches are constantly attempting to figure out how to put the most productive group of five players on the floor at one time. Research could be performed to see which groupings of positions performed well with each other, and if there were line ups that included positions combinations that consistently did not perform well. For example, researchers might ask how specific line up or position groupings predicted offensive or defensive efficiency. Also, researchers

might be able to find specific position groupings correlated with a high plus/minus rating, meaning they consistently outscored their opponents while in the game together. If a team's most talented player is a Close Range Dominator, this research would assist coaches in understanding which positions should fill the other four spots on the floor to maximize their best player and team's potential. This research would be beneficial in assisting coaches with improving their line up decisions and substitution patterns.

Chapter Summary

This research used performance metrics to identify nine positions in NCAA Division I men's basketball during the 2016-2017 season. The Bench Warmer, Role Player, Rebounding Shot Blocker, Defending Ball Handler, Three Point Scoring Ball Handler, Three Point Scoring Rebounder, Close Range Dominator, and Point Producer each had box score statistics that separated themselves from the other positions within college basketball. This research is important because it identifies positions solely based on a player's statistical production on the court and not on any preconceived notions based on a player's physical attributes or a traditional understanding of the positions of basketball. This research can lead to continued research into these positions and the effect a new understanding of positionality can have on college basketball.

Conclusion

The sport of basketball has evolved in many aspects since its inception in 1891. Rules, cultural popularity, and financial implications of basketball continue to change with the game. The positionality of basketball has continued to develop as well. As basketball and its positions continue to change, it is important to identify the positions that are currently being used in the game today. There are five traditional positions in basketball—point guard, shooting guard, small forward, power forward, and center. These positions are often defined by a player's physical qualities (i.e., height and weight). As the game of basketball has evolved, however, new positions (e.g., point-forward or stretch 4) have emerged. This research attempted to identify the current positions in NCAA Division I men's basketball using performance metrics. Performance metrics were used to avoid any preconceived notions of a player's positions based on physical attributes; only a player's in game performance was used to judge their positionality. The performance metrics used were basic box score statistics: Field Goal Percentage, Three-Point Field Goal Percentage, Free Throw Percentage, Points, Total Rebounds, Assists, Turnovers, Steals, and Blocks. The non-percentage statistics were adjusted to be "per minute" statistics, so a player was only judged by their on-floor performance, and not their playing time. Topological mapping was used to identify position clusters in this data. Topological mapping was effective for two reasons. First, topological mapping clustered data points based on data similarities, allowing the researcher to

identify statistical averages for each cluster. Second, topological mapping simplified data points that were affected by many different variables. In this research, each data point represented an individual that was affected by each statistic, and topological mapping reduced these nine variables to two dimensions, creating practical visualizations.

Topological mapping identified eight different positions currently being used in college basketball, and these positions were named based on their statistical differentiations. The Bench Warmer, Role Player, Rebounding Shot Blocker, Ball Handling Defender, Three Point Scoring Ball Handler, Three Point Scoring Rebounder, Close Range Dominator, and Point Producer were all found as positions. These positions were compared based on their team's winning percentage. While most positions had statistically similar team winning percentages, but the Close Range Dominator had a significantly higher team winning percentage than the Bench Warmer and Rebounding Shot Blocker.

These findings are important for both coaches and administrators of NCAA Division I basketball programs. This research will assist coaches in recruiting and developing players to maximize their potential and fit into the team's style of play. Administrators can use this research to best prepare their school or conference to reach the NCAA Tournament and have on-court success there. This success would lead to financial gains that would assist the entire athletic department for their school.

REFERENCES

- Alagappan, M. (2012). From 5 to 13. Redefining the positions in basketball. *MIT Sloan Sports Analytics Conference*. Retrieved from <http://www.sloansportsconference.com/content/the-13-nba-positions-using-topology-to-identify-the-different-types-of-players/>
- Anderson, F., & Albeck, S. (1964). *Coaching better basketball*. New York, NY. The Ronald Press Company.
- Aschbruner, S. (2010, December 21). LeBron a point forward? Well, he wouldn't be the first. *NBA.com*. Retrieved from http://www.nba.com/2010/news/features/steve_aschburner/12/15/point-forward/
- Ayer, R. (2012). Big 2's and Big 3's: Analyzing how a team's best players complement each other. *MIT Sloan Sports Analytics Conference*, 1-10. Retrieved from <http://www.sloansportsconference.com/wp-content/uploads/2012/02/Robert-Ayer-Sloan-Sports-Analytics-Conference.pdf>
- Barney, J. (2001). Is the resource-based "view" a useful perspective for strategic management research?. *Academy of Management Review*, 26, 101.
- Barney, J., Wright, M., & Ketchen Jr, D. J. (2001). The resource-based view of the firm: Ten years after 1991. *Journal of Management*, 27, 625-641.

- Belden, S. (2017, July 6). Celtics head coach Brad Stevens gave the firmest declaration yet that the NBA is going through a strategic revolution. *Business Insider*. Retrieved from <http://www.businessinsider.com/brad-stevens-nba-positions-revolution-2017-7>
- Borghesi, R. (2018). The financial and competitive value of NCAA basketball recruits. *Journal of Sports Economics*, 19, 31-49.
- Cosmell, Howard. (2011). 9 football formations every man should know. *Total Pro Sports*. Retrieved from <http://www.totalprosports.com/2011/07/26/9-football-formations-every-man-should-know/>
- Distributions. Retrieved from <http://www.ncaa.org/about/resources/finances/distributions>
- Gaines, C., & Yukari, D. (2017, March 17). The NCAA tournament is an enormous cash cow as revenue keeps skyrocketing. *Business Insider*. Retrieved from <http://www.businessinsider.com/ncaa-tournament-makes-a-lot-of-money-2017-3>
- Grasso, J. (2011). *Historical dictionary of basketball*. Lanham, MD: Scarecrow Press, Inc.
- Grundy, P., Nelson, M., & Dyreson, M. (2014). The emergence of basketball as an American national pastime: From a popular participant sport to a spectacle of nationhood. *The International Journal of the History of Sport*, 31, 134-155. DOI: 10.1080/09523367.2013.865016

Hall, Brandon. (2015, June 3). All of the football positions, explained. *Stack*.

Retrieved from <http://www.stack.com/a/football-positions>

Hayes, P. (2013, March 14). The stretch 4s' of the '90s speak on today's

perimeter-oriented big men. *SB Nation*. Retrieved from

<https://www.sbnation.com/2013/3/14/4100262/nba-power-fowards-three-point-shooters-cliff-robinson>

Hobson, W. (2014, March 18). Fund and games. *The Washington Post*.

Retrieved from <https://www.washingtonpost.com/graphics/sports/ncaa-money/>

Kirschman, L. (2014, November 29). Vanderbilt lays claim as the true 'birthplace of college basketball'. *The Beaver Times*. Retrieved from

<http://www.ncaa.com/news/basketball-men/article/2014-11-29/vanderbilt-lays-claim-true-birthplace-college-basketball>

Kram, Z. (2017, March 31). The batting order revolution will be televised. *The Ringer*. Retrieved from

<https://www.theringer.com/2017/3/31/16040426/2017-mlb-preview-leadoff-hitter-revolution-george-springer-kyle-schwarber-2e49f6ff7c58>

Krause, J. (1991). *Coaching basketball: The official centennial volume of the national association of basketball coaches*. Grand Rapids, MI: Masters Press.

