

Article

# Development of the Effect of Video Assistant Referee Application on Football Parameters

Hakan Buyukcelebi <sup>1</sup>, Serkan Duz <sup>1</sup>, Mahmut Acak <sup>2</sup>, Umur Nalbant <sup>3</sup>, Karel Svatora <sup>4</sup>, Tomasz Gabrys <sup>4</sup>  
and Raci Karayigit <sup>5,\*</sup>

<sup>1</sup> Department of Coaching Education, Faculty of Sport Sciences, İnönü University, Malatya 44000, Turkey; hakan.buyukcelebi@inonu.edu.tr (H.B.); serkan.duz@inonu.edu.tr (S.D.)

<sup>2</sup> Department of Coaching Education, Faculty of Sport Sciences, Çanakkale Onsekiz Mart University, Çanakkale 17100, Turkey; m.acak@hotmail.com

<sup>3</sup> Department of Exercise and Sport Sciences, Faculty of Health Sciences, Eastern Mediterranean University, North Cyprus 99628, Turkey; umut.nalbant@emu.edu.tr

<sup>4</sup> Sport Centrum Faculty of Pedagogy, University of West Bohemia, 301 00 Pilsen, Czech Republic; svatorak@icolud.com (K.S.); tomaszek1960@o2.pl (T.G.)

<sup>5</sup> Department of Coaching Education, Faculty of Sport Sciences, Ankara University, Ankara 06830, Turkey

\* Correspondence: rkarayigit@ankara.edu.tr; Tel.: +90-312-600-0100

**Abstract:** The Video Assistant Referee (VAR) application is a technological development that gives referees the chance to review their critical decisions. The current study aimed to determine the effect of the VAR system in international football organizations on the game over the years. The sample of the study consists of 115 football matches, specifically 64 matches played in the 2018 FIFA World Cup and 51 matches played in the 2020 European Football Championship. In the competitions handled, the number of goals, the number of yellow cards, the number of red cards, the first half time, the second half time, the total match time, the number of penalties and the number of offsides were examined. The Mann–Whitney U test was used to compare two independent groups. As a result, in the 2020 European Football Championship, there was a decrease in the second half time ( $p = 0.01$ ) and total match time ( $p = 0.01$ ), and a significant increase in the number of offsides ( $p = 0.03$ ) compared to the 2018 FIFA World Cup. On the other hand, there was no significant difference between the two tournaments in the variables of number of goals, number of yellow cards, number of red cards, half time and penalty shootout ( $p > 0.05$ ). In light of the data obtained, it can be said that the effect of the VAR system on the spirit of the game will decrease as the share of the VAR system in the pauses during the competition decreases over the years. The data revealed in the study may be a clue to explaining why the effect of the VAR system on game dynamics and game spirit has decreased over the years. Therefore, the concerns of football stakeholders about the effects of the system on the game may gradually decrease with the arrangements made for VAR.

**Keywords:** football; match analysis; referee; performance analysis; soccer; video assistant referee



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## 1. Introduction

The change and development of football over the years has been possible with formation changes, the differentiation of physical and tactical variables in the game, the innovations made and the measures taken for these innovations. Researchers, on the other hand, have tried to determine the internal and external factors that affect the success of teams [1–3]. While the teams have the obligation to obey the rules of the game, the referees have a supervisory role on the field. Decisions of referees that are open to interpretation can be affected by noise, pressure from fans, the importance of the match and the quality of the team [4]. Due to the decisions that can affect the result, the role of the referees in the game is quite high, and it is a remarkable situation [5]. Ultimately, referees often make critical decisions that determine the fate of the game and breaking points.

