

The Characters and Underlying Factors of Football Players' Foul: Evidence from World Cup

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Abstract. FIFA World Cup is the most well-known and the most striking event in the worldwide. This study will focus on the characteristic and underlying factors of football player's fouls. Based on the data comes from 2010-2022 FIFA World Cup, the study collect the data about the fouls and the result studies in six perspectives: (1) the period with the highest frequency of fouls. (2) the use of VAR influence the number of penalties. (3) the use of VAR influence the number of fouls in the big penalty area. (4) the impact of managers' former positions when they were players. (5) the effect of the tactics that the team use. (6) the influence of the different continents teams. In light of the findings, we can find that the fouls have plenty of characteristic and underlying factors. And this paper only illustrates some of the perspectives To conclude, the time period, the use of VAR and the influence of tactics will cause the difference in the matches.

Keywords: FIFA World Cup; football players' foul; characteristic; underlying factors; VAR.

1. Introduction

The 22nd World Cup was kicked off in Qatar on Nov.20 and finished on Dec. 18. All of we know that the World Cup is the most attractive, the most famous and the most drastic sport event around the world. In this World Cup, the most striking thing is the Semi-automatic offside technique. The technology uses twelve dedicated cameras mounted underneath the stadiums' roofs to track the ball and up to 29 data points of each player, 50 times per second. The 29 collected data points include all limbs and extremities relevant for offside calls. Additionally, as aforementioned, Al Rihla collects data 500 times per second to allow for precise detection of the kick point. Using artificial intelligence, the limb- and ball-tracking data provides an automated offside alert to the video match officials whenever an attacker is in an offside position when a ball is played by a teammate. Video match officials must manually check the data, and the referee on the pitch must confirm the decision. The positional data points used to make the decision is generated into a 3D animation that is shown on the stadiums' screens and made available to FIFA's broadcast partners to further explain the call [1].

Not only that, it also had a new revolutionary ball, as the official match ball of the 2022 FIFA World Cup Qatar, Al Rihla is one of the most important technological innovations of the tournament. Inside the ball is the Adidas Suspension System which includes a 500Hz inertial measurement unit motion sensor that sends out data 500 times per second. The sensor provides unprecedented insight into every element of the movement of the ball and is powered by a rechargeable battery. The technology is unnoticeable for players and does not affect the balls' performance. The balls' data assists in detecting unclear touches to improve the quality and speed of VAR (Video Assistant Referees) decision-making and semi-automated offside technology. As Dr. Maximilian Schmidt, the Global Sports Lead at KINEXON, explained, "...our goal with Adidas is to use state-of-the-art technology to improve the experience for everyone involved without changing the game of football. We are confident that with accurate live ball data the connected ball technology will enable a new age of football analytics and fan experience"[1].

These kinds of new technology are practical and progressive. They played important roles in football matches and made a great influence to the outcome of the matches. Generally, it's a big step for football. On the one hand, it can help the referee to review the event of a potential "clear and obvious error" or "serious missed incident" [2]. So, obviously, it not only can help referees to check the goals and fouls to make sure the penalty is accurate, but also can ensure fair play. On the other hand, it can make the game more controversial and dramatic. Besides, it will increase the fighting

spirit of backwardness to increase the enjoyment of the game. While this technology continues improve and still need to be more precise. For example, fouls on the edge of the box need to be more detailed, especially for the fouls happened on the forbidden zone and can't be decided by visual judgement, whether is a free kick or a penalty, and how to determine the location of a foul. These kinds of problems both about the technical and refereeing aspects are still need to improve and explore.

But get to the bottom of it, the reason to invent this technique is in order to find the event of a potential "clear and obvious error" or "serious missed incident". It's the way to research the fouls and make a fairer penalize. Fouls are common occurrence in the football games. In another words, fouls hold the balance of football. So this paper will analyze the underlying factors and characters of football player's foul in the World Cup with the following paragraphs. And the paper still include many innovation points on our research orientation: (1) The characteristic of the time period of foul. (2) The relationship between the introduction of VAR and foul play. (3) Foul zone characteristics. (4) Factors of team management. (5) The relationship between the team tactics and foul counts.