- Lum, P.Y., Singh, G., Lehman, A., Ishkanov, T., Vejdemo-Johansson, M., Alagappan, M., Carlsson, J., & Carlsson, G. (2013). Extracting insights from the shape of complex data using topology. *Scientific Reports*, 3, 1236-1244. <http://doi.org/10.1038/srep01236>
- Marshall, J. (2014, November 1). Positionless basketball taking hold in college. *Associated Press*. Retrieved from <https://collegebasketball.ap.org/article/positionless-basketball-taking-hold-college>
- Medcalf, M. (2013, October 10). End of guards, forwards, and centers. *ESPN.com*. Retrieved from http://www.espn.com/mens-college-basketball/story/_/id/9799167/traditional-positions-being-eliminated-college-basketball
- Newnham, B. (1995, March 6). College basketball history: defining moments - shot-clock, three-pointer define contemporary era. *The Seattle Times*. Retrieved from <http://community.seattletimes.nwsources.com/archive/?date=19950306&slug=2108637>
- Official 2007 NCAA Men's Basketball Records Book. 246-248. Retrieved from http://fs.ncaa.org/Docs/stats/m_basketball_RB/2007/2007RB.pdf

- Paine, Neil. (2016, October 13). Why baseball revived a 60-year-old strategy designed to stop ted williams. *FiveThirtyEight*. Retrieved from <https://fivethirtyeight.com/features/ahead-of-their-time-why-baseball-revived-a-60-year-old-strategy-designed-to-stop-ted-williams/>
- Piette, J., Pham, L., & Anand, S. (2011). Evaluating basketball player performance via statistical network modeling. *MIT Sloan Sports Analytics Conference*, 1-11. Retrieved from <http://www.sloansportsconference.com/wp-content/uploads/2011/08/Evaluating-Basketball-Player-Performance-via-Statistical-Network-Modeling.pdf>
- Potak, Matthew. (2017, September 11). All types of football offenses. *Livestrong*. Retrieved from <https://www.livestrong.com/article/406950-all-types-of-football-offenses/>
- Revenue. Retrieved from <http://www.ncaa.org/about/resources/finances/revenue>
- Reynolds, T. (2017, July 5). Tweener no more: Versatility wanted in positionless NBA. *Sports Illustrated*. Retrieved from <https://www.si.com/nba/2017/07/05/ap-bkn-summer-league-positionless-players>
- Spatz, Lyle. (2012). *Historical dictionary of baseball*. Plymouth: Scarecrow Press.

- Stephens, M. (2015, May 22). Shot clock has historically hurt college basketball scoring. *The Coloradoan*. Retrieved from <http://www.coloradoan.com/story/sports/csu/mens-basketball/2015/05/22/college-basketball-shot-clock/27797929/>
- Tighe, S. (2012, October 18). 15 tactical formations and what they're good for. *Bleacher Report*. Retrieved from <http://bleacherreport.com/articles/1375589-15-tactical-formations-and-what-theyre-good-for>
- Tjarks, J. (2015, November 20). The epitome of positionless basketball. *Real GM*. Retrieved from <https://basketball.realgm.com/article/239916/The-Epitome-Of-Positionless-Basketball>
- Trninić, S., Karalejić, M., Jakovljević, S., & Jelaska, I. (2010). Structural analysis of knowledge based on principal attributes of the game of basketball. *Physical Culture*, 64, 5-25.
- Trninić, S., & Dizdar, D. (2000). System of the performance evaluation criteria weighted per positions in the basketball game. *Coll. Antropol*, 20, 217-234.
- Wahl, G. (2008, February 12). Fast and furious. *Sports Illustrated*. Retrieved from <https://www.si.com/more-sports/2008/02/12/memphis0218>
- Wallace, W. (1991, February 25). Carril demands versatility. *The New York Times*. Retrieved from <http://www.nytimes.com/1991/02/25/sports/carril-demands-versatility.html>

Wright, P. M., Smart, D. L., & McMahan, G. C. (1995). Matches between human resources and strategy among NCAA basketball teams. *Academy of Management Journal*, 38, 1052-1074.