Over the years, various technological resources have been adapted to the game to minimize the influence of the referees on the outcome of the competition [6,7]. Since the introduction of yellow and red cards in the 1970 FIFA World Cup, the Video Assistant Referee (VAR) application has been one of the most remarkable developments in terms of refereeing [8]. Over the years, football's pace has accelerated and the number of actions in the game has increased significantly [9]. Since the acceleration of the game brings with it an increase in the number of movements of the players, the viewpoints of the referees may be blocked by the players from time to time [10]. With the Video Assistant Referee application, the referee has a chance to correct mistakes in critical decisions that may affect the outcome of the match that the referees overlooked.

The increase in pauses during the game due to the excess of warnings made by the VAR is a situation that can affect the physical (changes in the number of high-intensity running and sprints) and psychological (loss of concentration) requirements of the players. In this context, detecting the change in the effect of the use of VAR in the first tournament where the VAR application was used and in the following tournaments can make it easier to comment on the development of the application. In the years after the VAR application was accepted in football, some arrangements were made to clarify its effect on game time and the rules of the application. Although there are studies in the literature to examine the effect of the application on the competition before and after VAR, there is no study that reveals the development of the application over the years. Petty [11] investigated the effect of VAR implementation on home advantage in Italian Serie A and USA Major League. According to the findings of the study, it was determined that a decision was changed in every 3.29 matches played in the Serie A League due to the VAR system. In addition, a significant decrease was determined in the penalty win rates of the home teams after VAR was introduced in both leagues. Lago-Peñas et al. [12] examined the effect of VAR use on in-game variables in Italian Serie A and German Bundesliga leagues. They determined that there was a difference in the variables of goals, fouls and yellow cards before and after VAR in the Italian Serie A League. In the German Bundesliga, they found a significant difference in the first half time, total time, the number of offsides and yellow cards. When the differences in the VAR application between the two leagues are examined, it has been revealed that there are differences between the leagues in the total time, number of goals, red cards and yellow cards. Errekagorri et al. [13], on the other hand, found that there was no significant change in technical and tactical performances with the VAR application in their study on the competitions in the Spanish La Liga.

This study is very important in order to better understand the level of familiarization of referees and football stakeholders with the VAR application and the improvements in the elements that were discussed before the application. This study aimed to determine the differences in the effect of the VAR application in the two tournaments on the game by evaluating the 2018 FIFA World Cup and the 2020 European Football Championship. The hypothesis of the study is that, as the referees get used to the application of the VAR system, there would be a decrease in yellow and red cards, a decrease in the first half, second half and total game time, a decrease in the number of penalties and an increase in the number of offsides in the 2020 European Football Championship, which is the second major tournament where the system was applied.

## 2. Materials and Methods

### 2.1. Participants

The sample group included in the study consists of 115 football matches (64 matches—2018 FIFA World Cup, 51 matches—2020 European Football Championship). The data from the competitions that went to overtime or penalties after the group stage were also included in the sample group.

## 2.2. Data Collection

Considering the studies investigating the effect of VAR application on the results of the competition and the variables in the game [12–15], the number of goals in two tournaments, number of yellow cards, number of red cards, first half time, second half time, total match time, number of penalties and number of offsides were analyzed.

Data on in-game variables was taken from the website “Whoscored” ([www.whoscored.com](http://www.whoscored.com) (accessed on 12 February 2022)). The interoperator reliability of the observation system (OPTA Client System) used by the company to obtain in-game variables is at an acceptable level in terms of Kappa (0.92–0.94), ICC (0.88–1.00), *r* and SEM values [16]. Ethics committee approval of the study was obtained from the local university (3388-2022).

## 2.3. Statistical Analysis

All statistical analysis was performed using IBM SPSS statistics (version 22.0; IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as mean  $\pm$  SD. Normality analyzes of the variables were performed with Kolmogorov–Smirnov. Equality of variances were performed with Levene’s tests. All variables for Kolmogorov–Smirnov test showed non-normal distribution ( $p < 0.05$ ). The Mann–Whitney U test was used to compare two independent groups, and the statistical significance level was accepted as  $p < 0.05$ . Eta squared statistic was used to estimate the effect size (ES) ( $\eta^2 = Z^2 / (N - 1)$ ) with three ranges of interpretation: small = 0.010; medium = 0.060; and large = 0.140 [17].