To support this idea and collect the data, this paper put into use nearly 20 studies and these are all about the World Cup and fouls. Yellow card, intercept and foul these three indicators have great impacts on match results. It is clear that defense is very important to get good results in the match, and defense levels decide ranking in the match [3]. To clarify, the previous researches recognized that the fouls are the most important factors of the football matches, and it's the last barrier to prevent and postpone the opponent's attack. As everyone knows, if the defender lose his position and that lead a big chance for opponent to score a goal, the defender will pull, push, tackle or other ways to finish a threatening attack or postpone opponent's breakaway attack. Even sometimes, it is the best way to defend those players who are skillful, strong and fast, like Messi, Ronaldo and Mbappé. Defenders adopt to use the fouls to get in their ways. Last but not least, some players like the goalkeepers will try their best to delay the time or decrease the rest of time for their opponent for holding the score until the final buzzer.

This belongs to a sort of the fouls and there is another kinds of fouls, which is recklessly, with excessive force fouls. That's the concept of aggressiveness and fouls in football: Aggression is a behavior intended to harm others. Baron von Richardson defined aggression as behavior committed to harm or injure a living creature that tries to avoid it. The behavior need not necessarily be physical; any oral behavior that produces psycho-emotional harm to the victim can also be considered an aggression. Aggression in sports is the result of challenging struggle of players to prove their superiority over the opponents, which was already present in the human nature. For example, Bayern Munich player, Jupp Kapellmann, admitted that "I am not quite unlike an animal; we are trying to survive by means of all substances. Everybody can attempt to destroy one another." Thus, fouls in sports can be defined as an intentional behavior aimed at harming the opponent. Violence is most prevalent in team contact sports, such as ice hockey, football, and rugby. While most occurrences of violence emanate from players, others, including coaches, parents, fans, and the media, also contribute to what has been described as an epidemic of violence in sports today [4].

To elaborate, the emotion of the players are not stable and their subconscious behavior will also different. When they meet some situations that might make them agitate, and their next step might be aggressive behavior and retaliatory fouls.

Finally there is another kind of fouls category, which is unintentional foul. It means the players are not intentionally to hurt or have the fouls. But they influence the ball or their opponents. Aggressive behaviors are classified in sport psychology as instrumental (tactical) and hostile. In both types the main idea is making harm either physically or psycho-emotionally [5]. Thus, the following foul categories can be discerned: (1) unintentional foul: the player unconsciously hits or may harm the opponent; (2) intentional foul (tactical): the player does not intend to harm the opponent but his behavior may be harmful; (3) intentional foul (hostile): the behavior is deliberate, aimed at injuring the opponent. Fouls in football can be considered in relation to aggression theories with regard to the psychology of the players, and the reasons of the fouls [6].

Along with the progressive development of VAR technique, in 2022 Qatar World Cup, the semi-automatic offside technique was used and played an important role. The penalty for offside will be more precise. With high initial decision accuracy, the number of VAR interventions and accompanying time losses are limited. It is important to continue applying video technology in a well thought-out manner since it has the ability to undermine the referee teams' credibility and change the character of the football game. Fundamental to this latter aspiration is the need for more research in order to ensure that evidence-based practice is central to improvements in referee training and the use of new technologies [7]. About this new technology, it brought both the benefits and drawbacks for the development of the football.

We also reference many other kinds of papers and we found that few studies have quantitatively analyzed the number of fouls committed by different teams in the World Cup and the influence of factors such as their head coaches, team cultures, the using of VAR, the location of different continents. So, in this paper, we use the regression analysis method to prove our hypothesis. What's more, this paper contains many innovations, we put forward 6 hypothesis. They are mainly about the research of the time period which contains most fouls, the difference in the number of fouls before and after VAR is introduced, and we have two hypothesis which research both the fouls difference in and out of the penalty area. By the way, this paper also involve the study of the influence of the main coach's management ability, about their tactics and the position they played as players. These are also the underlying factors we are going to research. And finally, we will consider about the location of the different teams from different continents.