APPENDICES

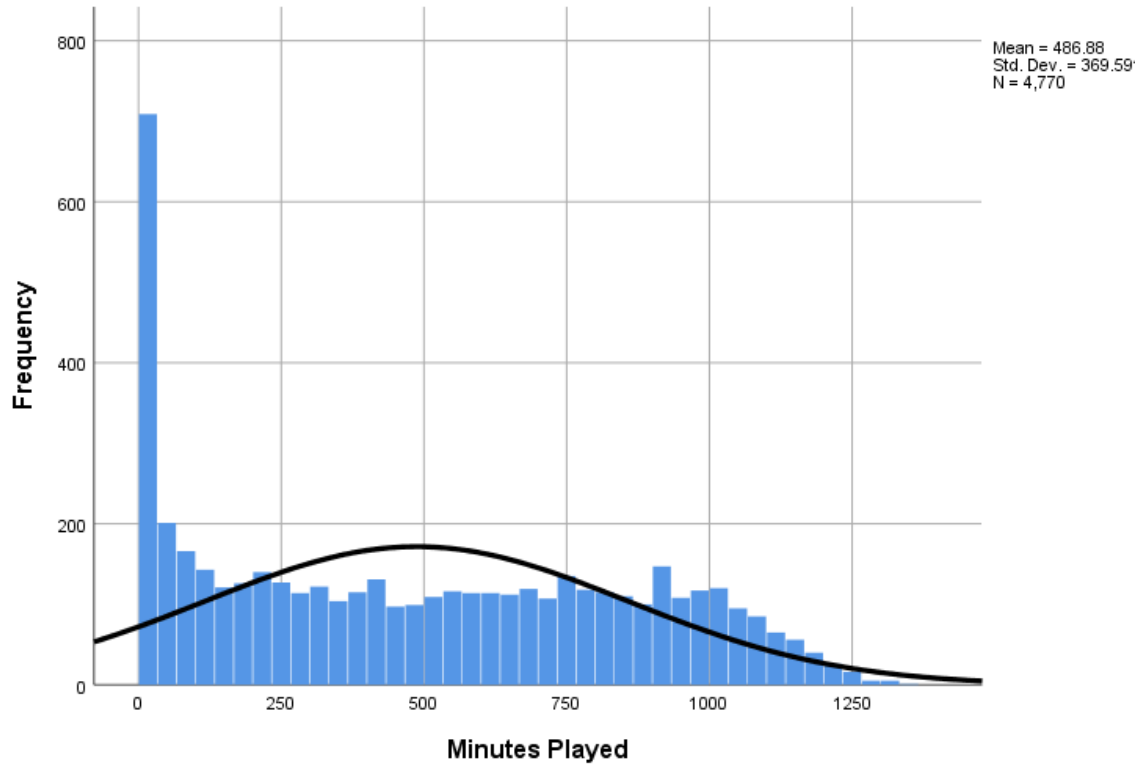
Appendix A

Example of a Team Roster with Season Box Score Statistics

Jersey	Player	Yr	Pos	Ht	GP	GS	MP	FGM	FGA	FG%	3FG	3FGA	3FG%	FT	FTA	FT%	PTS	Avg	ORebs	DRebs	Tot Reb	Avg	AST	TO	STL	BLK	Fouls	Dbl Dbl	Trpl Dbl	DQ
11	Alexander, Kyle	So	F	6-10	32	23	447.00	41	88	46.59	1	6	16.67	22	44	50.00	105	3.28	57	72	129	4.03	6	15	6	33	53			
0	Bone, Jordan	Fr	G	6-1	23	17	450.00	61	164	37.20	14	46	30.43	30	39	76.92	166	7.22	6	33	39	1.70	66	32	12		29			
23	Bowden, Jordan	Fr	G	6-3	30	28	683.00	75	202	37.13	35	111	31.53	53	63	84.13	238	7.93	24	63	87	2.90	40	22	27	5	62			1
24	Campbell, Lucas	So	G	6-2	3	0	5.00							4	6	66.67	4	1.33												
21	Evans, Lew	Sr	F	6-7	32	3	475.00	30	87	34.48	13	44	29.55	37	54	68.52	110	3.44	35	56	91	2.84	30	26	10	7	74			2
10	Fulkerson, John	Fr	F	6-7	11	6	160.00	17	30	56.67				13	20	65.00	47	4.27	14	32	46	4.18	10	8	11	9	23	1		
3	Hubbs III, Robert	Sr	G	6-5	32	32	1011.00	170	364	46.70	4	26	15.38	93	111	83.78	437	13.66	40	107	147	4.59	53	47	23	7	56	1		
15	Mostella, Detrick	Jr	G	6-1	15	1	323.00	53	131	40.46	26	70	37.14	26	37	70.27	158	10.53	8	51	59	3.93	18	22	6	6	31			1
12	Parker, Kwe	Fr	G	6-0	25	1	202.00	10	31	32.26	3	13	23.08	1	8	12.50	24	0.96	4	17	21	0.84	22	23	6	3	30			
25	Phillips, Shembari	So	G	6-3	31	13	648.00	58	151	38.41	18	48	37.50	58	75	77.33	192	6.19	21	74	95	3.06	52	44	19	4	74			2
05	Schofield, Admiral	So	F	6-4	28	1	533.00	78	172	45.35	21	54	38.89	53	68	77.94	230	8.21	26	98	124	4.43	21	32	9	5	65	1		2
01	Turner, Lamonte	Fr	G	6-0	32	6	663.00	76	214	35.51	41	125	32.80	70	91	76.92	263	8.22	10	71	81	2.53	86	55	19	6	67			
2	Williams, Grant	Fr	F	6-5	32	29	814.00	132	262	50.38	12	32	37.50	126	189	66.67	402	12.56	94	95	189	5.91	36	62	26	61	105	4		6
32	Woodson, Brad	So	G	6-0	4	0	11.00	2	7	28.57	1	4	25.00	2	2	100.00	7	1.75					1		1	1	1			

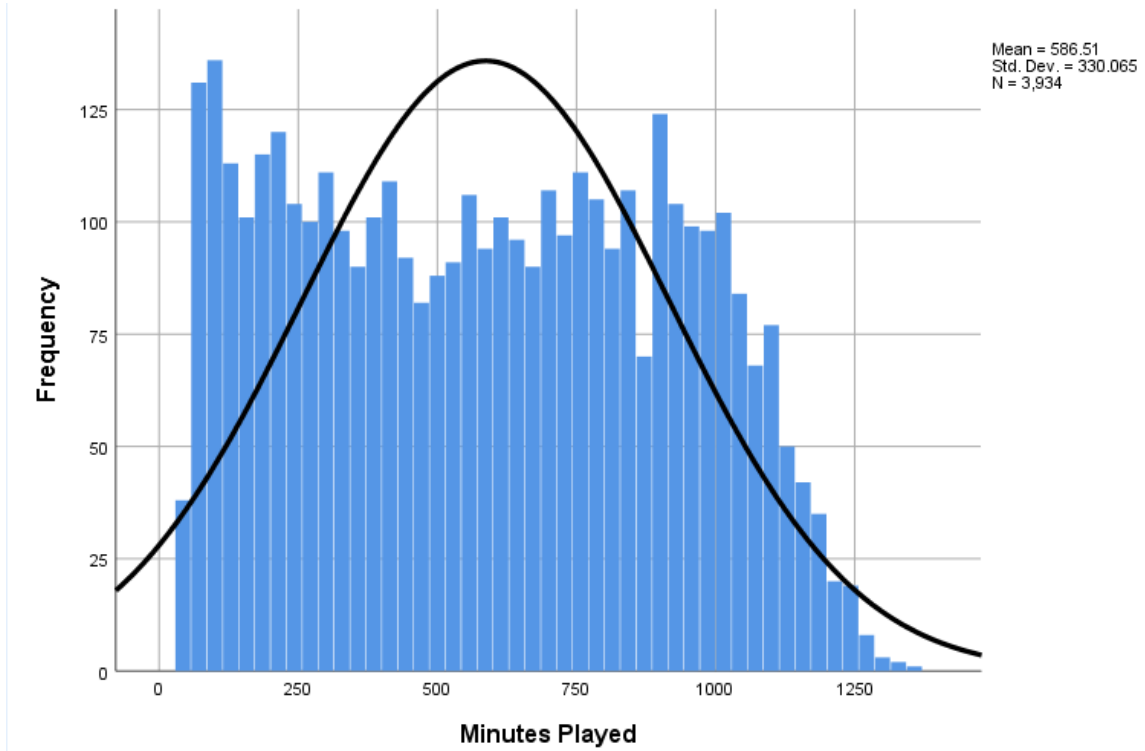
Appendix B

Histogram of NCAA Division I Men's Basketball Players by Minute Played



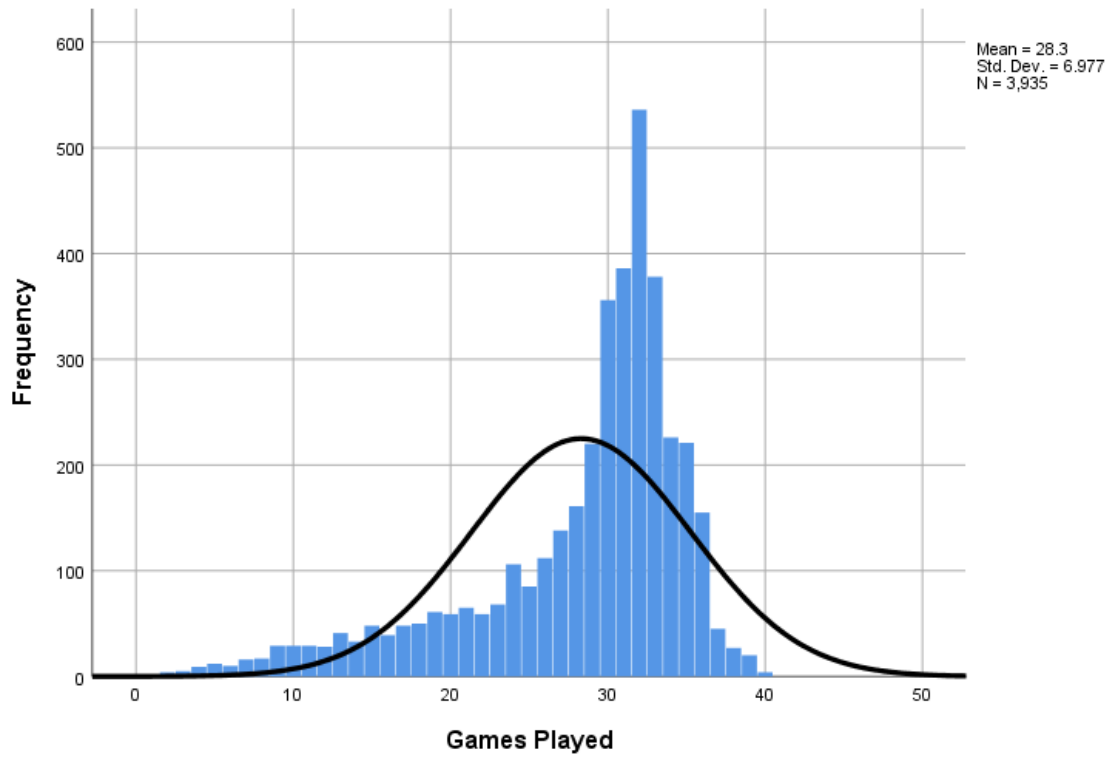
Appendix C

Histogram of NCAA Division I Men's Basketball Players Who Played More Than Fifty Minutes