## 3. Results

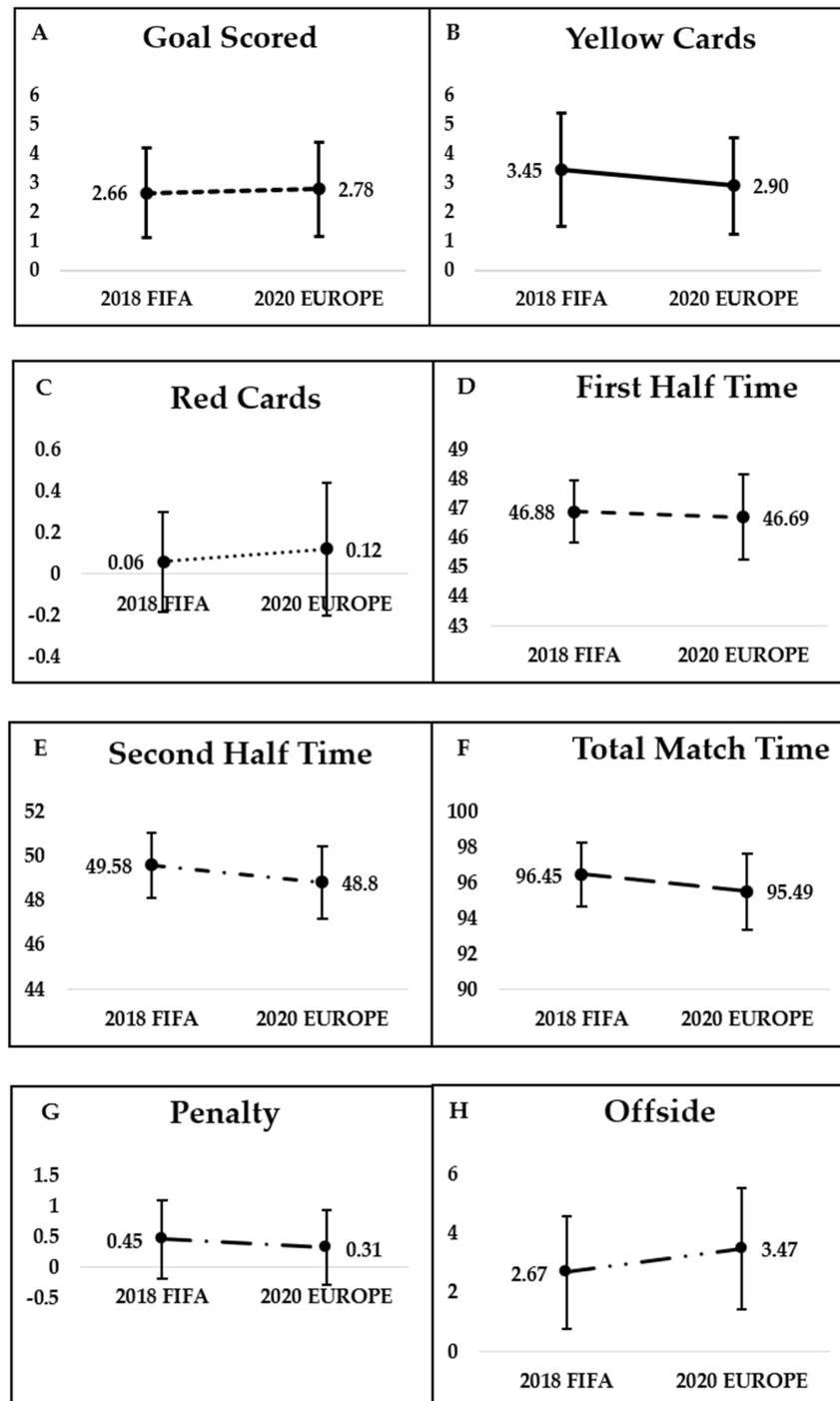
Descriptive statistics and comparison of all variables examined between the 2018 FIFA World Cup (FIFA WC), where the VAR system was used for the first time, and the 2020 European Football Championship (EFC), where it was used for the second time, are given in Table 1.

