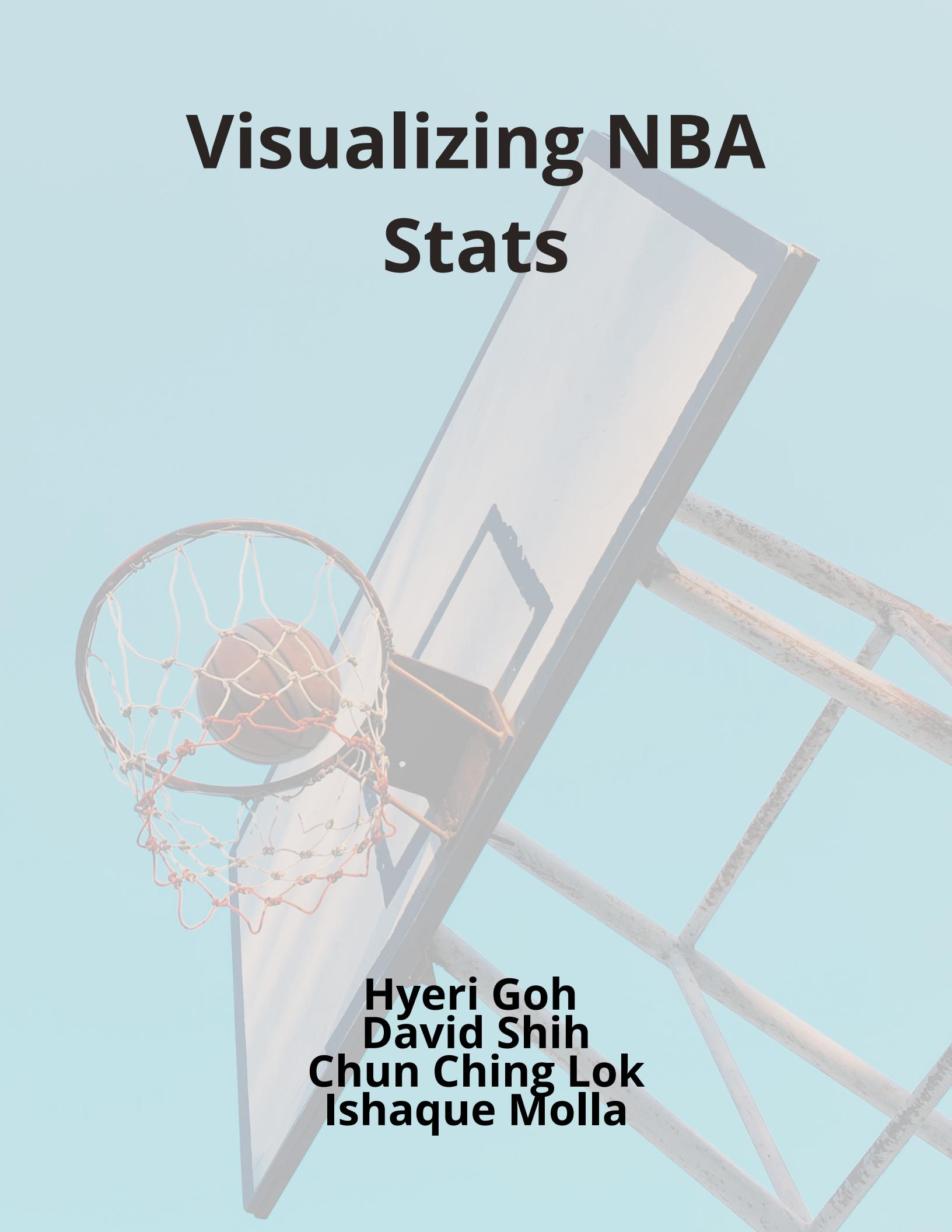


# Visualizing NBA Stats

A photograph of a basketball hoop and backboard set against a clear, light blue sky. The hoop is positioned on the left side of the frame, showing the rim and the white net. The backboard is angled towards the right. The metal frame of the hoop is visible on the right side of the image.

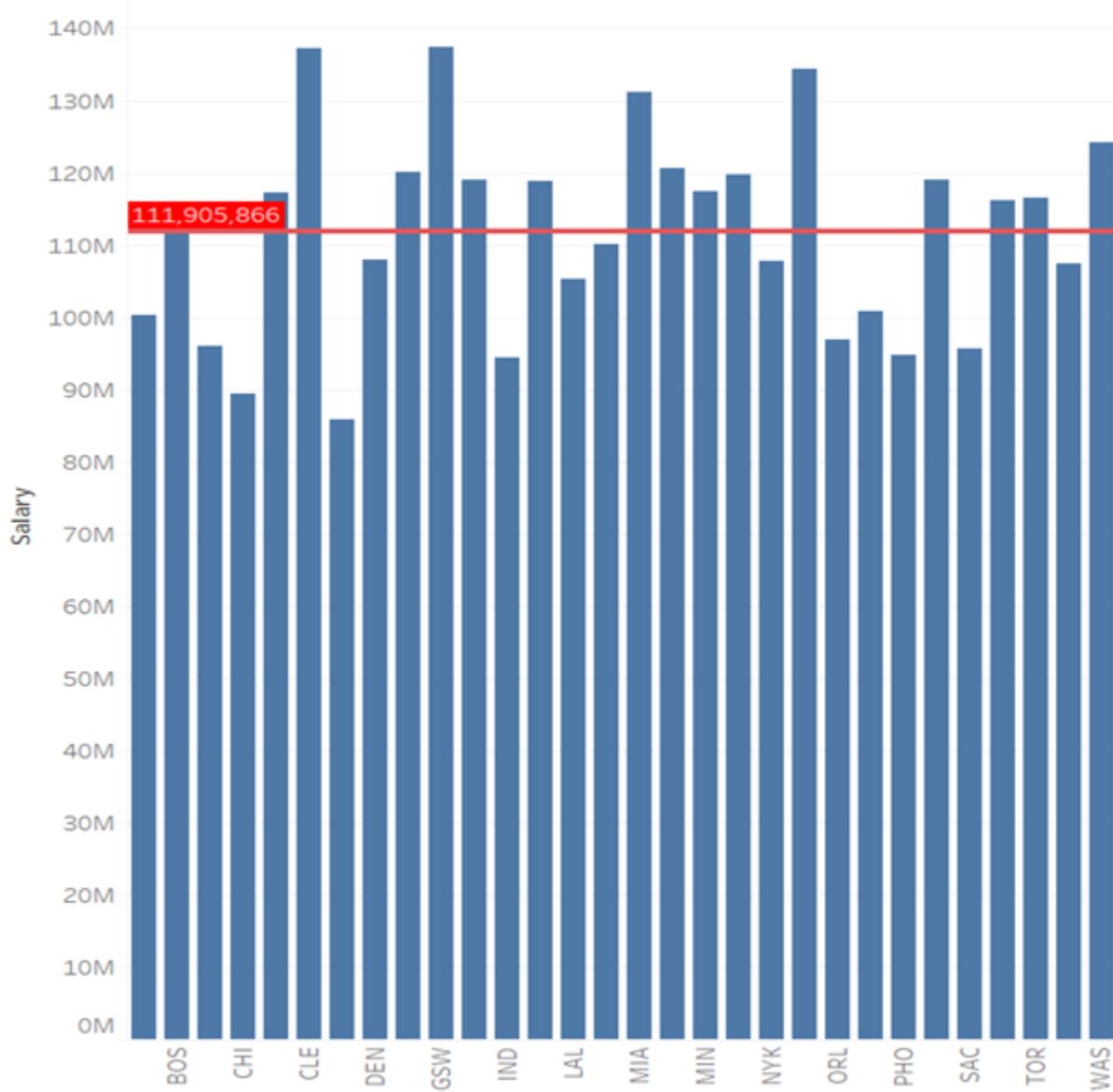
**Hyeri Goh  
David Shih  
Chun Ching Lok  
Ishaque Molla**

## Introduction

The NBA generates billions of dollars every year through broadcasting deals and merchandising, so we decided to take a closer look at the driving force responsible for this highly profitable business, The teams and the players.

## Problem Statement

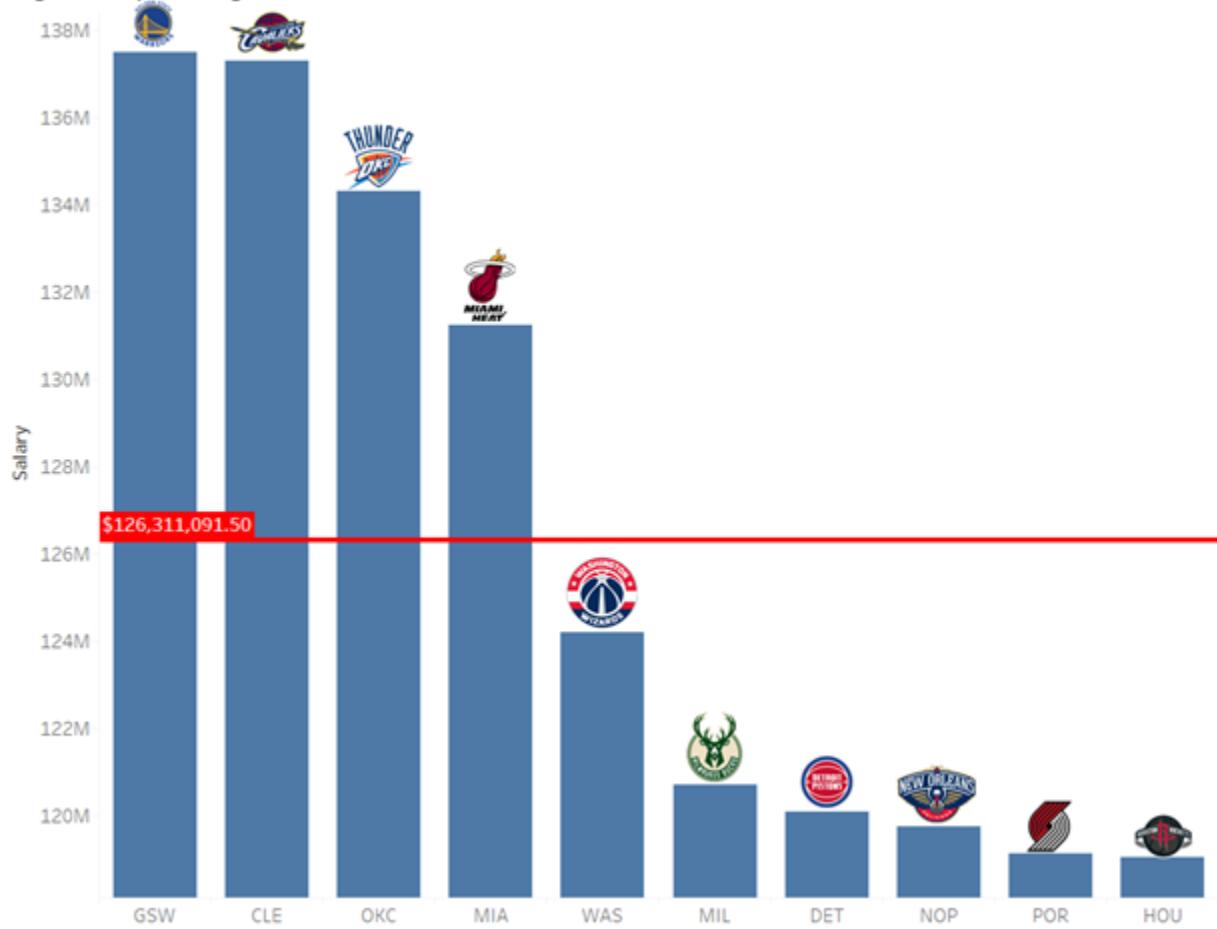
In this report, we explore the relationship among the players and their teams in terms of finances and salaries and its effect on teams performance. We also will be taking a look into various performance measure metrics to compare players through advanced statistics.