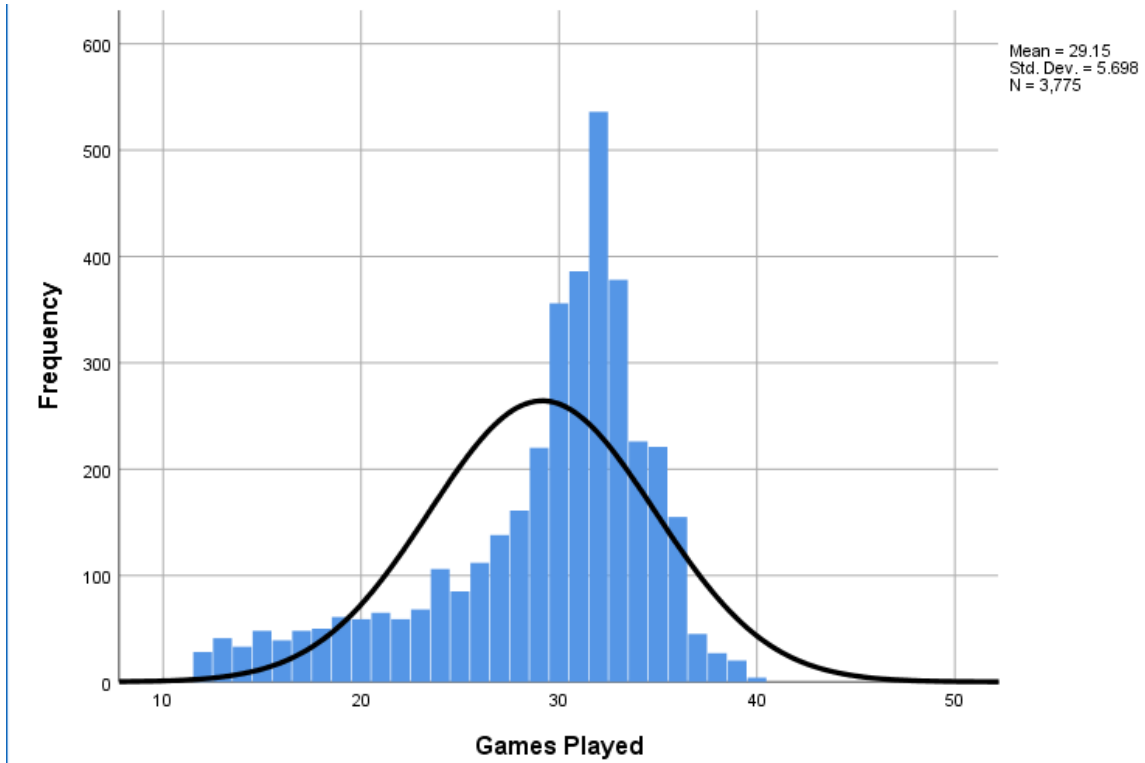
Appendix D

Histogram of NCAA Division I Men's Basketball Players by Games Played



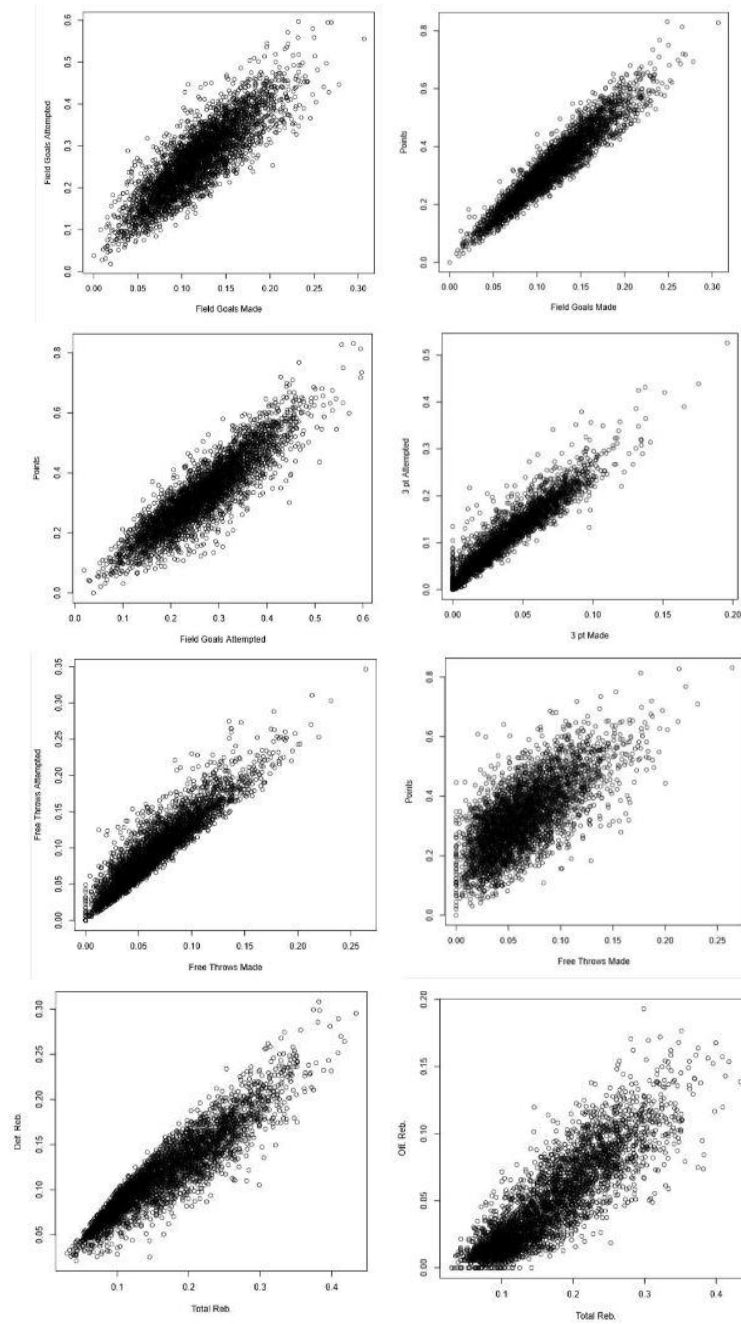
Appendix E

Histogram of NCAA Division I Men's Basketball Players Who Played 11 or More Games