**Table 1.** Mann–Whitney U test results of the VAR application in 2018 FIFA World Cup and 2020 European Football Championship.

Variable	Tournament	N	Mean Rank	Sum of Ranks	U	z	p	$\eta^2$
Goal Scored	2018 FIFA WC	64	56.39	3609.00	1529.00	−0.59	0.552	0.003
	2020 EFC	51	60.02	3061.00				
Yellow Cards	2018 FIFA WC	64	61.75	3952.00	1392.00	−1.37	0.170	0.016
	2020 EFC	51	53.29	2718.00				
Red Cards	2018 FIFA WC	64	56.59	3622.00	1542.00	−1.03	0.299	0.009
	2020 EFC	51	59.76	3048.00				
First Half Time	2018 FIFA WC	64	61.97	3966.00	1378.00	−1.48	0.138	0.019
	2020 EFC	51	53.02	2704.00				
Second Half Time	2018 FIFA WC	64	64.95	4157.00	1187.00	−2.56	0.010 *	0.057
	2020 EFC	51	49.27	2513.00				
Total Match Time	2018 FIFA WC	64	65.59	4198.00	1146.00	−2.77	0.005 *	0.067
	2020 EFC	51	48.47	2472.00				
Penalty	2018 FIFA WC	64	61.16	3914.00	1430.00	−1.38	0.165	0.016
	2020 EFC	51	54.04	2756.00				
Offside	2018 FIFA WC	64	52.16	3338.00	1258.00	−2.13	0.033 *	0.040
	2020 EFC	51	65.33	3332.00				

\*  $p < 0.05$ .

A significant difference was found in the second half time, total match time and number of offsides between the first big tournament in which the VAR was used and the second big tournament ( $p < 0.05$ ). As seen in Table 1, there was a decrease in the second half time and total match time of the 2020 European Football Championship. In the second use of the VAR system, it was determined that there was an increase in the number of offsides. There was no significant difference in the number of goals, number of yellow cards, number of red cards, first half time and penalties ( $p > 0.05$ ). Additionally, the variable differences between the two tournaments are shown in Figure 1.



**Figure 1.** Differences of variables with the VAR application in the 2018 FIFA World Cup and the 2020 European Football Championship.

#### 4. Discussion

The aim of the study is to determine the variables of the VAR system that have a direct effect on the match result, and the differences between the FIFA 2018 World Cup, the first tournament in which the system was used, and the 2020 European Football Championship. 2020 European Football Championship is the second largest tournament in which it was used VAR system. According to the main findings of the research, it has been determined that the second half time and total match time in the 2020 European Championship were significantly less compared to the 2018 FIFA World Cup. It was determined that there was a significant increase in the number of offsides in the 2020 European Football Championship. Our hypothesis was that there would be a decrease in the second half time and total match time and an increase in the number of offsides in the second international event where the VAR system was applied; this hypothesis has been confirmed.

One of the biggest criticisms related to the VAR application faced before it was implemented was that the natural flow and spirit of the game would be negatively affected by technology [18,19]. In the current study, the effect of VAR application on game time was found to decrease over time. Another concern with the natural flow of the game is that the increase in pauses in the game may have physiological and psychological negative effects on the referee and players [19,20]. Oliveira et al. [21] analyzed the effects of said technological innovation on technical and physical performance in the 2014 World Cup, where the VAR system was not implemented, and the 2018 World Cup, where the VAR system was implemented for the first time. They reported a decrease in the number of sprints with the VAR application. Although there are no findings on physical performance data in our study, the decrease in game time in the second use of the VAR system can be interpreted as a decrease in physical performance needs.

