

## DIGITALIZATION – TECHNOLOGY IS TRANSFORMING THE BEAUTIFUL FOOTBALL

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**Abstract:** *Football is a sport which demands a high level of technical-tactical training but at the same time a higher level of physical training. Always needs to record and objectify your game strategy, the technology of VAR implementation also helps to know these technical-tactical parameters, physical even in real time. The purpose of this study was to define which elements of the game-penalty, red cards, identifying mistakes; goals are the most important in football and defining the final result and the influence of VAR technology in the objectivity of decisions made by referee. Based on the results of major international competitions, a program for the implementation of technology in the strong world championships was designed and hence the conclusion that this technology must be promoted and implemented in Romania. The results showed that there was a significant difference in performance before and after the implementation of VAR in major competitions. In conclusion, the performance of the technical-tactical, physical and strategic skills of basic football games has improved after all in the world where it has joined the VAR technology.*

**Key words:** *decision-making, goals, penalty decisions, technology in football.*

### 1. Introduction

Following numerous international competitions in which the final score was set after controversial sequences of play or discussions on the interpretation of the rules of the game after which the champion trophy was handed out, the world football community, through its ruling bodies and in the light of technological advances in the aerospace industry, agreed to investigate in 2012-

2014 how video assistance for game referees could be used in football [9], [11], [17], [20], [22].

More recent systems are based on frequency modulated continuous wave (FMCW) technology to track positions. The most common representative of this technology is the GPS system. Players have to carry a transmitting unit while playing, to be detected by the system. A comparison of accuracy of GPS and video-based systems showed an overestimation

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of 4.8% for GPS and 5.8% for video examining distances during games [2]. At present, the LPM system produced by ABATEC has the lowest distinction of just 1.6% underestimation of real and measured distance [21]. It uses FMCW sensors that send a permanent signal to a certain number of receivers around the pitch. A central processing unit collects these data and is able to present it in real time. Although FMCW systems a more accurate and faster in presenting the data, they can just be used in training due to FIFA regulations at this time [2], [6].

FIFA has managed to gather enough data from major world clashes and together with the department for technological innovation in football to develop an experiment for video assistance during games and to make it possible to replay live sequences of play, such that the main referees, the field and reserve referees could analyze the respective play or duels between the players more clearly [7, 8], [10].

It has thus been agreed that a video-assistance experiment, based on a specific draft, would be the best step to know the benefits and the disadvantages of video support.

All the recommendations of the video assistance technology specialists led to the following conclusion: real-time testing would be the best solution and could bring advantages and benefits for football. [10], [13, 14, 15]

The human factor and everything it has generated during the history of football has led to the introduction of some video systems to analyze and control the times, achievements, mistakes, crimes of all kinds, both of the players and of all the others involved in the football game [4].

**Tasks:** The research in this field has begun in different countries such as: Australia, Belgium, Brazil, China, Czech Republic, England, FIFA, France, Germany, Italy, The Netherlands, Poland, Portugal, Qatar, Saudi Arabia, Korea Republic, Turkey and the USA. The results of more than 500 games have reported "live" use of VAR's in professional football matches.

**The stages of the research:** In order to be as clear as possible in expressing the results, the technology discussed and analyzed in the game - VAR - will have to come with corrections on the errors of interpretation of decisions following which the game could be decided by a penalty kick or the elimination of a player. The purpose of the VAR experiment is to correct the refereeing team in interpreting different duels between players and ensure the objectivity of their decisions regarding the moments of the game [15, 16], [18,19], [21].

The aim is not to achieve 100% accuracy for all decisions, nor to interrupt the match frequently. Some factors that led to the decision use the technology [23]:

- The difficult situations in which you have to ask –VAR, are those related to the change of the final result if it was goal/or no, penalty/or no, red cards, various incidents;

- In order not to interrupt the flow of the game the checks take place in real time or while the ball is out of play which adds to the attractiveness of the game;

- The speed of the game, the quality of the players makes the decision making more and more difficult today without VAR;

- Before and during games (from since 2013 in the various competitions to which the VAR system applied) onwards, statistics clearly show that only a decision

in 3 matches is a "clear and obvious error" in the decision categories that can be reviewed;

- Due to subjectivity and unclear human observation, the end game result may be distorted, today to advanced gaming assistance technologies has increased by 6-8% to it has grown to almost the maximum.