Appendix F

Regression Analysis of High Correlated Box Score Statistics



Appendix G

Visual Representation of the Topological Mapping Process

A Original Point Cloud



B Coloring by filter value



C Binning by filter value

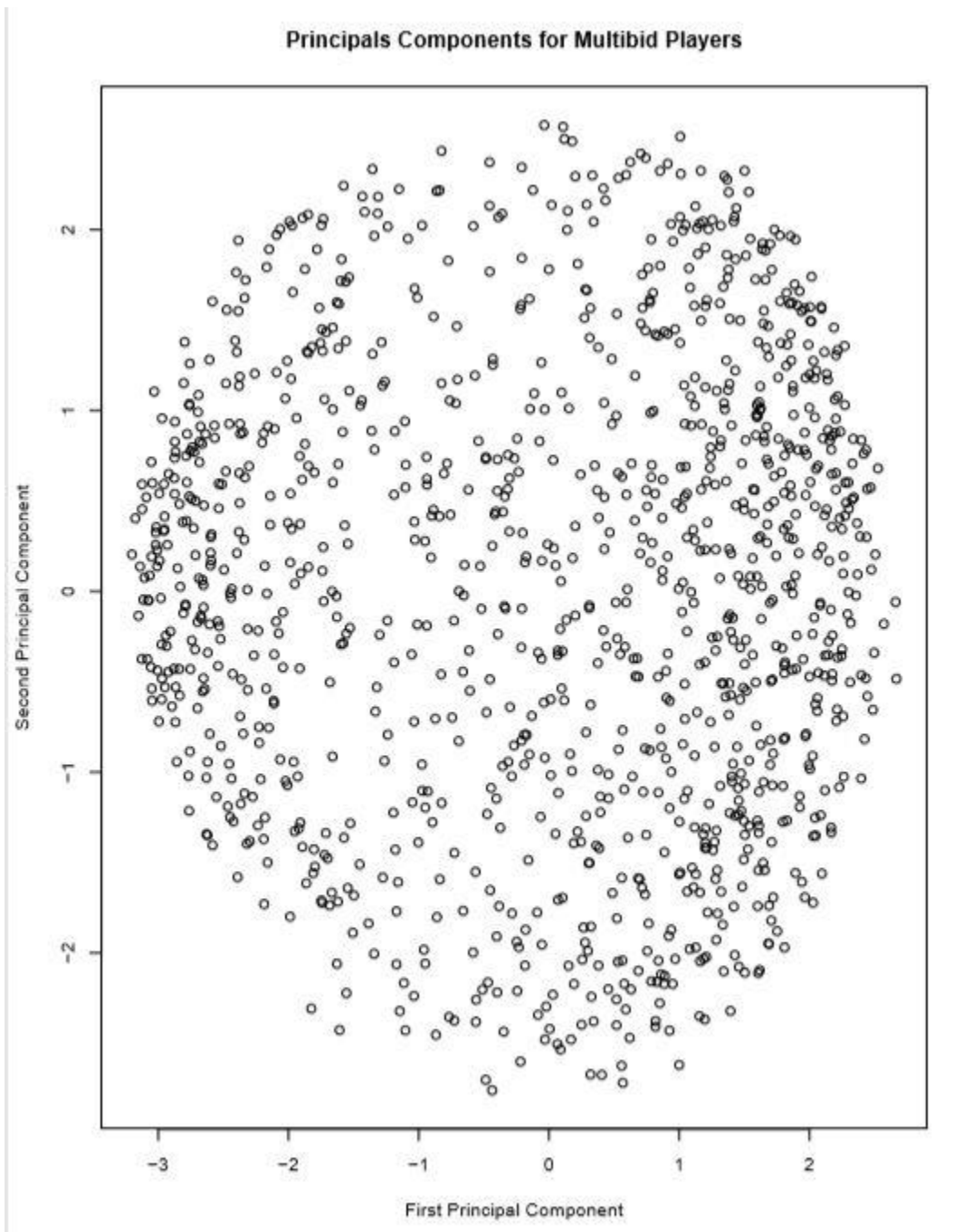


D Clustering and network construction



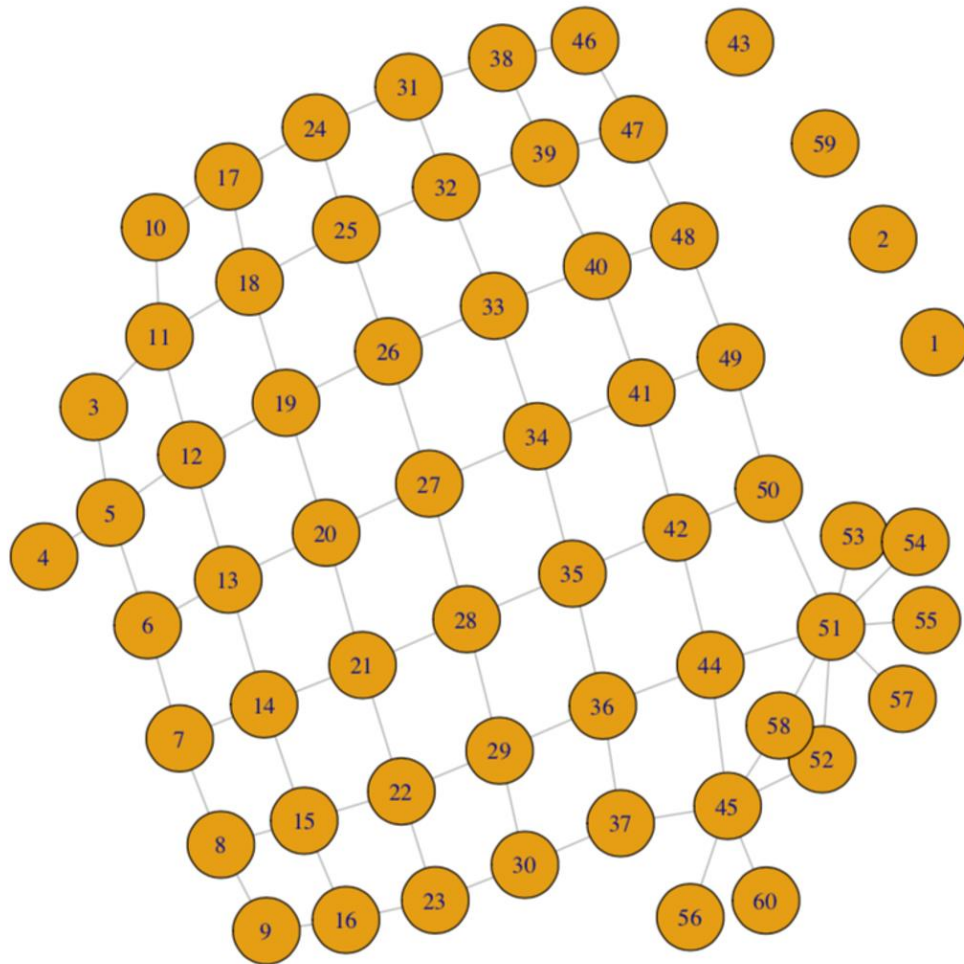
Appendix H

PCA Scatterplot of NCAA Division I Men's Basketball Players



Appendix I

Topological Map of NCAA Division I Men's Basketball Players



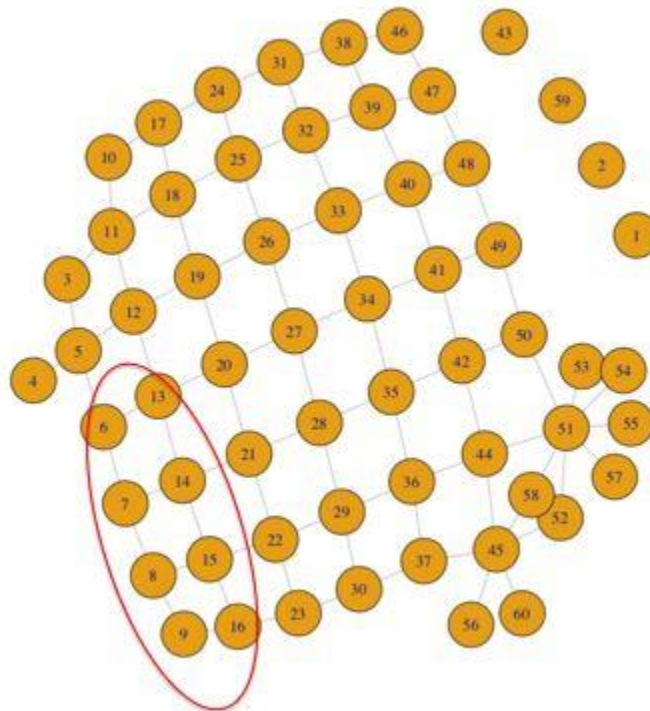
Appendix J

Average Statistics for NCAA and Each Position

Position	FG%	3FG%	FT%	Points per Minute	Total Rebounds per Minute	Assists per Minute	Turnovers per Minute	Steals per Minute	Blocks per Minute
NCAA Average	44.86%	27.28%	66.95%	0.337	0.168	0.062	0.059	0.029	0.022
Bench Warmer	35.10%	29.40%	62.70%	0.224	0.119	0.052	0.044	0.025	0.007
Role Player	43.40%	33.20%	65.70%	0.303	0.16	0.05	0.054	0.029	0.015
Rebounding Shot Blocker	49.00%	7.29%	50.70%	0.233	0.221	0.027	0.055	0.021	0.045
Ball Handling Defender	40.00%	35.10%	74.80%	0.313	0.104	0.081	0.05	0.034	0.006
Three Point Scoring Ball Handler	42.30%	37.10%	77.20%	0.394	0.108	0.101	0.065	0.036	0.006
Three Point Scoring Rebounder	47.40%	40.10%	68.50%	0.344	0.22	0.044	0.061	0.026	0.028
Close Range Dominator	54.80%	17.30%	65.10%	0.422	0.26	0.042	0.071	0.025	0.046
Point Producer	45.30%	35.90%	75.30%	0.465	0.149	0.096	0.074	0.039	0.012