In this diagram above, we can see the teams plotted against their salary expenditure. The average expenditure by an NBA team on salary in the 2017-18 season is about \$112 million.

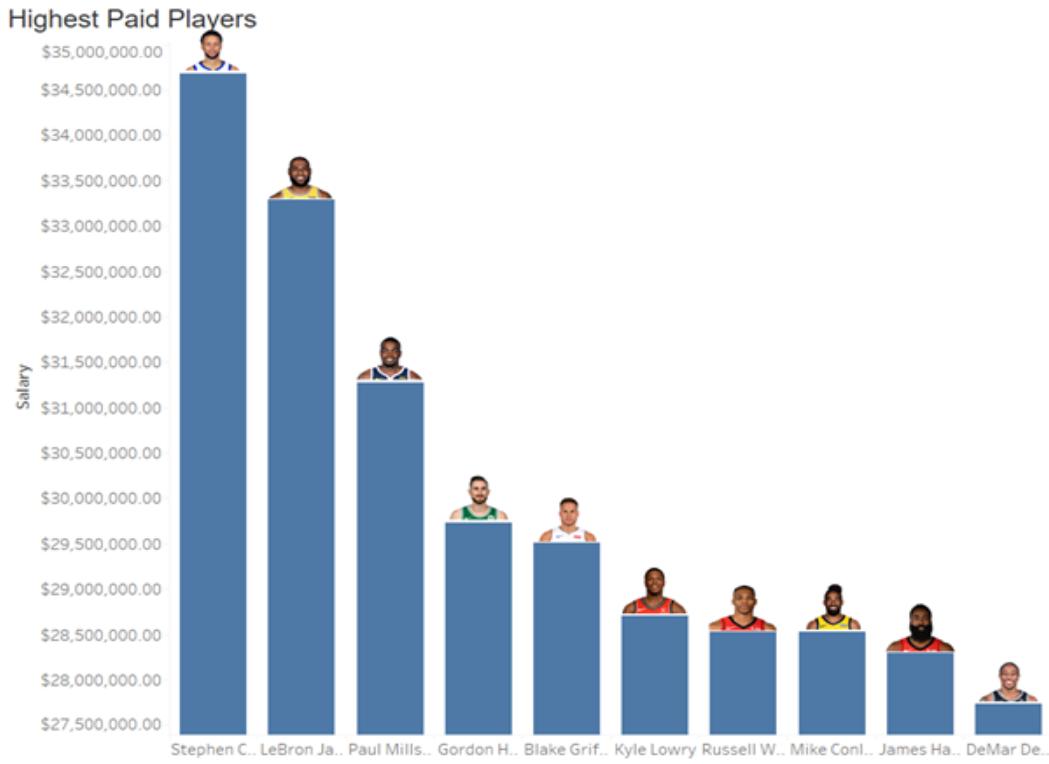
Almost every team spent more than \$100 million in salaries that season.

## Highest Spending Teams



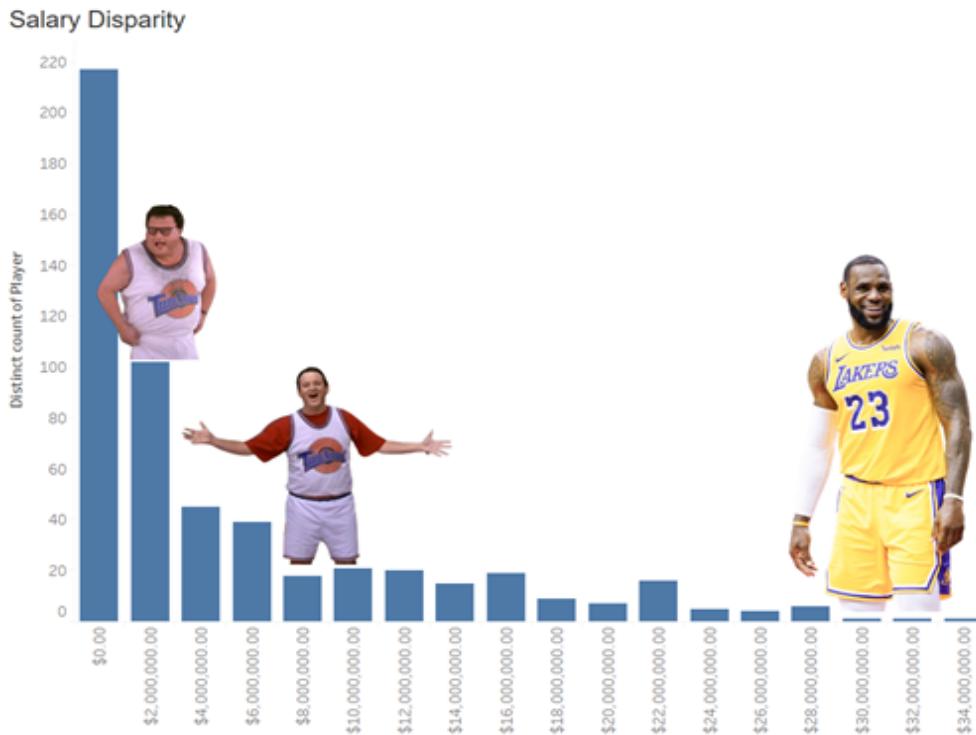
Golden State Warriors spent **\$137,494,845**, the highest of all teams that season.  
Dallas Mavericks had the lowest salary expenses at **\$85,821,361** for that season.

Average salary of the top 10 highest spending is around **\$126,311,091**, which is very close to the average of all teams indicating most teams spend virtually the same amount of money on salaries.



At the top of the list, we have Stephen Curry with almost \$35 million in salaries for the 2017-18 season. Lebron James is a close second with around \$33 million in salaries. The list comprises of the most elite players in the league, each of them making well over \$25 million.

But not all players in the league get these kinds of high salaries. In fact, there is a high salary disparity among the players



In this histogram, we can clearly notice the skewness indicating how the salary range among the players are spread.

217 players out of 535 have salaries lower than \$2,000,000. There are 309 players in total who have salaries less than \$4 million.

Only 3 players out of 535 have salaries higher than \$30,000,000.

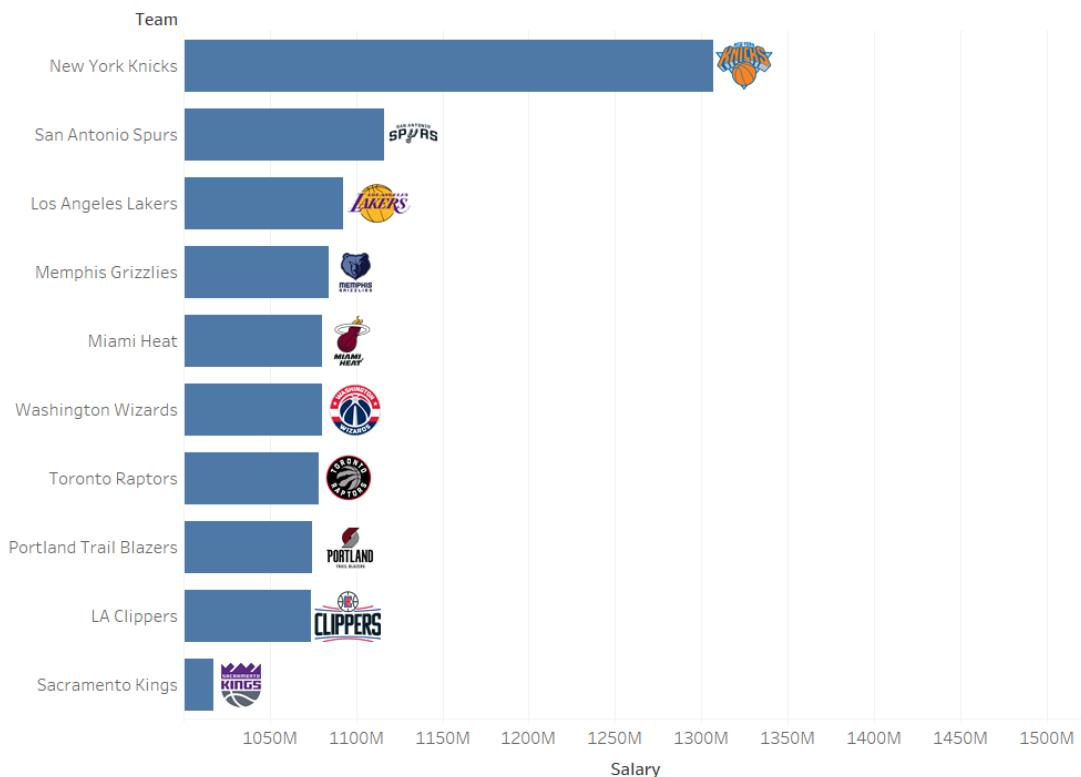


To sum up the numbers around player salaries,

- All 30 NBA teams spent more than \$3.3 billion on salaries in the 2017-18 season alone.
  - The average salary of an NBA player is around \$6 million.
  - 23 out of the 30 teams have a salary budget of more than a \$100 million that season.
  - Only 41 out of the 535 players have salaries higher than \$20 million.
- Do all these hundreds of millions of dollars turn into wins and championships for teams? Our report aims to explore this question further by studying the recent history of team's salaries and their performance.