When the literature is examined, no study has been found on the development of the use of the VAR application over time. However, there are many studies dealing with the effects of technical and physical parameters on the VAR application. There is an increase in the number and duration of pauses in the game [12,13], and an increase in the first half, second half and total match time [21], despite the decrease in the number of fouls. It has been revealed that there is an increase in the number of cards [12]. It has been determined that there is a significant difference in the decision accuracy rate of the referees [6]. However, there are also studies examining the difference between the effects of the VAR application according to leagues. Gürler and Polat [22], in their study in which they analyzed the effect of the VAR system in the Turkish Super League, found that the number of goals per match, the number of yellow cards, the number of red cards, the duration of the match and the duration of the ball in the game increased after the VAR. However, in another study in which in-game variables in the Spanish Football League were analyzed, it was determined that the VAR system did not significantly affect the variables other than offside [17]. Han et al. [9] revealed that after application of the VAR in the Chinese Super League, there was a decrease in the number of offsides and fouls, but a significant increase in the first half, second half and total game time. Based on all this data, it can be said that the effect of the VAR differs according to the organization and league.

The fact that the VAR system was used for the first time at FIFA 2018 World Cup has brought about many speculations. There were those who believed that the application would bring justice, as well as those who believed that the duration of the game, its spirit and the pleasure of possible mistakes would be lost [18,23]. While the VAR application was being implemented, it was very important for all stakeholders to understand the application rules and to get used to them. FIFA holds seminars on a regular basis, taking into account issues that may arise while using the VAR system and the updates that can be made [24]. Updates have been made in the implementation of the VAR system, such as the warning process of the referees, waiting for the position to end unless there is an obvious offside and not warning in the positions open to interpretation, taking into account the decision of the referee [25]. Therefore, the development of the VAR application over the years and its impact on the game were aimed at a minimum level. When the findings

of our study are examined, it is observed that the intervention made by the VAR in the decisions of the referees has decreased. There is a decrease in the second half and overall match time as the game is less frequently stopped by the VAR. The referees, who were more determined in the offside positions, decided without waiting for the VAR warning. Thus, a significant increase was detected in the number of offsides. This data, which can be a clue to explain the development of the effect of the VAR system on game dynamics over the years, can give football stakeholders an idea of their concerns about the system. However, it can be said that referees should understand the effect of the VAR application on the game and the importance of decisions and feedback speed. This should be avoided as prolonged decision-making time can distract players' concentration.

The current study contains some limitations that should be considered when being addressed by future research. These limitations can be explained as the inability to determine the amount and duration of the pause in the game due to external factors, the place where the matches are played, the evaluation of the instant results and the effect of the VAR application according to the quality of the teams. In addition, it would be healthier to compare the data presented with larger sample groups. By considering the tournaments where the VAR system is not applied, the effect of the system on the game can also be evaluated together with the development of the system. The competitions discussed in the present study were played on a neutral ground. Although there are studies stating that the implementation of the VAR system differs according to home advantage [11], the effect of the system on the home and away team can be evaluated by examining the competitions in the local leagues.

## 5. Conclusions

The findings obtained from this study showed the effect of the VAR system on football parameters in two different international tournaments. Although the effect of the VAR system on football is indisputable, the positive aspects of the application seem to have been accepted by the referees and players over the years. Although the criticisms about the prolongation of game time were justified in the 2018 World Cup, it is observed that the regulations made to reduce the effect of the system on the game have yielded results. Future studies may focus on the development of VAR in different leagues and tournaments. In this way, it is possible to have more ideas about the direction of the system, the measures to be taken or the innovations to be made.

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**Data Availability Statement:** Data is available for research purposes upon reasonable request to the corresponding author.

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