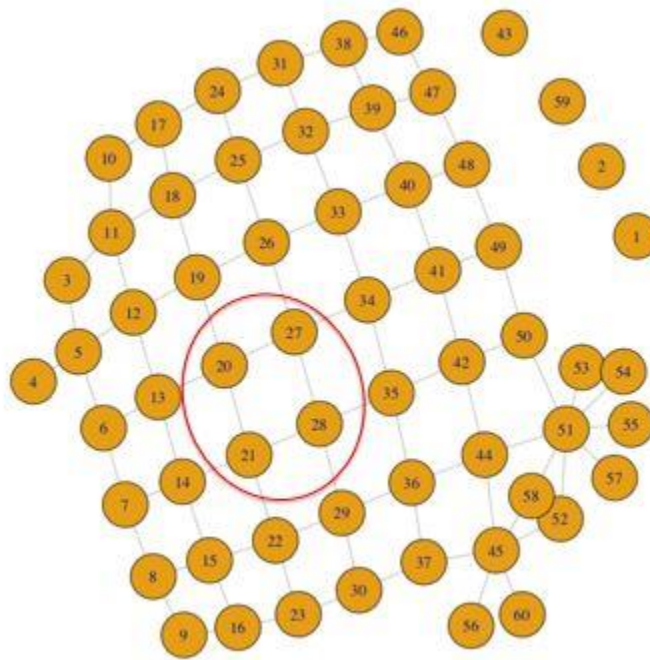
Appendix K

Bench Warmer Clusters Within Topological Map



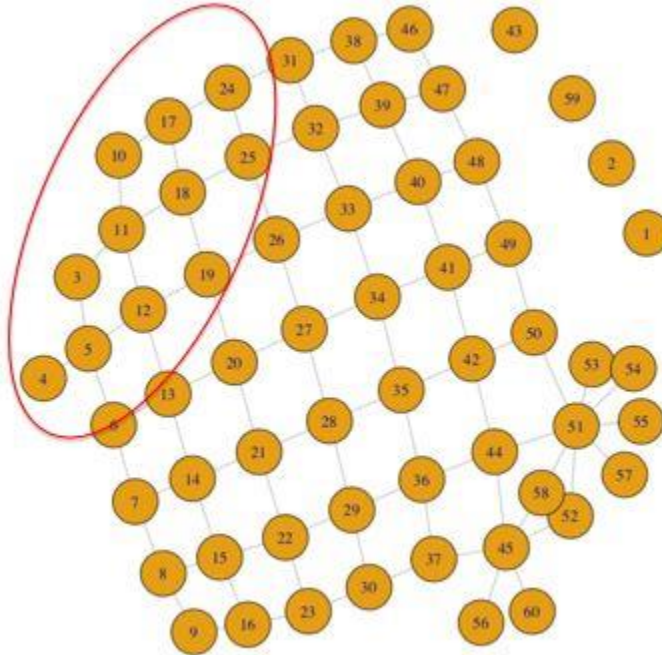
Appendix L

Role Player Clusters Within Topological Map



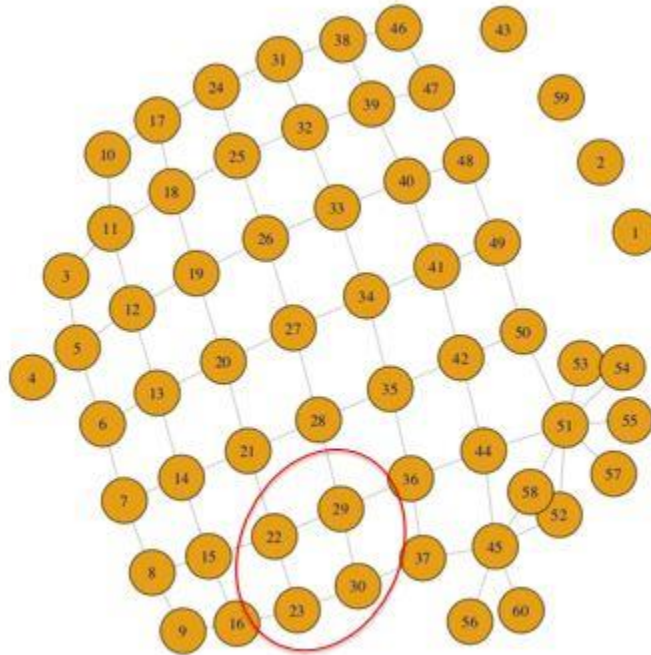
Appendix M

Rebounding Shot Blocker Clusters Within Topological Map



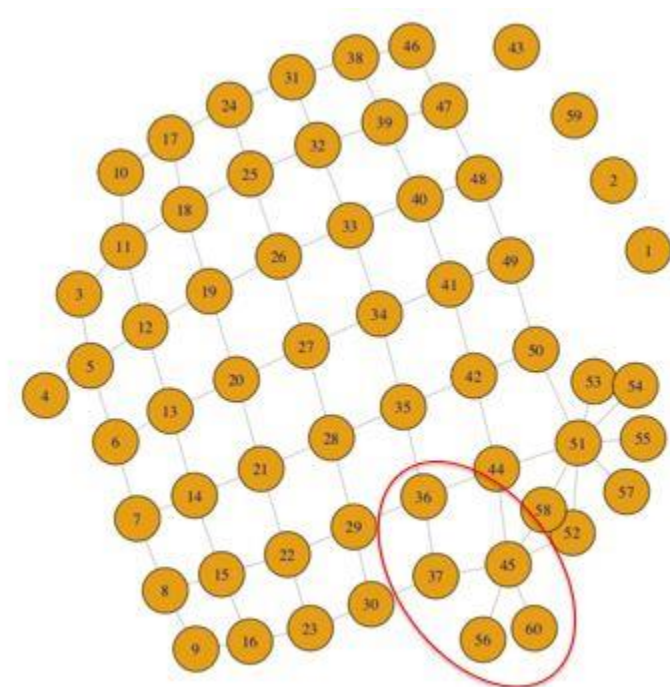
Appendix N

Ball Handling Defender Clusters Within Topological Map



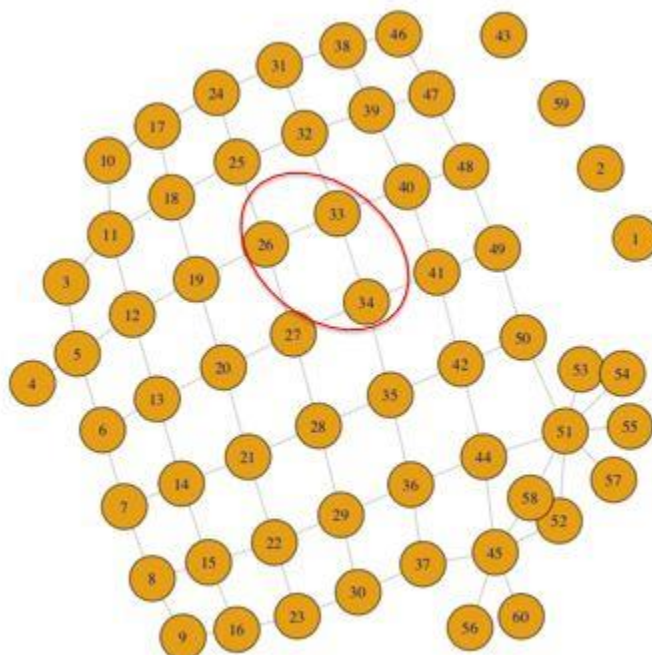
Appendix O

Three Point Scoring Ball Handler Clusters Within Topological Map



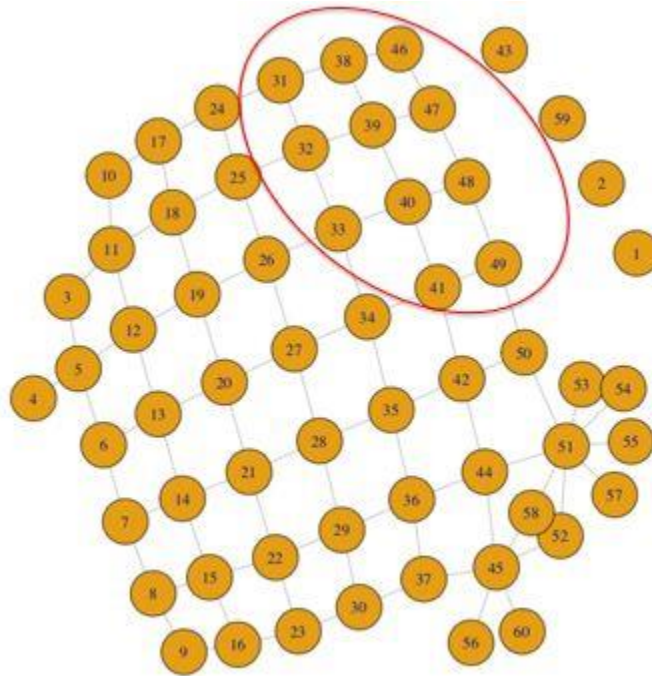
Appendix P

Three Point Scoring Rebounder Within Topological Map



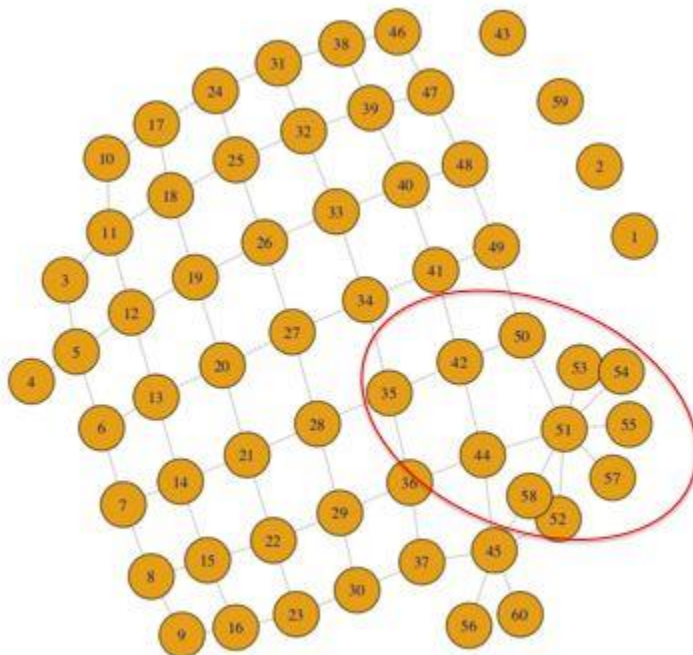
Appendix Q

Close Range Dominator Clusters Within Topological Map



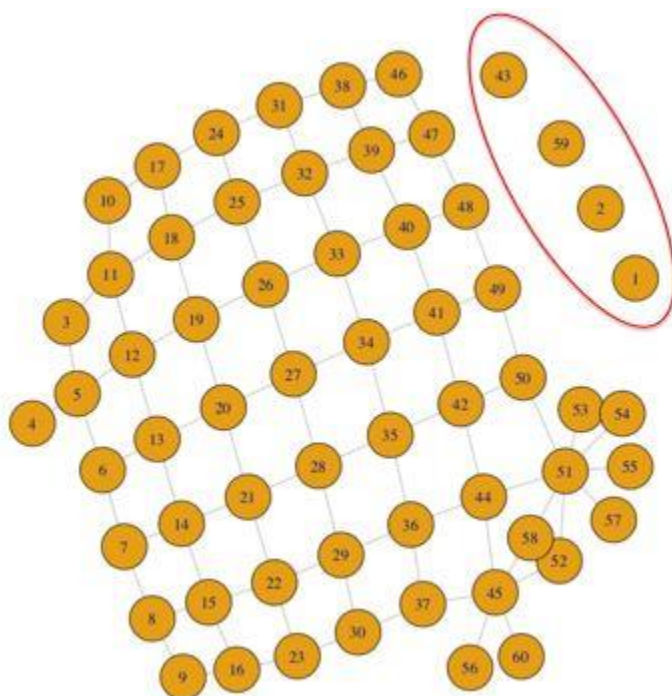
Appendix R

Point Producer Clusters Within Topological Map



Appendix S

Other Clusters Within Topological Map



Appendix T

Levene's Test Results

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Team Winning %	Based on Mean	1.060	7	1153	.388
	Based on Median	1.035	7	1153	.405
	Based on Median and with adjusted df	1.035	7	1147.382	.405