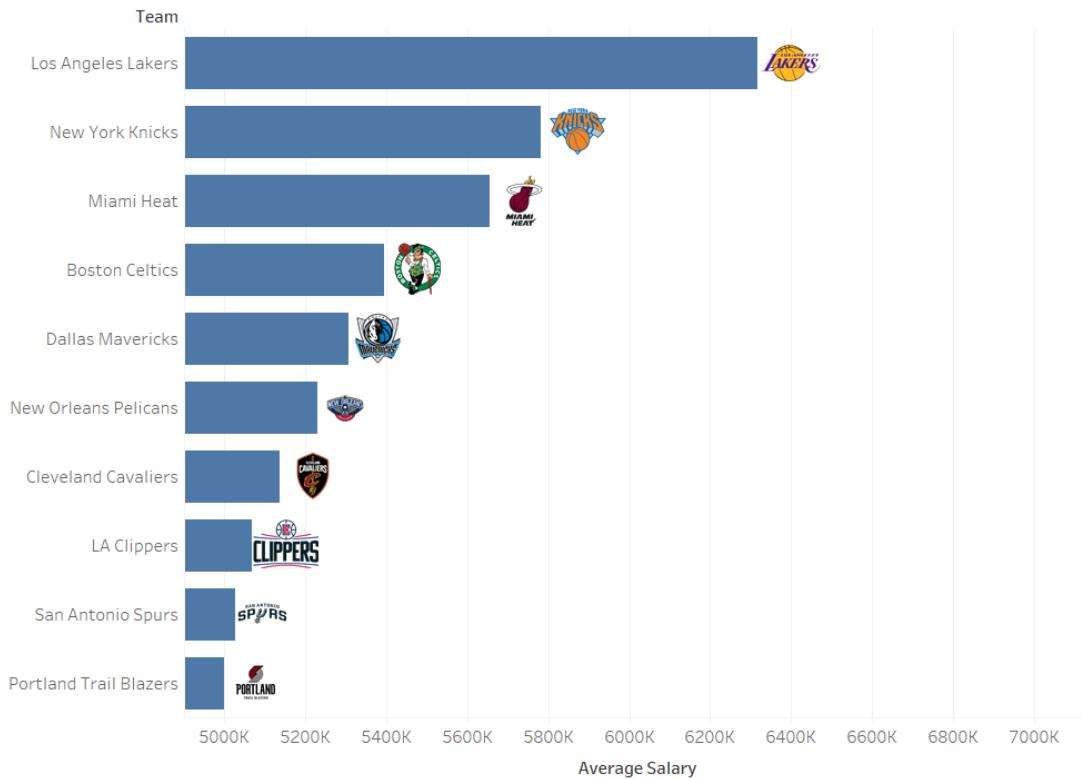
## NBA Financial History

### Top 10 Total Team Salary (2003 - 2018)



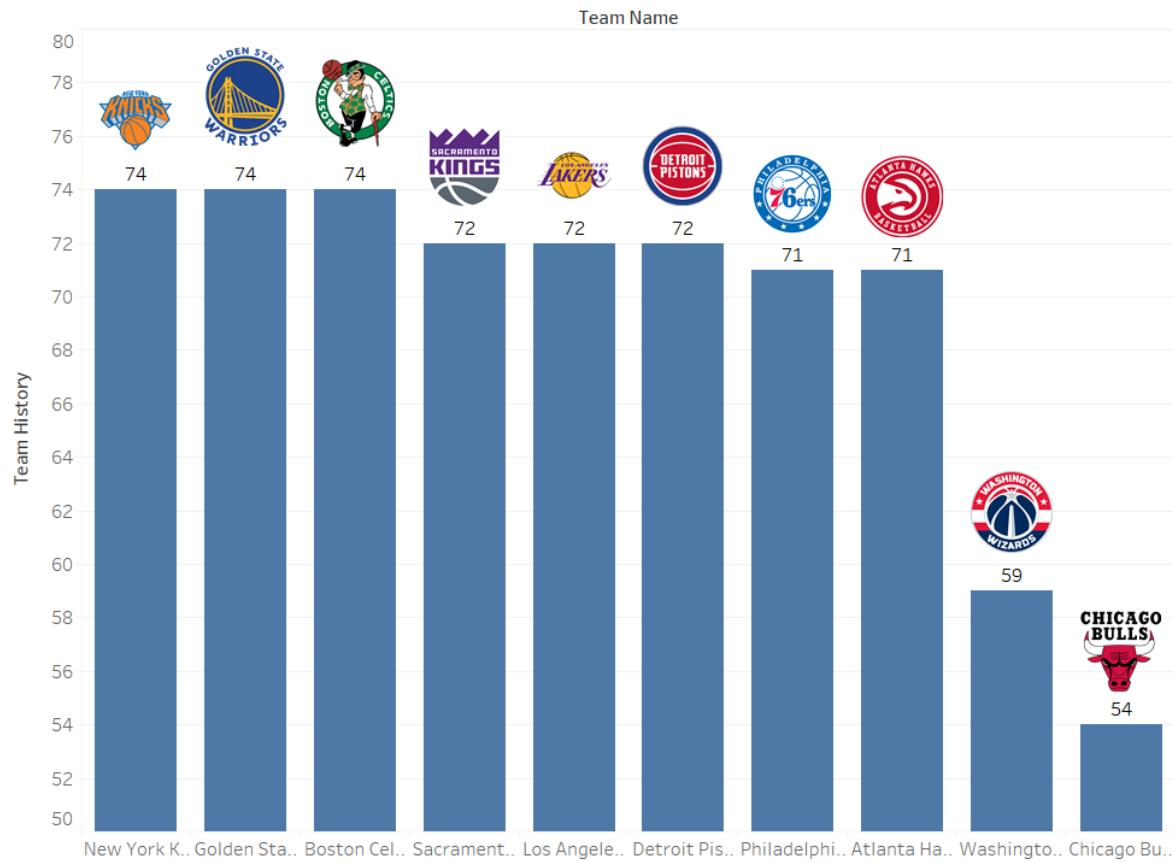
Using a salary dataset from 2003 to 2018, we can get some info here. In this top 10 total team salary bar graph, we can see that New York Knicks spent the most on NBA players. They spent about 1350 million dollars. The first runner up is the San Antonio Spurs which spent 1150 million dollars. The second runner ups are the Los Angeles Lakers and the Memphis Grizzlies which spent 1100 million dollars. We came up with a question: If a NBA team spent more on team salary, would this team be more successful? To answer it, we define success as the number of NBA championships won. This is a very popular quantitative indicator for any sport.

## Top 10 Average Team Salary (2003 - 2018)



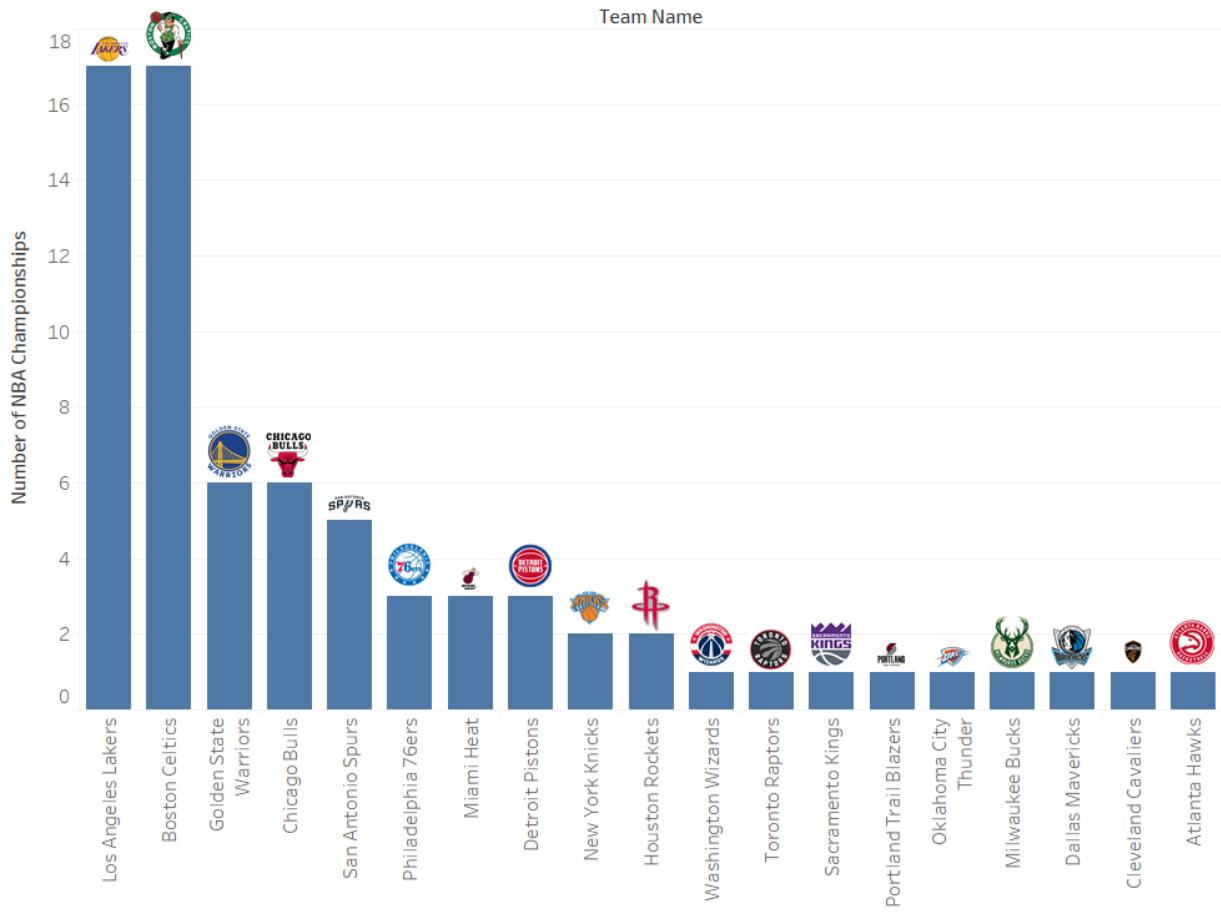
In another bar graph, both the Los Angeles Lakers and the New York Knicks are on the top 10 list again. They spent more than 57 million dollars every year in team salary. The Miami Heat and the Boston Celtics also spent similarly. Again, we want to answer the same question: If a NBA team spent more on team salary, would this team be more successful?

## Top 10 Established NBA Teams



These are the top 10 established NBA teams. Another question we want to answer is if a nba team had a longer team history, would they be more successful?

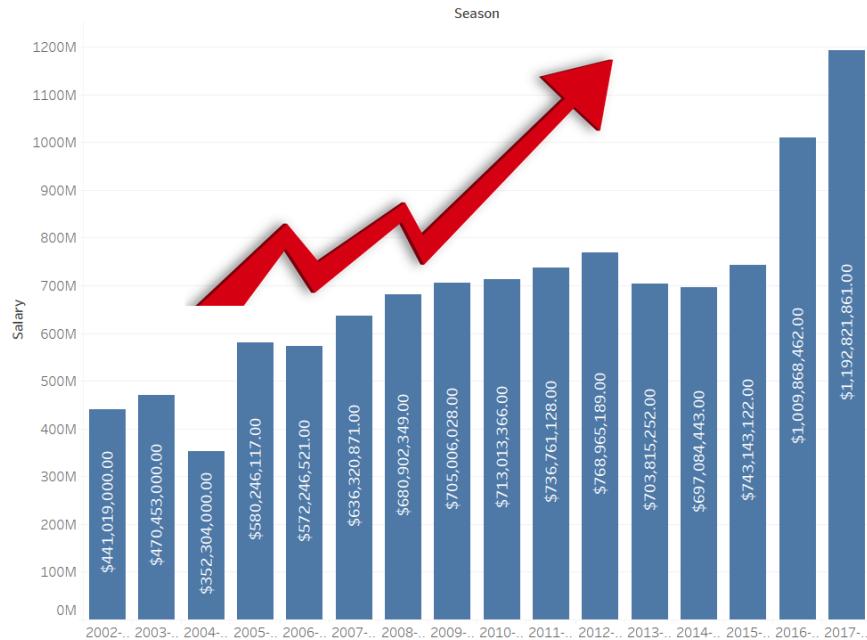
## Number of NBA Champions Won



For the first question, the answer is no. Although the Los Angeles Lakers and the Boston Celtics won a lot of championships, the New York Knicks only won one. The reward ratio for the New York Knicks is way too low when comparing with that of the Los Angeles Lakers. Also, the Memphis Grizzlies do not win any championship. Interestingly, both the Golden State Warriors and the Chicago Bulls won 6 NBA championships but they do not appear on the list.

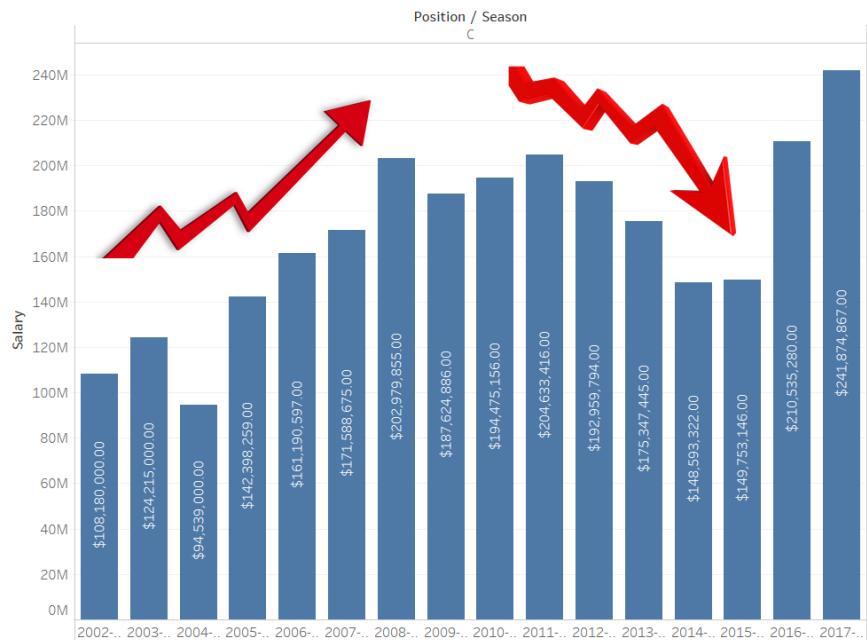
For the second question, the answer is yes. All 10 teams have won 1 or more nba championships. Of course, the number of NBA championships varies among different teams.