- In most of the games tested, VAR had a positive impact the experiment showed that in 30% of games VAR intervened in the key moments of the game at the disputed stages and changed the referees' decisions.

- The time elapsed between the referee's decision and the technology in the audio headset is 30 seconds and the final decision given by VAR can reach up to 80 seconds;

- It was found that the time lost with VAR decision making is not so much as to influence the flow of the game compared to game interruptions caused by injuries, substitutions, free kicks, corner kicks;

- Modern technology has brought us where 1 in 10 mistakes can be fixed, this number of 6-8% is encouraging in decision making given the speed of the game, the perception of the eye or the art of communication [18], [19], [21], [3].

This would be the new technology VAR's "game flow-increased objectivity".

## **2. Materials and Methods**

### **2.1. Participants**

The study included a sample of professional footballers from the professional football championships. All participants were informed about the details of the study. The criteria for inclusion in the study were: age between 18-32 years. The selection was made only

in the men's football camps. The sample included 1600 footballers, 22, with a mean age  $X \pm SD 26.74 \pm 1.94$  years; average height  $X \pm SD 184.39 \pm 5.60$  cm; average weight  $X \pm SD 74.30 \pm 5.56$  kg.

### **2.2. Procedure**

The first video-assisted games took place in the United States to test the new procedures, and then at the Club World Cup in Japan in December 2016, VAR was officially introduced in a competition of this magnitude much later, in the Cup. World Cup 2018-Russia.

The study began in 2013 by FIFA and UEFA in various domestic championships but also at major intercontinental competitions. The analysis of the impact on certain key factors that may influence the final result of a football match began a few years ago when goal scoring or offside were revised from several angles or 2D then 3D but it was not possible to intervene during the game, live (World Cup 2010, South Africa).

### **2.3. Program VAR**

Between the initial and final tests, the independent variable consists of a program provided online that includes exercises to inform the central referee about the different situations created on the field and the development of communication and decision making following the video image on the central monitor of the field. The program included multi-phase replays and 20-second interruptions of play on each half of the game and coordination exercises with the sideline referee who sends beep signals that are received by the central referee's arm. Study participants were monitored

online through video assistive technology; the exercise program was performed during the official games.

Prior to each official game, participant were given description and imaging instructions, including a description of them, the nature of the signal, and the length of the break between game interruptions. The training sessions, as well as the monitoring of the correctness of the assessment of the phase or of the decision taken, took place under the verbal and video guidance of the VAR technology experts.

#### **2.4. Measures**

We have selected the VAR technology because while the game is playing, the phases for which the referee requests the game interruptions can be resumed. Each piece of land is monitored by 24 moving recording cameras. VAR technology not only operates with frame-by-frame recordings of the game but also offers numerous opportunities for game development from a technical-tactical point of view but also for managerial, financial development on the individual ability of the professional football player, forecast on his development from the point of view physically, technically, tactically, strategically. Interference between game leaders (referees) and video and technical support equipment should be kept to a minimum in terms of time and action, all to the benefit of the live audience and viewers who are in greater numbers from one competition to another. This means more financial benefits for those involved in broadcasting live matches but also more information about the efficiency of the players on the different areas of the field [12]. The

central referee on the field has all the power to make a decision even if it has not been announced by the VAR, he can, in any part of the game, request a review of the incident with the slow motion and thus correct the game, the result. In this approach, he can also consult the assistant referee on the field, but he can also ask the video referees to re-analyze the game. The final decision is made by the referee in one of the following situations - penalty, red card, elimination or mistakes of giving the yellow or red card to another player than the one in question.

#### **3. Results of the Research**

This is the place and role of this article, which comes to highlight some of the benefits and the VAR advantage from the last World Football Championship in Russia, 2018 compared to the previous editions and especially the affluence of the audience in the national championships of the countries where VAR system was implemented. What was the general objective of introducing new technology-VAR?