	Based on trimmed mean	1.054	7	1153	.391

Appendix U

Team Winning Percentage Descriptive Statistics by Position

Descriptives								
Team Winning %								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Bench Warmer	167	.5328749609	.1649977144	.0127679065	.5076665457	.5580833762	.1562500000	.9487179487
Rebounding Shot Blocker	185	.5411574739	.1791243558	.0131694846	.5151748639	.5671400839	.1562500000	.9487179487
Role Player	88	.5639993148	.1537115337	.0163857046	.5314309527	.5965676769	.1562500000	.8611111111
Ball Handling Defender	161	.5966045351	.1715614570	.0135209370	.5699020157	.6233070546	.1562500000	.9487179487
Three Point Scoring Rebounder	56	.5859717619	.1779590412	.0237807772	.5383140195	.6336295044	.2500000000	.8648648649
Close Range Dominator	198	.6104385499	.1655599453	.0117658330	.5872353974	.6336417025	.1562500000	.9487179487
Point Producer	149	.5993039953	.1763550471	.0144475684	.5707538305	.6278541602	.1935483871	.9487179487
Three Point Scoring Ball Handler	157	.5957472562	.1605052342	.0128097122	.5704443916	.6210501207	.1562500000	.8888888889
Total	1161	.5782079131	.1710625391	.0050204056	.5683578214	.5880580048	.1562500000	.9487179487