## Salary Trend Across Seasons (2003 - 2018)



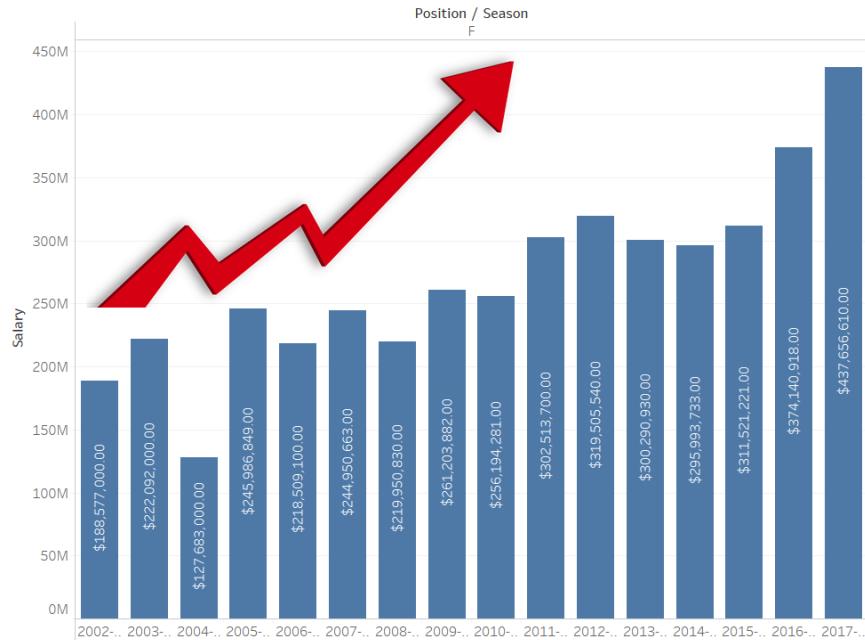
Back to the salary trend, the salary trend kept increasing from the 2003 season to the 2018 season. We can spot out a sudden surge from 2015 season to 2016 season. We would like to explore it more by looking into different NBA positions.

## Salary Trend Across NBA Centers (2003 - 2018)



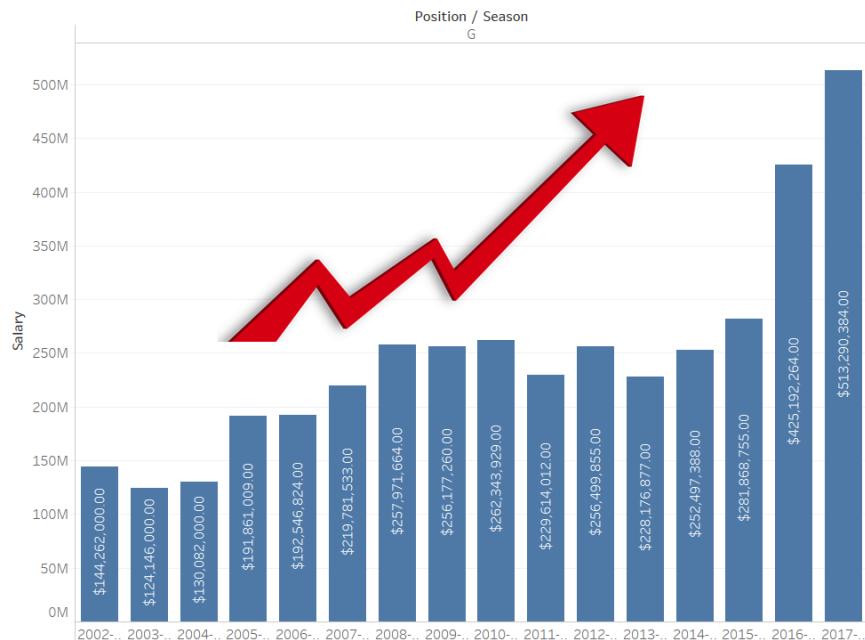
In this bar graph, the salary trend across NBA centers increased in the first half of period and decreased in the second half of period. When it came to the 2016 season, it had a sudden surge and the surge boosted the salary trend upward.

## Salary Trend Across NBA Forwards (2003 - 2018)



In this bar graph, the salary trend across NBA forwards shows an increasing trend. Again, when it came to the 2016 season, it had a sudden surge and the surge boosted the salary trend upward.

## Salary Trend Across NBA Guards (2003 - 2018)



In this bar graph, the salary trend across NBA guards shows an increasing trend. Again, when it came to the 2016 season, it had a sudden surge and the surge boosted the salary trend upward.

# Major Impact of NBA Reportedly Increasing Salary Cap

ADAM FROMAL

OCTOBER 6, 2014



Even though the world knew a television deal was coming for the league, the number itself was still enough to induce some slack-jawed reactions. Per [Richard Sandomir](#) of *The New York Times*, the NBA agreed to a new deal with ESPN and TNT that will secure broadcasting rights for the next nine years and pay the Association \$24 billion.

Twenty-four billion dollars.

It's a huge number, and one that is going to lead to huge salary-cap changes in the coming years. Of course, as of now there's no telling exactly how high the cap is going to rise, as [Grantland's Zach Lowe](#) makes clear by breaking down one of the many potential options:

The reason behind this is the increasing salary gap. 6 years ago, the NBA agreed to a new deal with ESPN and TNT that will secure broadcasting rights for the next nine years and pay the nba association 24 billion dollars. Because of that, this led to huge salary cap changes in the coming years.

# Report: NBA salary cap will increase at least 2% annually

By Dan Feldman

Nov 6, 2020, 12:03 PM EST



Bill O'Leary/The Washington Post via Getty Images

0 The salary cap will reportedly [remain approximately flat](#) next season (\$109.14 million).

Comments

What about beyond?

NBA teams could [lose money](#) next season. Even 2021-22 revenue could be [hampered by coronavirus](#).

But the salary cap apparently won't drop.

**Shams Charania of The Athletic:**

***"There will be a minimum of two percent annual growth in the salary cap and luxury tax for the remainder of the collective bargaining agreement."***

Charania again reports the salary cap will remain flat next season. So, apparently this provision won't take effect until 2021-22.

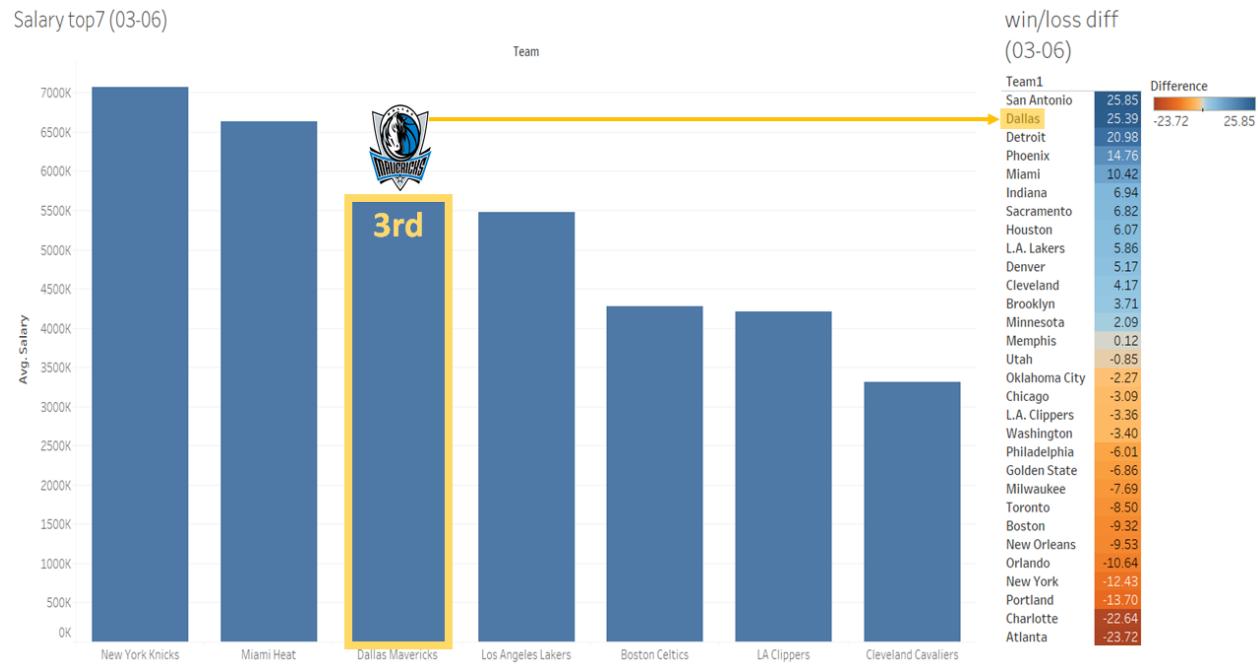
Assuming the 2020-21 salary cap remains exactly flat, the 2021-22 salary cap would be *at least* \$111,322,800.

This is good news for teams clearing cap space for 2021 free agency (Heat, Mavericks, Raptors, and more teams that will reveal themselves this offseason) and 2021 first-round picks. Though the 2021-22 salary cap could fall far below the [\\$125 million projection](#), it'll be much higher than [otherwise would've been possible](#).

Even in 2020, the increase of the salary cap doesn't stop. A quote from an nba analyst: there will be a minimum of two percent annual growth in the salary cap and luxury tax for the remainder of the collective bargaining agreement. That is why NBA players become more and more rich.

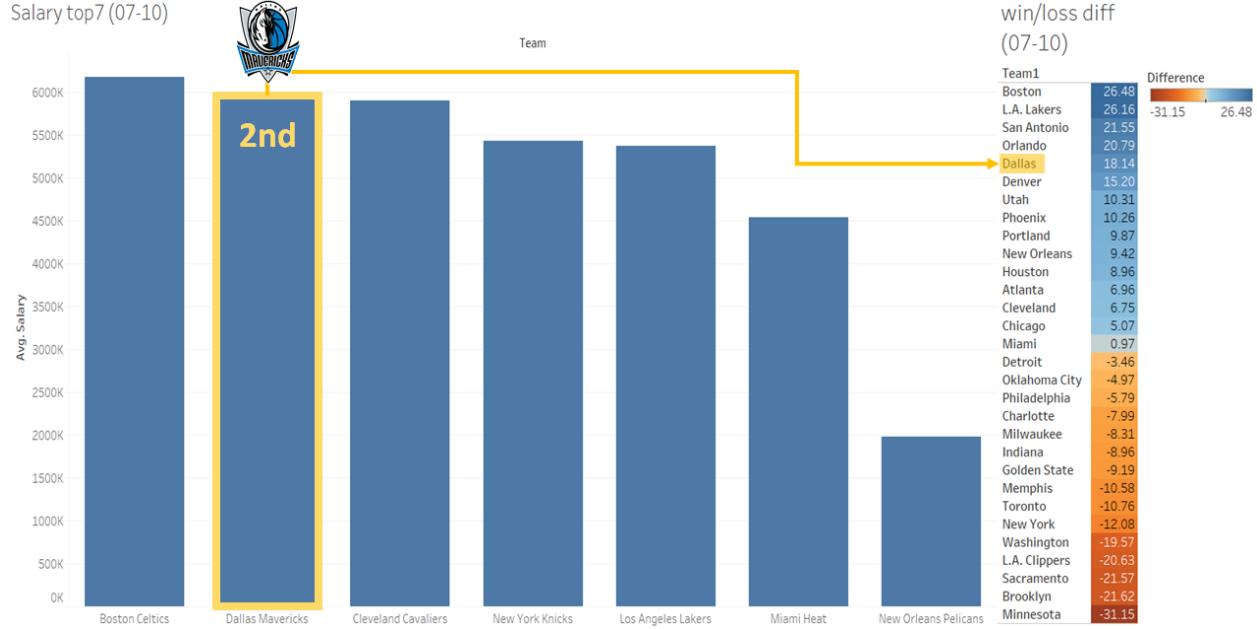
## Salary and Performance

Adding to exploration on salary during 2003 - 2018, we broke down these 16 years into 4 periods with 4 years in each period in order to see if the amount of capital teams spent on a player's salary can contribute to good team performance. The team, Dallas Mavericks is the key example to answer this doubt. For measuring the performance, we calculated the difference between the average number of games the team won and the one of games the team lost. Positive value on this measurement means the team was winning more than they were losing.