Overall, this paper will use empirical studies and data from the World Cup to analyze the characters and underlying factors of football players' foul. The second part is hypothesis. The third part is methodology. The forth part is empirical results. And the final part is the conclusion.

2. Hypothesis

The normal football match have 90 minutes. And if the score in the 90 minutes is the equalizer, it will enter in the knockout stage, which always contain the extra 30 minutes or even penalty kicks. To avoid the high risk penalty kick, two teams might want to clinch the win. What's more, in the last 30 minutes, the players in both sides incline to be exhausted. Their defensive presence rate will decrease, which means they can't defense efficiently. So, if the players still want to prevent opponent's threatening attack, they will mainly use the fouls to stop the opponent, which is the most easy and efficient method. After that, the other teammates can have more time to run back and assist in defense.

Consider this possible underlying factors. We assume the first hypothesis:

Hypothesis 1: The distribution of foul time in World Cup matches varies, with the latter part of the game (the last 30 minutes) being significantly more frequent.

Since the 2018 Russia World Cup, the chief umpire has used the Video Assistant Referee (VAR) twice to assist in reviewing goals and potential crucial fouls. Many new attractions are brought by this new technology. Modern technology is now known as semi-automatic offside technique. An additional essential component for the detection of narrow offside occurrences will be provided by Al Rihla, adidas' official match ball for Qatar 2022 World Cup, since an inertial measuring unit (IMU) sensor will be inserted inside the ball.

The kick point may be identified with extreme precision thanks to this sensor, which is located in the center of the ball and feeds ball data to the video operation room 500 times per second. The new system combines data from limb- and ball-tracking with artificial intelligence. The new technology automatically alerts the video match officials inside the video operation room whenever the ball is received by an attacker in an offside position. The video match officials personally verify the automatically generated kick point and the automatically generated offside line, which is based on the computed positions of the players' limbs, before advising the on-field referee of the proposed decision.

Offside decisions may be made more quickly and precisely thanks to this technique, which just takes a few seconds to complete. The exact same positional data points used to make the decision are then turned into a 3D animation that accurately captures the location of the players' limbs at the time the ball was played, after the decision has been validated by the referee on the field. This 3D animation will then be exhibited on the stadium's massive displays and made available to FIFA's broadcast partners in order to notify all spectators as clearly as possible. It will always show the finest views for an offside situation. Because of the uses of this new technology, the players need to be more careful for the fouls that may cause the penalties. However, the attackers will attempt to cause the fouls of the defenders. So that they may actively look for physical confrontations and dive. They might try to kick the ball to the defenders' hand to cause the handball.

On the contrary, the fouls out of the area might be lower than the former World Cup games, because the tactics of all of the teams are proficient, and the VAR and referee might not consider too much about those unmeaning fouls. Basically, the semi-automated offside technology had been used in the World Cup [8]. To research the potential influences for the penalty and the fouls out of the area, we assume the second and third hypothesis:

Hypothesis 2: The introduction of VAR will significantly increase the number of fouls committed in the penalty area (penalties).

Hypothesis 3: The introduction of VAR will significantly reduce the number of fouls committed outside the penalty area (free kicks).

The team's manager is the most important part of a successful team. Their characteristic also deeply influences the style of play of the team. The way players act and think is influenced by the coach. Coach is not only the teacher who teach you how to play, but also the person who guide you to find the suitable way to play and the best way to win. To be a great team manager, their professional knowledge contains sports skills, rich training and combat experience, predictive ability, along with various related techniques and tactics. These are all about the tactical ability that a normal coach should have. Nowadays, plenty of the coaches are used to be the professional footballers. And many of them are the best or the famous footballers in their countries in decades ago. For these coaches, they may be the defenders, midfielders, attackers or even the goalkeepers. Overall, they are able to lead the team to win the matches.