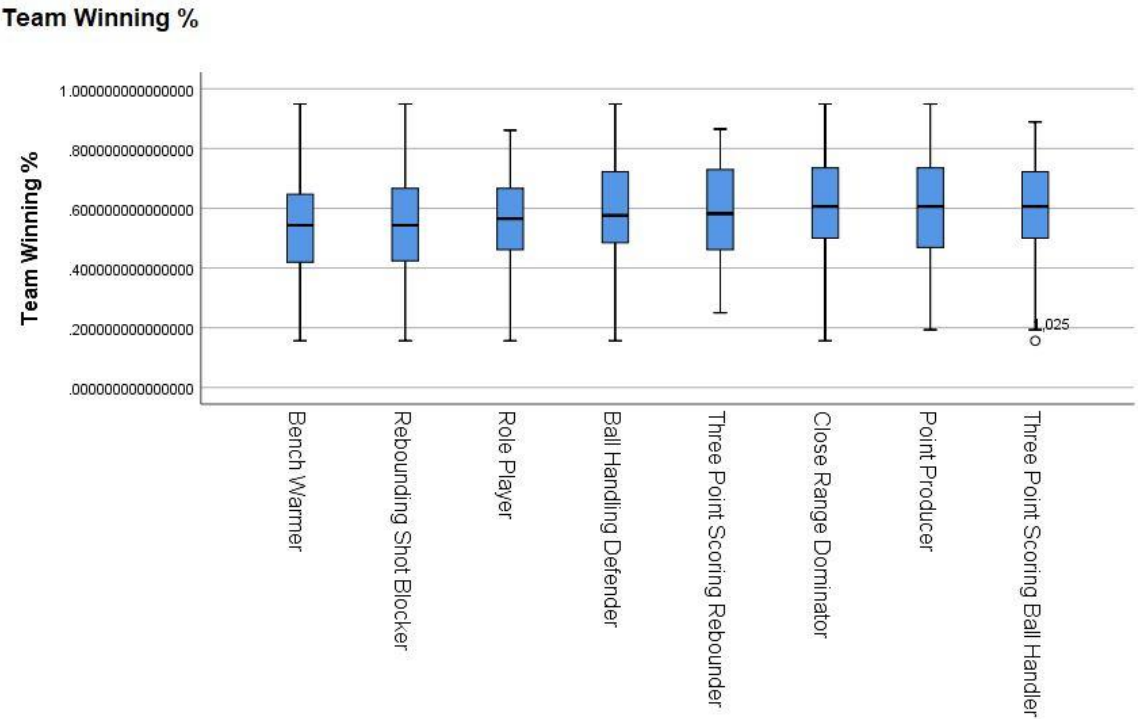
Appendix V

One-way ANOVA Test Results

Multiple Comparisons								
Dependent Variable Team Winning %								
		Mean Difference (I-J)			95% Confidence Interval			
(I) Position ID	(J) Position ID		Std. Error	Sig.	Lower Bound	Upper Bound		
Tukey HSD	Bench Warmer	Rebounding Shot Blocker	-.008282513	.0180446656	1.000	-.063074761	.0465097349	
		Role Player	-.031124354	.0222685595	.858	-.098742367	.0364936591	
		Ball Handling Defender	-.063729574*	.0186718502	.015	-.120426255	-.007032893	
		Three Point Scoring Rebounder	-.053096801	.0261048852	.459	-.132363736	.0261701345	
		Close Range Dominator	-.077563589*	.0177614005	.000	-.131495708	-.023631470	
		Point Producer	-.066429034*	.0190508245	.012	-.124276463	-.008581606	
		Three Point Scoring Ball Handler	-.062872295*	.0187925645	.019	-.119935522	-.005809068	
	Rebounding Shot Blocker	Bench Warmer	.0082825130	.0180446656	1.000	-.046509735	.0630747608	
		Role Player	-.022841841	.0218915105	.968	-.089314953	.0436312708	
		Ball Handling Defender	-.055447061*	.0182205236	.049	-.110773298	-.000120824	
		Three Point Scoring Rebounder	-.044814288	.0257839974	.662	-.123106854	.0334782784	
		Close Range Dominator	-.069281076*	.0172863194	.002	-.121770622	-.016791530	
		Point Producer	-.058146521*	.0186086917	.038	-.114651423	-.001641620	
		Three Point Scoring Ball Handler	-.054589782	.0183442081	.060	-.110291585	.0011120202	
	Role Player	Bench Warmer	.0311243539	.0222685595	.858	-.036493659	.0987423669	
		Rebounding Shot Blocker	.0228418409	.0218915105	.968	-.043631271	.0893149526	
		Ball Handling Defender	-.032605220	.0224112977	.831	-.100656655	.0354462143	
		Three Point Scoring Rebounder	-.021972447	.0288979810	.995	-.109720559	.0657756652	
		Close Range Dominator	-.046439235	.0216586155	.387	-.112205166	.0193266957	
		Point Producer	-.035304681	.0227280046	.778	-.104317789	.0337084278	
		Three Point Scoring Ball Handler	-.031747941	.0225119692	.853	-.100105063	.0366091800	
		Ball Handling Defender	Bench Warmer	.063729574*	.0186718502	.015	.0070328935	.1204262549
			Rebounding Shot Blocker	.055447061*	.0182205236	.049	.0001208242	.1107732983
			Role Player	.0326052203	.0224112977	.831	-.035446214	.1006566550
			Three Point Scoring Rebounder	.0106327732	.0262267527	1.000	-.069004210	.0902697567
			Close Range Dominator	-.013834015	.0179400354	.995	-.068308555	.0406405259
			Point Producer	-.002699460	.0192174774	1.000	-.061052927	.0556540063
			Three Point Scoring Ball Handler	.0008572790	.0189614874	1.000	-.056718879	.0584334370
Three Point Scoring Rebounder		Bench Warmer	.0530968010	.0261048852	.459	-.026170134	.1323637365	
		Rebounding Shot Blocker	.0448142880	.0257839974	.662	-.033478278	.1231068544	
		Role Player	.0219724471	.0288979810	.995	-.065775665	.1097205594	
		Ball Handling Defender	-.010632773	.0262267527	1.000	-.090269757	.0690042102	
		Close Range Dominator	-.024466788	.0255865573	.980	-.102159832	.0532262557	
		Point Producer	-.013332233	.0264978958	1.000	-.093792537	.0671280705	
		Three Point Scoring Ball Handler	-.009775494	.0263128304	1.000	-.089673851	.0701228626	
Close Range Dominator		Bench Warmer	.077563589*	.0177614005	.000	.0236314696	.1314957084	
		Rebounding Shot Blocker	.069281076*	.0172863194	.002	.0167915304	.1217706217	
		Role Player	.0464392351	.0216586155	.387	-.019326696	.1122051659	
		Ball Handling Defender	.0138340148	.0179400354	.995	-.040640526	.0683085555	
		Three Point Scoring Rebounder	.0244667880	.0255865573	.980	-.053226256	.1021598317	
		Point Producer	.0111345546	.0183341429	.999	-.044536685	.0668057945	
		Three Point Scoring Ball Handler	.0146912938	.0180656404	.992	-.040164644	.0695472312	
Point Producer		Bench Warmer	.066429034*	.0190508245	.012	.0085816060	.1242764628	
		Rebounding Shot Blocker	.058146521*	.0186086917	.038	.0016416201	.1146514228	
		Role Player	.0353046805	.0227280046	.778	-.033708428	.1043177889	
		Ball Handling Defender	.0026994602	.0192174774	1.000	-.055654006	.0610529267	
		Three Point Scoring Rebounder	.0133322334	.0264978958	1.000	-.067128070	.0937925373	
		Close Range Dominator	-.011134555	.0183341429	.999	-.066805794	.0445366853	
		Three Point Scoring Ball Handler	.0035567392	.0193347855	1.000	-.055152931	.0622664091	
Three Point Scoring Ball Handler	Bench Warmer	.062872295*	.0187925645	.019	.0058090681	.1199355224		
	Rebounding Shot Blocker	.0545897823	.0183442081	.060	-.001112020	.1102915847		
	Role Player	.0317479414	.0225119692	.853	-.036609180	.1001050627		
	Ball Handling Defender	-.000857279	.0189614874	1.000	-.058433437	.0567188790		
	Three Point Scoring Rebounder	.0097754942	.0263128304	1.000	-.070122863	.0896738511		
	Close Range Dominator	-.014691294	.0180656404	.992	-.069547231	.0401646437		
	Point Producer	-.003556739	.0193347855	1.000	-.062266409	.0551529307		

Appendix W

Comparative Box Plots of Team Winning Percentage by Position



VITA

Nathan Diambra, originally from Knoxville, Tennessee, is a masters student in the Sport Management program at the University of Tennessee, Knoxville (UTK). He has worked as a Graduate Teaching Assistant in the Physical Education Activity Program, teaching conditioning, exercise & nutrition, basketball, soccer, racquetball, and badminton courses. While pursuing his master's degree, Nathan worked at the Tennessee Fund as a Development Intern. Also, he was the recipient of the Dr. Joy DeSensi Professionalism Award, the American Kinesiology Association Masters' Scholar Award, and the A.W. Hobt Memorial Teaching Award during his time in the master's program. Before beginning his masters studies, Nathan graduated with his bachelor's in Business Analytics with a concentration in Marketing from UTK.

Nathan has an extensive career in coaching basketball at the middle school, high school, and collegiate levels. He began his coaching career at the Christian Academy of Knoxville as a middle school boy's coach. After a season there, he took the position of Men's Basketball Assistant Coach at Maryville College, an NCAA Division III institution in Maryville, TN, where he coached for two seasons. Most recently he has served as a Boys' Basketball Assistant Coach at The Kings Academy, a high school in Seymour, TN.

Upon graduation, Nathan intends to pursue a career in either basketball coaching or collegiate athletics development.