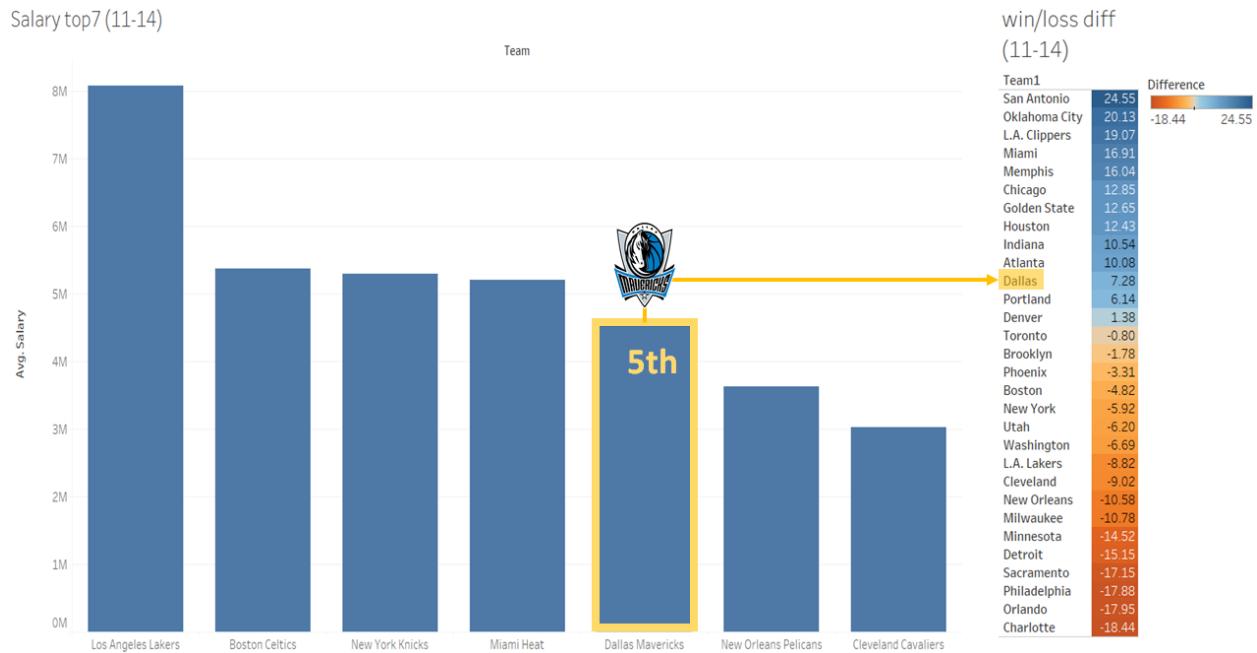
The bar chart above shows the top 7 teams which had spent the most for salary after sorting 30 NBA teams based on their expenditure on salary for 2003 - 2006. Dallas Mavericks was in the 3<sup>rd</sup> position and their team performance recorded very high according to the measure of difference between the number of games they won and they lost for corresponding periods. The team won an average 25.4 games more than the games they lost. It seemed like they made good output through the investment.

Salary top7 (07-10)



For the next 4 years, which is from 2007 to 2010, Dallas Mavericks recorded the 2<sup>nd</sup> position when it comes to expenditure on salary. But, surprisingly, the team performance got a bit worse compared to last 4 years by ending up in 5th position on team performance, which is 3 levels lower than last period.

Salary top7 (11-14)



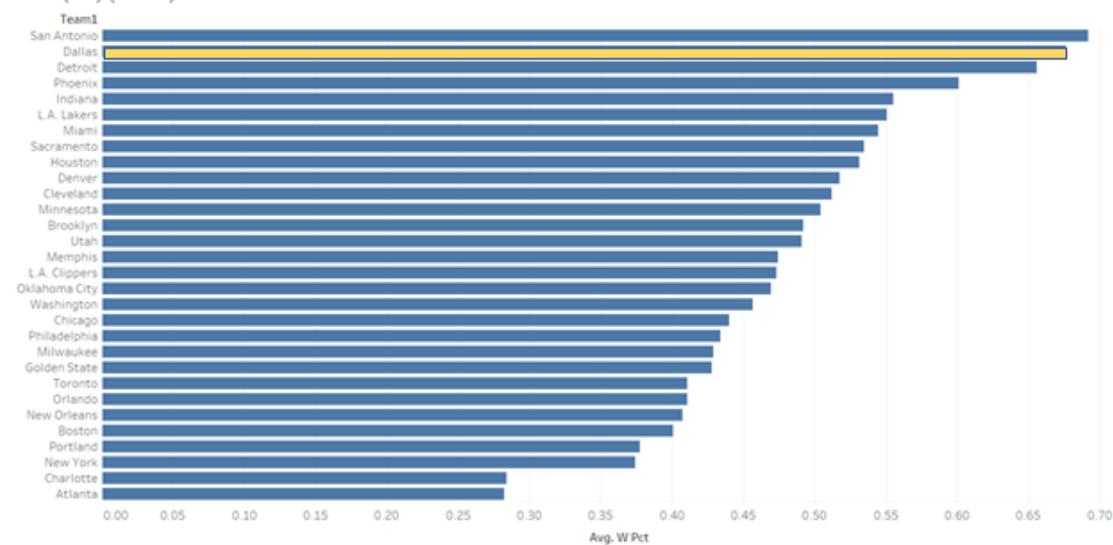
From 2011 to 2014, Dallas Mavericks spend average 4.5 million dollars, which was the 5<sup>th</sup> most amount of expenditure out of 30 NBA teams, however, their team performance belonged to one of middle group, which is 11<sup>th</sup>.

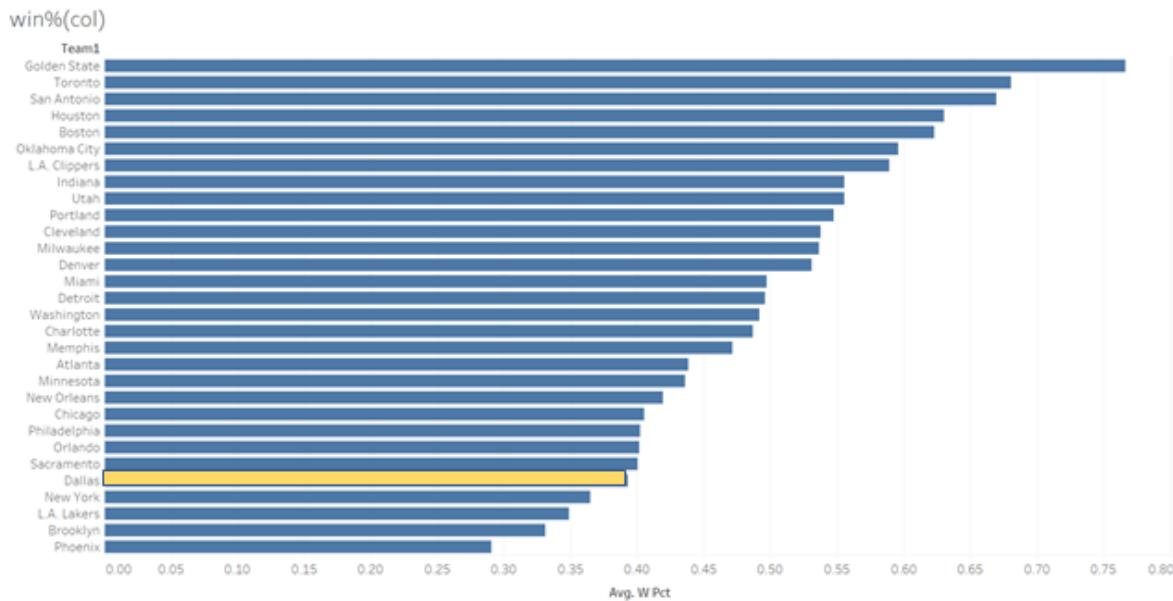
Salary top7



For the recent 4 years, from 2015 to 2018, Dallas mavericks still has been investing a lot compared to other NBA teams, and they were losing more than they were winning. Now they belonged to the group with bad performance, recording 8<sup>th</sup> worst team performance.

win%(col) (03-06)





Not only the number of the games they won over the game they lost, the Dallas Mavericks also recorded their win percentage heading downward. Win percentage is measured by dividing the number of win games by total games teams play. The Dallas Mavericks's win percentage during 2003-2006 was 0.68. But it kept going down and ended up 0.4 at the end. Hence, they have fallen from 2<sup>nd</sup> to 26<sup>th</sup> among 30 NBA teams for 16 years.

RANK	Dallas	Toronto
03~06	3	16
07~10	2	19
11~14	5	23
15~18	6	17

AMOUNT	Dallas	Toronto
03~06	5800k	4500k
07~10	6000k	4300k
11~14	4500k	3800k
15~18	5500k	5200k

Here is another key example, the team Toronto Raptors, that shows “the more salary, the better performance”, is not always true. The Toronto Raptors has very opposite strategy to the Dallas Mavericks when it comes to salary.

The tables above are for comparison between Dallas maverick and Toronto Raptors in terms of the average amount they spend on salary for each period and the ranking of the salary amount each team paid. While Dallas Mavericks spent an average 5800k, 6000k, 4500k and 5500k dollars for each 4 years, Toronto Raptors spent less than that for the same periods.