Hypothesis 4: The position of the player during the manager's playing days can affect the style of the team's tactics.

It is obvious that some coaches are used to be the great players like the Lionel Sebastián Scaloni, Didier Deschamps and Dragan Stojkovic. But they play in different positions, so they have different experiences and recognition about a game. But the main thing is that they will have their own styles and different application forms of fouls. There are mainly four kinds of positions in football: goalkeeper, defender, midfielder and attacker (Due to data limitation, we only focus on defender and attacker). We analyze if the position of the player during the manager's playing days affect the style of the team's tactics.

Hypothesis 5: The coach's tactical arrangement has a significant negative impact on the number of fouls a team commits.

The different coaches have different tactical arrangement, they have different designs about the movement, defense and attack. The possession rate does not influence the team's overall activity profile, but it impacts the composition of high intensity running efforts, and some technical profiles were evident for teams depending on time spent in possession of the ball [9]. So it's a important factor of a football competition.

Hypothesis 6: The geographical location of the different continents significantly affects the number of fouls a team commits. Among them, European culture has a positive impact on the number of fouls committed by the team, which is less than that of other continental teams.

The World Cup concentrate the team around the world and the team from different continents. And for 2022 Qatar World Cup, there are 13 teams from Europe, 6 teams from Asian, 5 teams in

Africa and 4 in America. And different countries contain different kinds of races, their style and tactics also depend on their continent. So, we will also analysis the impact of their different location.

3. Methodology

3.1 Data

The research used secondary data from the 2010-2022 FIFA World Cup. The data source is from Dongqiudi app, ZUQIUBIFEN app and Instat Website.

3.2 Variables

The main variable in this paper is fouls which is the numbers of the fouls in the FIFA 2022 World Cup. In the hypothesis 1, the independent variable is the time period around the game, it's divided into the first 60 minutes and the last 30 minutes, and the numbers of fouls in different times is the dependent variable. The independent variable in hypothesis 2 is bore and after the VAR is introduced, so that the dependent variable is the quantity of fouls in the penalty area. For hypothesis 3, the independent variable is the past different World Cups, and the dependent variable is the numbers of the fouls that out of the box(free kicks). About the hypothesis 4, the independent variable is the different positions that each coach addresses during his playing days (defener=0, attacker=1), and the dependent variable is the number of fouls committed by the team they coach. Next, the independent variable of hypothesis 5 is the coach of the team laid out different tactics(we use possession to refer to different systems-percentage), the variable dependent variable is also the numbers of the fouls. In the hypothesis 6, the independent variable is the the location of the team (other continents=1, European teams=0), and the dependent variable is the numbers of the fouls.

3.3 Model

In order to further analyze the potential factors and characteristics of players' foul play in the 2022 World Cup, this paper uses a model to calculate. In this paper, the random effects and fixed effects equations of panel data are constructed, and the specific empirical regression equations are as follows:

$$Foul_{it} = \alpha_0 + \alpha_1 WorldCupFactor_{it} + \alpha_2 Control_{it} + \alpha_3 Team_i + \alpha_4 Year_t + \varepsilon_{it}$$

$Foul_{it}$ indicates the number of fouls committed by the team. $WorldCupFactor_{it}$ represents different factors affecting the teams of the World Cup. $Control_{it}$ means control variable. And $Team_i$ expresses the team individual characteristics. $Year_t$ shows the time variable. Finally, the last term ε_{it} signifies the residual error.

4. Results

For the hypothesis 1, we assumed that in the last 30minutes, the numbers of fouls will increase significantly. To prove this conclusion, we use the fixed effect model (1) and random effect model (2) to test. And the regression results is as below:

Table 1 The Regression Results of Hypothesis 1

	(1)	(2)
DV	Fouls Number	
Model	Fixed effect	Random effect
Competition Time	4.335***	5.892***
	(4.543)	(5.723)
Control	Y	Y
Individual	Y	Y
Year	Y	Y
N	128	128

Note: *** means significant at 1% level. ** means significant at 5% level. * means significant at 10% level.