## Dallas vs Tronto

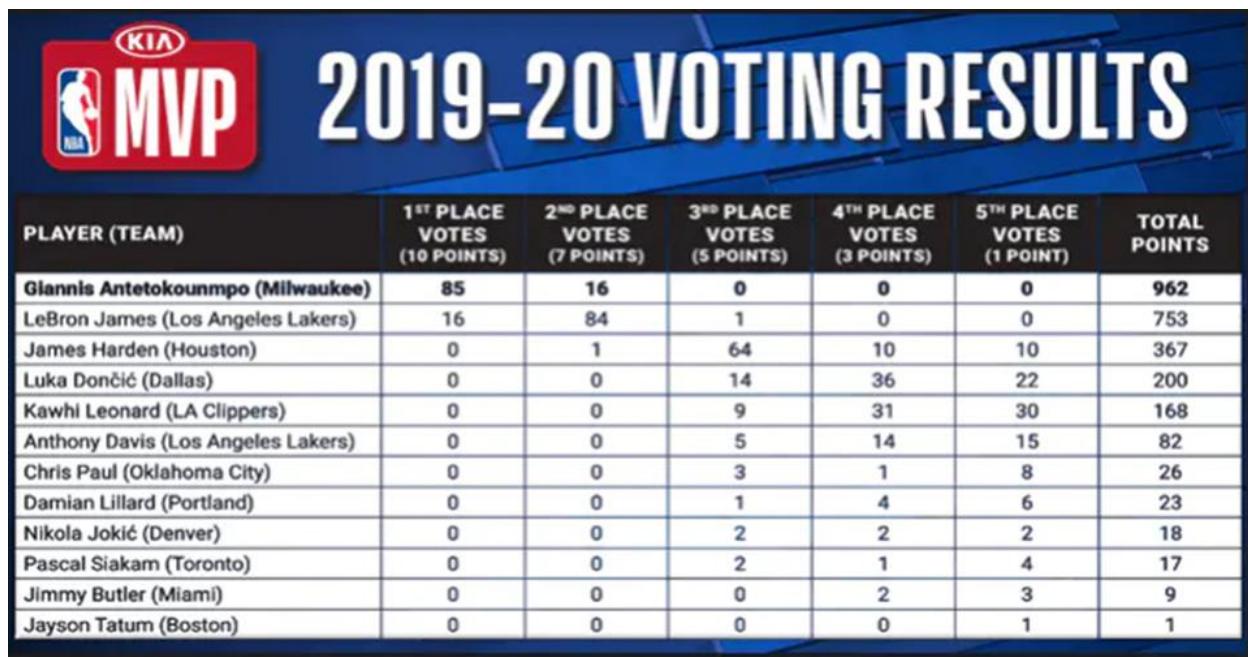


The line chart indicates the fluctuation of win percentage over the last 16 years, from 2003 to 2018. While Dallas Mavericks has been recording their team-performance dragged down in spite of their huge investment, Toronto Raptors has been gradually growing with less expenditure than Dallas Mavericks.

Thus, from these two very different examples, we can conclude the salary paid to players can be a one of many reasons to explain team performance, but not a necessary factor to contribute to performance.

Another question we wanted to answer with visualization is “Did Giannis Antetokounmpo deserve MVP over Lebron James in 2020? Or was it just Media Bias?”

Giannis was the back to back NBA MVP in 2019 and 2020. In 2019, his first MVP year, Giannis won the award after posting amazing statistics and leading his team to a very impressive 60 win season. The same year, Lebron James suffered an injury and was not able to play for a big portion of the season causing the LA Lakers to miss the playoffs. In 2020, Giannis had a better season than his previous, posting amazing statistics at an even more efficient rate. Yet the argument still remains, did Giannis deserve the MVP over Lebron who is 35 years old, playing in his 17<sup>th</sup> season. To answer this question, I will be taking a look at advanced statistics to compare these 2 elite player’s performances.



The graphic features the KIA NBA MVP logo on the left and the text "2019-20 VOTING RESULTS" in large, bold, white letters on the right, set against a blue background with geometric patterns.

PLAYER (TEAM)	1 <sup>ST</sup> PLACE VOTES (10 POINTS)	2 <sup>ND</sup> PLACE VOTES (7 POINTS)	3 <sup>RD</sup> PLACE VOTES (5 POINTS)	4 <sup>TH</sup> PLACE VOTES (3 POINTS)	5 <sup>TH</sup> PLACE VOTES (1 POINT)	TOTAL POINTS
Giannis Antetokounmpo (Milwaukee)	85	16	0	0	0	962
LeBron James (Los Angeles Lakers)	16	84	1	0	0	753
James Harden (Houston)	0	1	64	10	10	367
Luka Dončić (Dallas)	0	0	14	36	22	200
Kawhi Leonard (LA Clippers)	0	0	9	31	30	168
Anthony Davis (Los Angeles Lakers)	0	0	5	14	15	82
Chris Paul (Oklahoma City)	0	0	3	1	8	26
Damian Lillard (Portland)	0	0	1	4	6	23
Nikola Jokić (Denver)	0	0	2	2	2	18
Pascal Siakam (Toronto)	0	0	2	1	4	17
Jimmy Butler (Miami)	0	0	0	2	3	9
Jayson Tatum (Boston)	0	0	0	0	1	1

The NBA MVP award is decided by a panel of sportswriters and broadcasters throughout the United States and Canada, each of whom casts a vote for first to fifth place selections. Each first-place vote is worth 10 points; each second-place vote is worth seven; each third-place vote is worth five, fourth-place is worth three and fifth-place is worth one.

## Standings

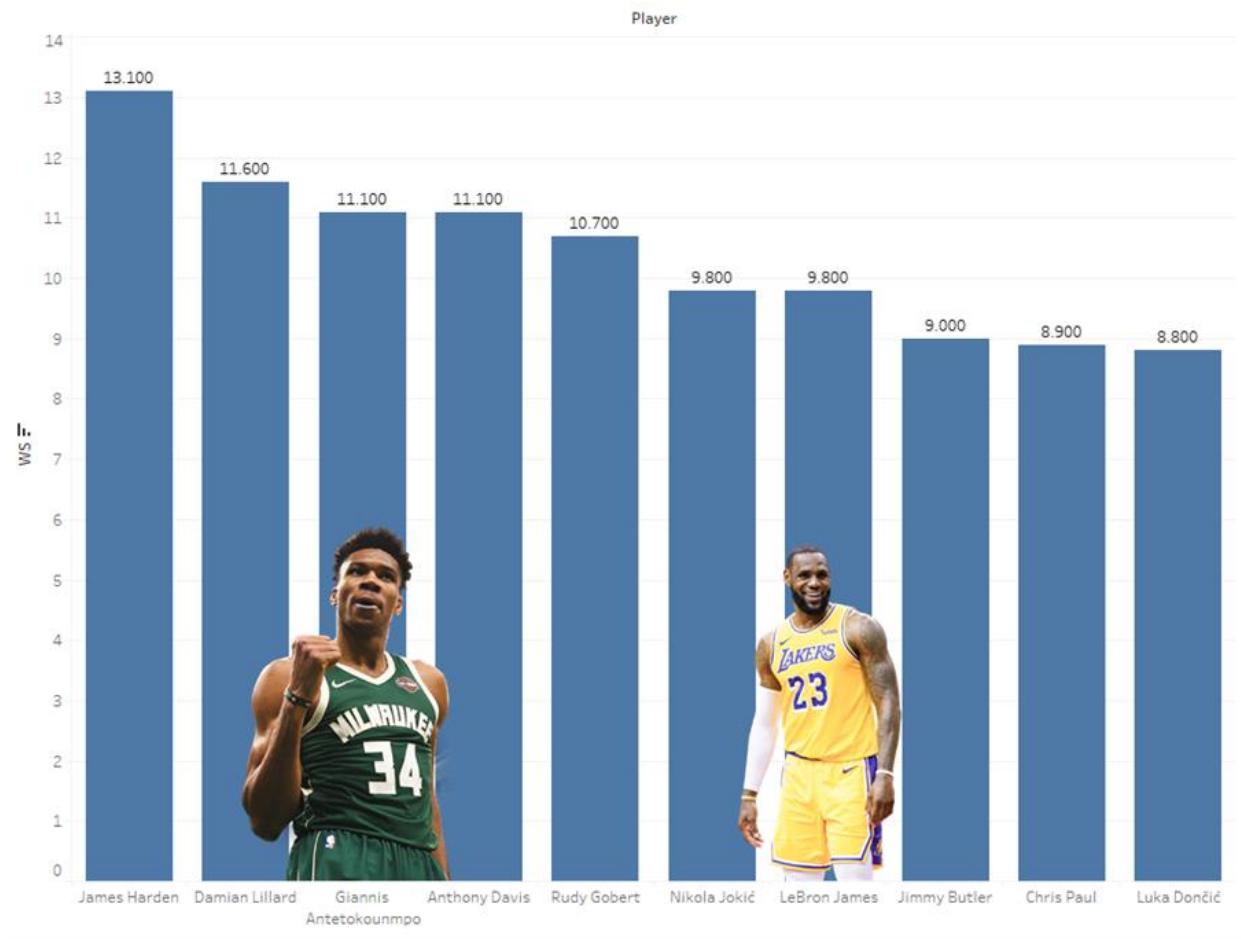
Season Id	Conference	Team	Wins	Loses	Win Percentage
19-20 Pre bubble standings	East	Milwaukee	53.00	9.00	0.81
	West	L.A. Lakers	47.00	13.00	0.79

\*shortened season due to the pandemic

Another major factor to consider when selecting MVPs is team performance. Historically speaking, most MVPs came from a top 3 team in their respective conferences. Coincidentally in 2020, both the LA Lakers and Milwaukee bucks were the first teams in their respective conferences.

The first advanced stats I will be taking a look at is win shares:

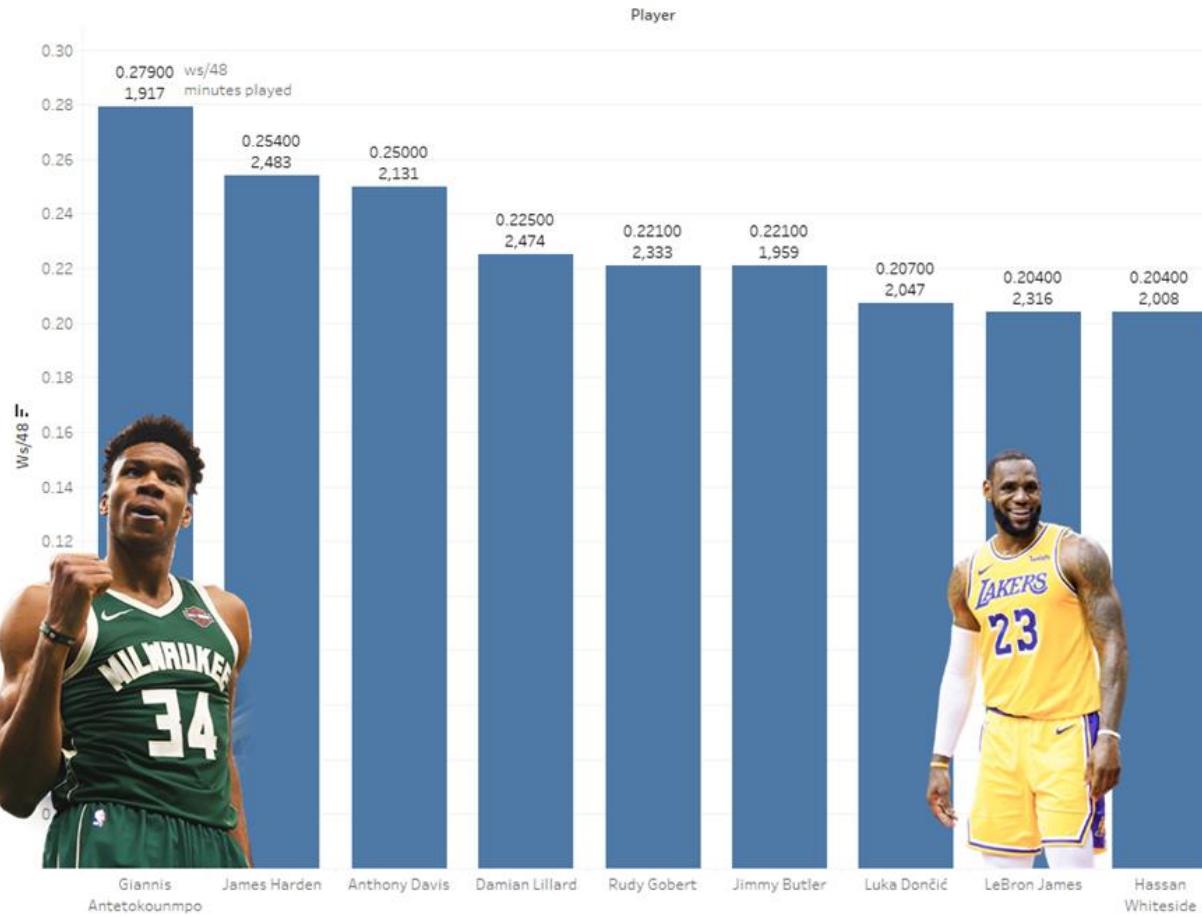
WS



Each team win is equal to 1 win share. If a team has 50 wins, it has 50 win shares to divide up. Number of win shares is equivalent to how many wins that player personally contributed to their team. Giannis personally contributed 11.1 win shares to his team, beating Lebron who has only 9.8

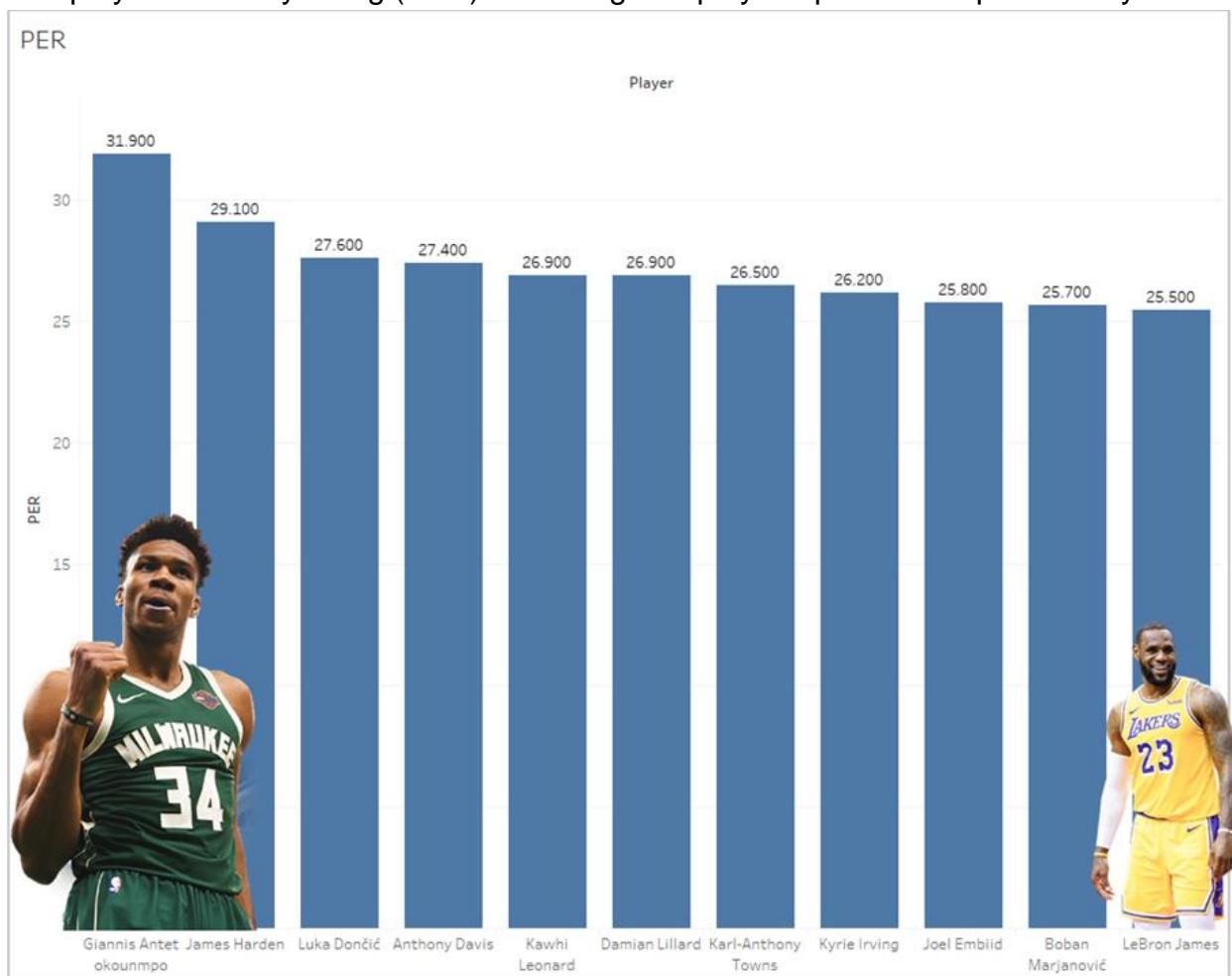
The next stat is win shares/ 48 mins of play:

WS/48



This normalizes the data for how many win shares a player produces every 48minutes on the court. This allows us to compare player performance as the performance is normalized over 48 mins of play. Giannis' win share per 48 is 0.279 compared to Lebron's 0.204. And he was able to achieve this in a more efficient manner with less minutes played this season.

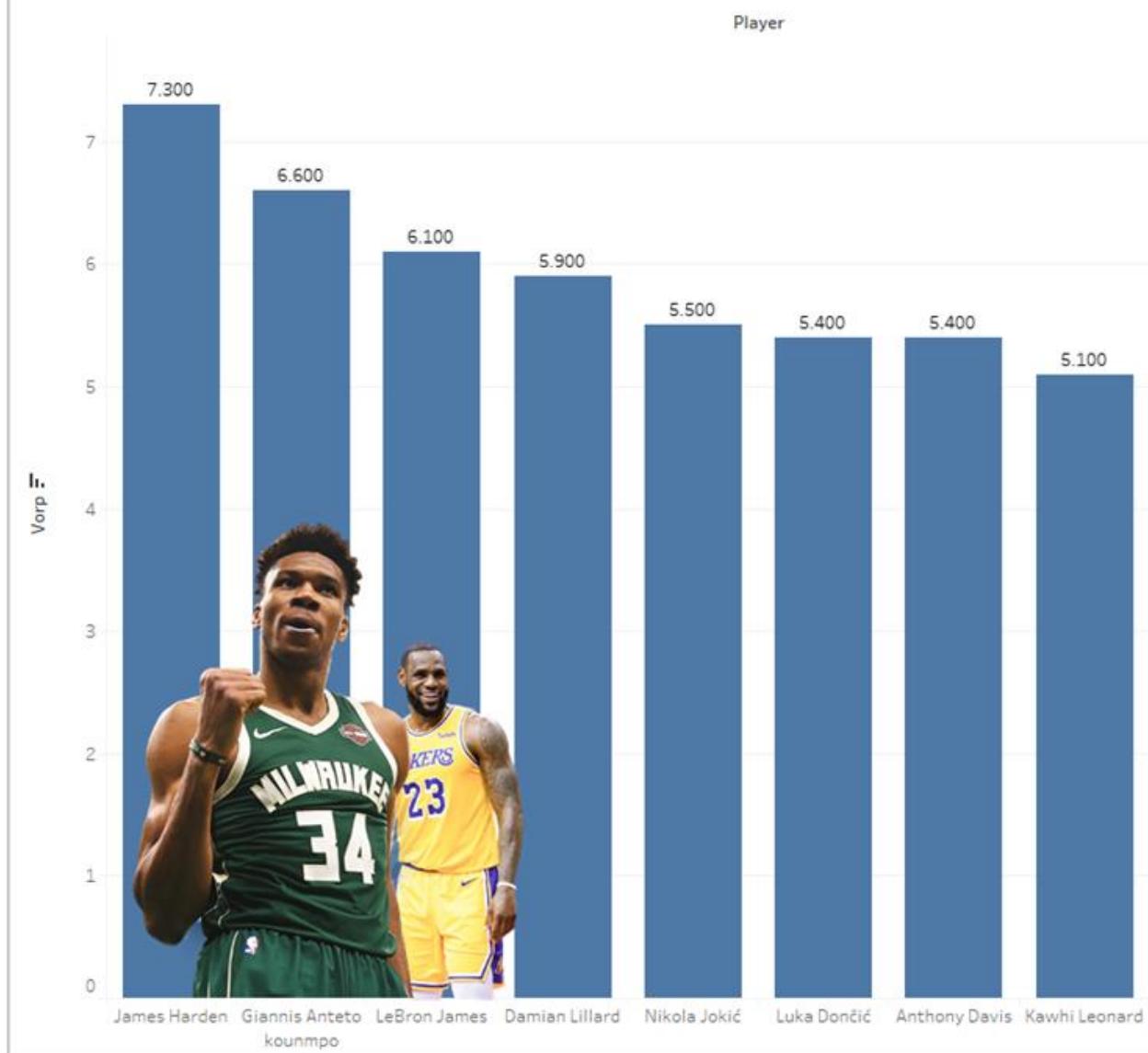
The player efficiency rating (PER) is a rating of a player's per-minute productivity:



Includes positive accomplishments such as field goals, free throws, 3-pointers, assists, rebounds, blocks and steals, and negative ones such as missed shots, turnovers and personal fouls. Two important things to remember about PER are that it's per-minute and is pace-adjusted. Because it's a per-minute measure, it allows us to compare different players, even though there is a disparity in their minutes played. PER also adjusts each player's rating for his team's pace, so that players on a slow-paced team aren't penalized just because their team has fewer possessions than a fast-paced team.

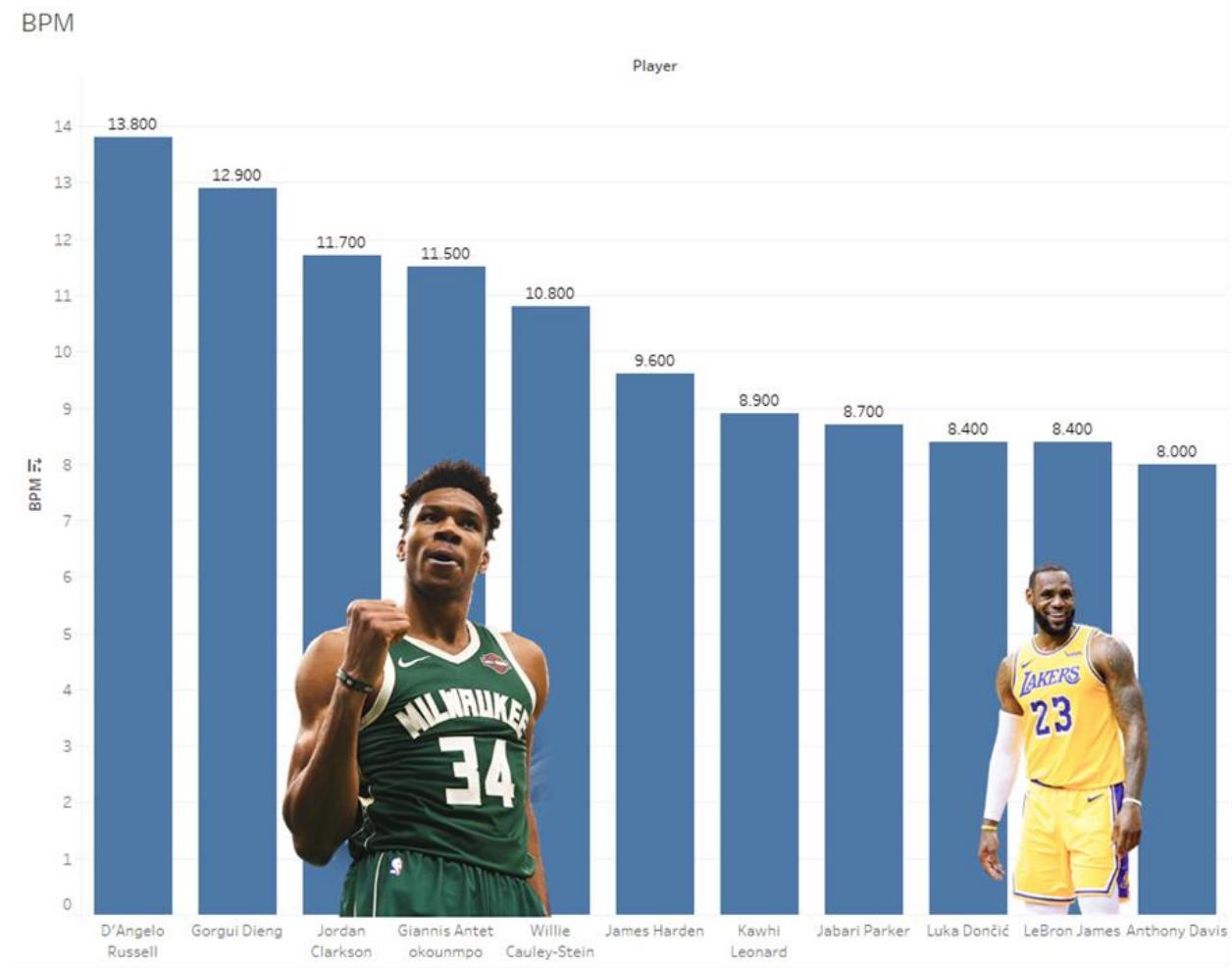
Value over replacement player or VORP is defined as a measure to estimate each player's overall contribution to the team, measured vs what a theoretical "replacement player" would provide:

## VORP



A replacement player would be a player on a minimum contract salary or someone who is not normally on the team's rotation. Think of it as comparing it to an average NBA player. Giannis contributes to his team's performance at 6.6 times more than if you replace him with an average NBA player. LeBron James lags closely behind at 6.1. Since this is a rate statistic, it is hard to make a direct comparison, but it can still provide a picture of Giannis contributions.

Box plus minus estimates a players contributions to the team when that player is on the court:



Box plus minus is derived from players box score stats, such as points , rebounds, assists, combined with team statistics. Even though this stat isn't normalized and is purely a rate statistic and does not account for playing time, I wanted to show the comparison between the 2 players.

Giannis was clearly the winner from every advanced stat. But why did people claim that Lebron James was robbed of another MVP award?

# LeBron James was clear MVP over Giannis Antetokounmpo, defends Stephen A. Smith



by [Kreil Ibarrola](#) September 18, 2020



\*\* Kreil Ibarrola, "Lebron James was clear MVP over Giannis Antetokounmpo, defends Stephen A Smith", Clutch Points, Sep 18 2020.

The answer is simple. Stats are boring. Stats by itself don't generate revenue. The media plays a big role in promoting any sports league. Headlines drive revenue. Storylines drive excitement. Rivalries whether organic or made up drive viewership numbers up. That is the business model that the NBA takes. The media is there to draw excitement and discussion to help promote the game, the players and viewership.

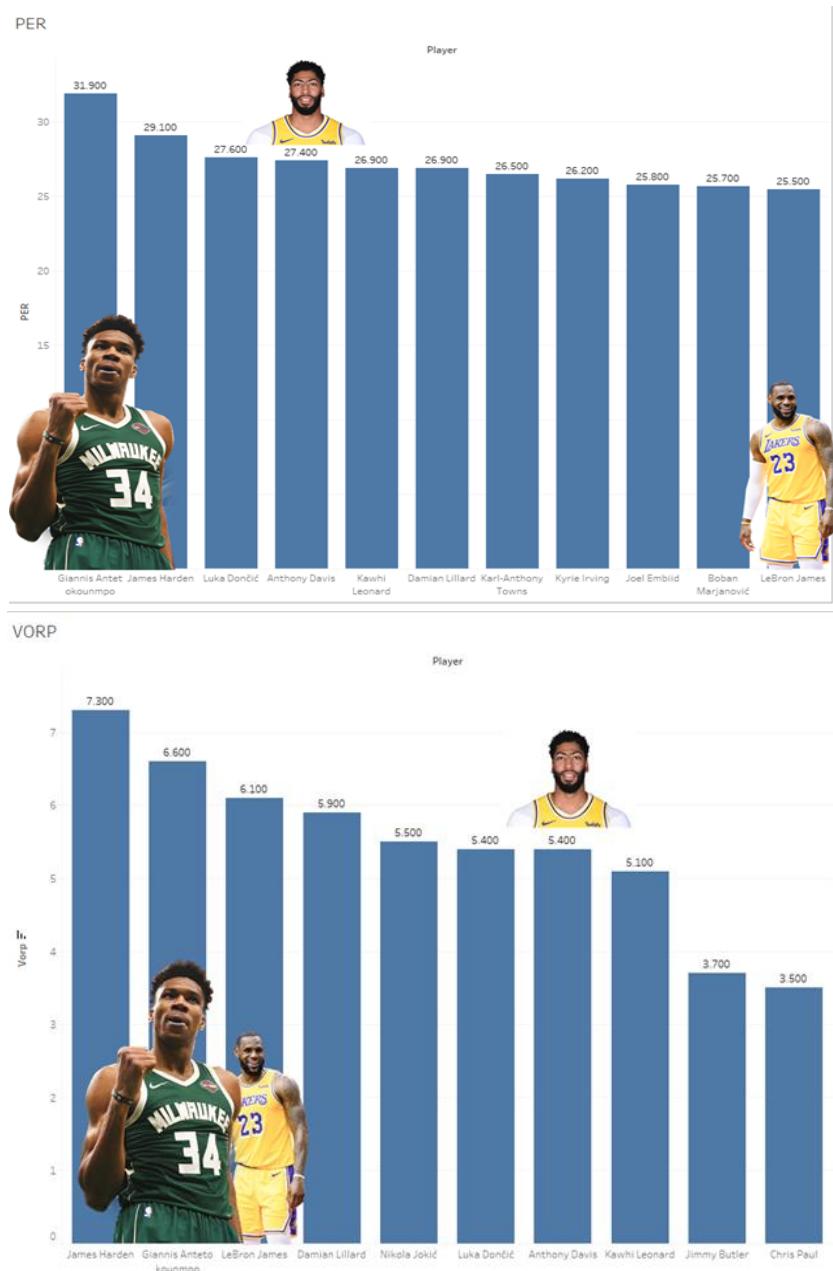
Another reason why is because Lebron had more help from better teammates in LA.

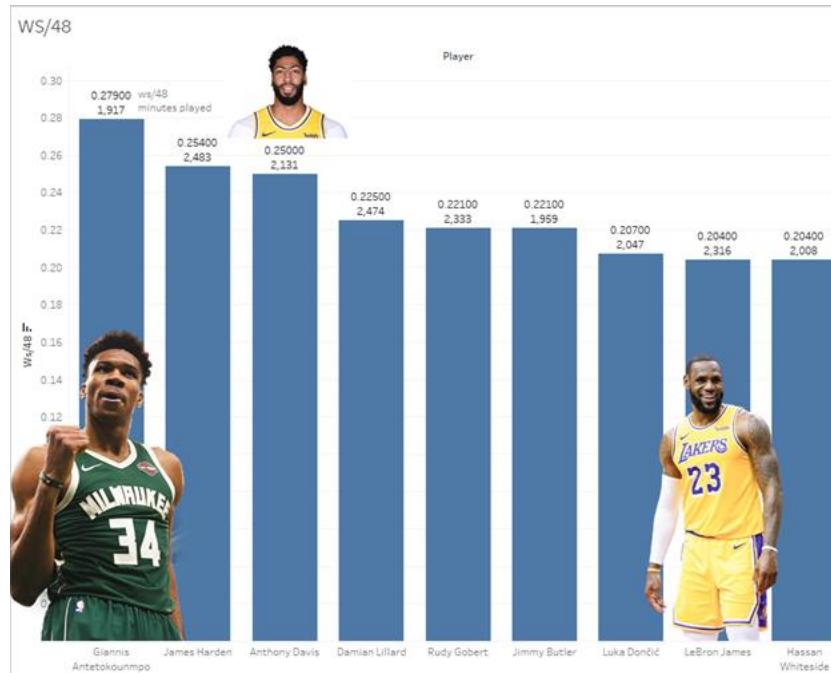
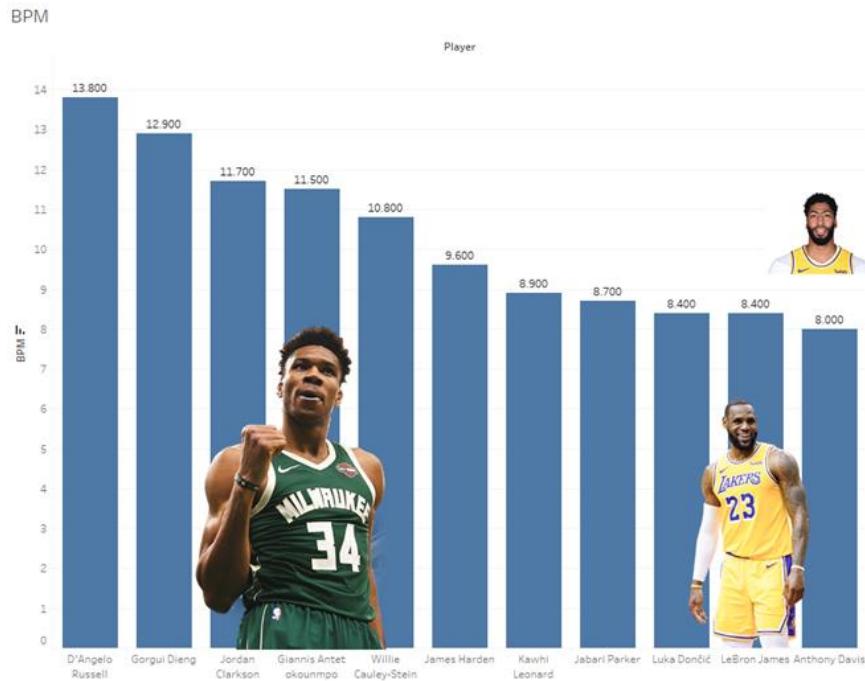
Player	Age	PER	BPM	Vorp	WS	Ws/48
Giannis Antetokounmpo	25.00	31.90	11.50	6.60	11.10	0.28
Khris Middleton	28.00	21.10	4.10	2.90	7.90	0.21
LeBron James	35.00	25.50	8.40	6.10	9.80	0.20
Anthony Davis	26.00	27.40	8.00	5.40	11.10	0.25



When comparing the top 2 players of each respective team. Lebron James had another elite team mate, Anthony Davis, with high contributions to the team's success.

Among my previous advances stat graphs, Anthony Davis was actually present as well in many of them and even posted better stats than lebron in a few measurements while Giannis's team mate, Khris Middleton was nowhere to be found.





Did Giannis deserve the MVP over Lebron in 2020?

The verdict is yes. Based on advanced stats, win record, and season performance, Giannis deserved the MVP award. Giannis also was able to achieve a better season win record with less help as compared to Lebron James. Media headlines, hot takes, and storylines also added fuel to the rivalry and made the race to MVP closer than it actually was.

## **Conclusion**

Sports analytics have become a prominent household feature. Almost every NBA team employs an analytics department to try and exploit any weaknesses they can find. Although many argue that analytics is taking away from the art form in professional sports, it does enhance the team's chances of winning. In any major sports leagues, winning is everything. Success is defined as the number of NBA championships a team has. Players' contracts and endorsements all come from their ability to win games and win championships. This is the legacy that they are working so hard to achieve. Analytics aids them in their goal to be the very best in sports.