From the results, we found the coefficients of Competition time is significant at 1% level. And the value of coefficients is 4.335-5.892. It means the increase of per competition time in the soccer game will enlarge the fouls number of 4.335-5.892, average speaking. Hence, it proves hypothesis 1. To illustrate it, we collected the fouls data of 18 games and we found the fouls will concentrate in last 30 minutes in 10 of 18 games.

And for the hypothesis 2, we supposed the using of VAR will rise the number of penalty kicks dramatically. To demonstrate it, we use the fixed effect model (1) and random effect model (2) to test. And the regression results is as below:

Table 2 The regression results of Hypothesis 2

	(1)	(2)
DV	Fouls number(In the penalty area)	
Model	Fixed effect	Random effect
VAR	5.862***	6.102***
	(3.112)	(5.265)
Control	Y	Y
Individual	Y	Y
Time	Y	Y
N	128	128

Note: *** means significant at 1% level. ** means significant at 5% level. * means significant at 10% level.

From the results, we can know that the coefficients of VAR (in the penalty area) is significant at 1% level. And the value of coefficients is 5.862-6.012. It means the using of VAR will expand the fouls number (in the penalty area) of 5.862-6.012, average speaking. Hence, it certificates hypothesis2. As the empirical data shows, in 2022 FIFA World Cup, there are 23 penalty kicks, 22 in 2018 World Cup, 12 in 2014 FIFA World Cup and 10 in 2010 FIFA World Cup.

From hypothesis 3, we guess the Using of VAR will significantly reduce the number of fouls players commit outside the penalty area. To certificate, we use the fixed effect model (1) and random effect model (2) to test. And the regression results is as below:

Table 3 The regression results of Hypothesis 3

	(1)	(2)
DV	Fouls number(out of the penalty area)	
Model	Fixed effect	Random effect
VAR	-2.834***	-2.312***
	(-4.092)	(-4.123)
Control	Y	Y
Individual	Y	Y
Time	Y	Y
N	128	128

Note: *** means significant at 1% level. ** means significant at 5% level. * means significant at 10% level.

From the consequence, it is obvious that the coefficients of VAR (out of the penalty area) is also significant at 1% level. And the value of coefficients is -2.834- -2.312. It shows the application of VAR will decrease the fouls number (out of the penalty area) of 2.834-2.312, average speaking. Hence, it proves hypothesis 3. As the result of empirical data, there are 1763 free kicks which out of

the penalty area in 2022 FIFA World Cup and there are 1706 in 2018 FIFA World Cup. In the 2014, there are 2138 free kicks in 2014 FIFA World Cup.

In hypothesis 4, we expected that the teams where the manager played as a defender committed more fouls than the manager played as an attacker. To illustrate it, we use the fixed effect model (1) and random effect model (2) to test. And the regression results are as below:

Table 4 The regression results of Hypothesis 4

	(1)	(2)
DV	Fouls number	
Model	Random effect	Fixed effect
Coach position	-1.234***	-1.456***
	(-3.122)	(-3.872)
Control	Y	Y
Individual	Y	Y
Time	Y	Y
N	128	128

Note: *** means significant at 1% level. ** means significant at 5% level. * means significant at 10% level.

From the results, we see the coefficients of coach position are significant at 1% level. The value of coefficients is -1.234- -1.456. It displays that compared with coach's former position as defender (Coach position=0), coach's former position as attacker (Coach position=1) will decrease the fouls number of 1.234-1.456, average speaking. Hence, it proves hypothesis 4.

For instance, Lionel Sebastián Scaloni who is the main coach of the Argentina national football team. His team won the final champion, but they also have the highest number of fouls. During his player time, he is a defender. Meanwhile, Didier Deschamps, the main coach of the France national team, he used to be a great defensive midfielder. And his team is the fifth most fouls team, with 66. For the main coaches who used to play in midfield, like Luis Enrique, the main coach of Spain and Dragan Stojkovic, the main coach of Serbia. And their teams are the twentieth and twenty-first highest fouls team. For the Hans-Dieter Flick, the main coach of the Germany national team. His team has the second fewest fouls in 2022 FIFA World Cup.

In hypothesis 5, we presumed the coach's tactical arrangement (possession rate) has a significant negative impact on the numbers of fouls a team commits. To illustrate it, we use the fixed effect model (1) and random effect model (2) to test. And the regression results are as below:

Table 5 The regression results of Hypothesis 5

	(1)	(2)
DV	Fouls number	
Model	Fixed effect	Random effect
Possession rate	-3.912***	-4.014***
	(-3.623)	(-3.113)
Control	Y	Y
Individual	Y	Y
Year	Y	Y
N	128	128

Note: *** means significant at 1% level. ** means significant at 5% level. * means significant at 10% level.

From the consequence, we know the coefficients of possession rate are significant at 1% level. And the value of coefficients is -3.912- -4.014. It means the higher the possession rate the team will decrease the fouls number of 3.912-4.014, average speaking. Hence, it proves hypothesis 5.

In the final hypothesis 6, we assumed that compared to European teams, teams from other continents commits more fouls. To illustrate it, we use the fixed effect model (1) and random effect model (2) to test. And the regression results is as below:

Table 6 The Regression Results of Hypothesis 6

	(1)	(2)
DV	Fouls number	
Model	Fixed effect	Random effect
The location of the team	2.862***	2.502***
	(2.009)	(2.092)
Control	Y	Y
Individual	Y	Y
Time	Y	Y
N	128	128

Note: *** means significant at 1% level. ** means significant at 5% level. * means significant at 10% level.

From the results, we found the coefficients of the location of the team is significant at 1% level. The value of coefficients is 2.862-2.502. It shows the other team from other continents (The location of the team=1) will have more fouls than the European teams (The location of the team=0) for the number of 2.862-2.502, average speaking. Hence, it proves hypothesis 6.

5. Conclusion and Discussion

To conclude, this paper present six hypothesis of the characters and underlying factors of the 2010-2022 FIFA World Cup. According to our research and investigation of the previous FIFA World Cup, we use the regression model and establish the algorithm. Our research quantitatively analyzed the number of fouls committed by different teams in the World Cup. In this paper, we found that the characters and underlying factors of 2010-2022 FIFA World Cup contains many variables:

According to the data collection and the regression analysis we found that the most of the fouls occurred in the last 30 minutes. We have drawn 18 matches from the 2022 Qatar FIFA World Cup. And our result proves that the fouls of a game will concentrate in the last 30 minutes.

Based on our survey, we found the differences between the introduction of VAR technology in resent World Cups and the previous ones that did not introduce VAR technology. The regression analysis results for hypothesis 2 and hypothesis 3 displays that the use of VAR will increase the frequency of the penalty kicks, but it will reduce the times of the free kicks which out of the penalty area.

Because of the important role of the team's coach, the hypothesis 4 and 5 focussed on the tactical arrangement and the former position of the coaches during their playing time. Because it's hard to know all the tactics and formations of the coach in a game, we applied possession percentage, the most important data of reference tactical play to indicate our results. And the results is the same as our hypothesis 4-5: the higher the possession rate will cause more fouls; the more forward position a coach plays as a former player, the fewer fouls his team commits.

In the hypothesis 6, we considered that the difference of team's continents has an impact on the number of fouls a team commits. The different continents contains different cultures, different races and different location. And in our results, the European teams will have more fouls than other continents' teams.

Generally, however, this paper also contains some obvious limitation. It contains variables for several major assumptions. But there are some variables that are not taken into account, which still need more accurately and deeper researches to prove all of the character and underlying factors of FIFA World Cup in the future research.

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