As in the case of each experiment, the objective is having the video assistant referees improve the decision-making regarding the game, the decisions during its play and especially the correctness in making decisions that can lead to the elimination of players, the awarding of the penalty kicks or other incidents that might decide the winning side. As part of the evaluation, the interested international bodies, FIFA, UEFA, IFAB want to extend this knowledge given by the video assistance to all those involved in the football phenomenon (e.g. coaches, financiers, sponsors, referees, spectators, supporters, officials).

Fairness offers millions of viewers and especially viewers the hope that matches are only on the ground.

The analysis of the impact on certain key factors that may influence the final result of a football game began some years ago when scoring the goal or the offside were revised from several angles or 2D then 3D but it wasn't possible to intervene directly (World Cup 2010, South Africa).

World Cup-Brazil 2014 brought "line technology" that could provide the accuracy of offside lines and the passing or not of the goal line, to validate the goal or not, but nothing about the faults in the penalty area or in the other parts of the field, especially when the central referee is facing the ball or the game. Thus, time and technology worked for the correctness of a football game and it was possible to intervene in not influencing the final result (VAR was and is used in other sports disciplines)

The beginning of the change started in 2016, when, in a series of conferences and events on the topic of video assistance, a series of interested international bodies were invited, as well as representatives of professional leagues from various countries. Thus, the USA, Germany, Australia, and the Netherlands have shown their readiness to implement and cooperate to adopt measures and protocols for the new technology and to also specialize some referees in the matter. The first video-referee assisted games took place in the USA in order to test the new procedures, and then at the Club World Cup in Japan, in December 2016, VAR was officially introduced to a competition of this magnitude [22-27].

A number of 'trial' matches were held in the USA in summer 2016 to test and refine the protocols and procedures. These were

following by further offline and online practical testing and in December 2016 the FIFA Club World Cup in Japan served as a key trial before The International Board authorized 'live' tests in 2017.

By the end of 2017 other country began to adhere to this system, not all simple and not cheap, had been joined by: Belgium, France, Italy, Spain, Turkey.

Even though there were some changes, the initial protocol where the central referee was warned of the various incidents, especially around the penalty area (where they intervened with the new technology of slow-motion replays) was maintained. All this required a staff properly trained and equipped, in a video operation room, to help make the right decision. With the help of the new technology, the game is analyzed and the video assistant referees check each incident - red cards / penalties / eliminations - and where there is a mistake or an oversight of the central referee on the field, the game is interrupted and the respective incident is analyzed by him.

If the VAR believes that the referee has made a 'clear and obvious error' or there has been a 'serious missed incident' the VAR informs the referee who will then decide whether or not the incident should be reviewed using replay footage. The referee can also initiate a review without any initial VAR input.

If the referee decides to have a review the referee's final decision may be based solely on information from the VAR (VAR only' review) or it may also involve the referee going to the side of the field to look at the replay(s) (on-field review). The referee will make a final decision and the original decision will only change if it was clearly wrong.

Information from the VAR can only be used by the referee if there is a 'clear and obvious error' or 'serious missed incident' in one of the following categories:

- Goal /no goal
- Penalty/no penalty
- Direct red-card
- Mistaken identity -the referee gives a yellow card or red card to the wrong player of the offending team.

These four directions are the main topic of this article and come to emphasize that they are the ones that can influence the final result, this is why, and analyzing the four criteria in the last three World

Championships can lead us to important decisions that other National Football Championships along with our country will have to adopt. Is it necessary to bring VAR into the intern championship, can it influence the spectacular character of a football game, its drama, the final result? Here are some questions to which not only football leaders have to respond and at the same time find solutions for the implementation of new technologies. These new technologies are directed to four directions of action during the game exemplified in table no.1.

Table 1

*Decision directions imposed by new technology that can influence the end result*

Categories tracked in the experiment	World Cup 2018 Rusia	World Cup 2014 Brazil	World Cup 2010 South Africa
Goal	171/3	169/2,3	145/2,2
Penalty	8	13	15
Red cards	4	10	17
Mistaken identity	3	8	12

Figure 1 brings more information to the main topic of discussion; the figures indicate an increase in game greatness when more goals are scored. The World

Championship in Russia (2018) shows an average of about 3 goals per game, which attracted many millions of active viewers during the World Championship.

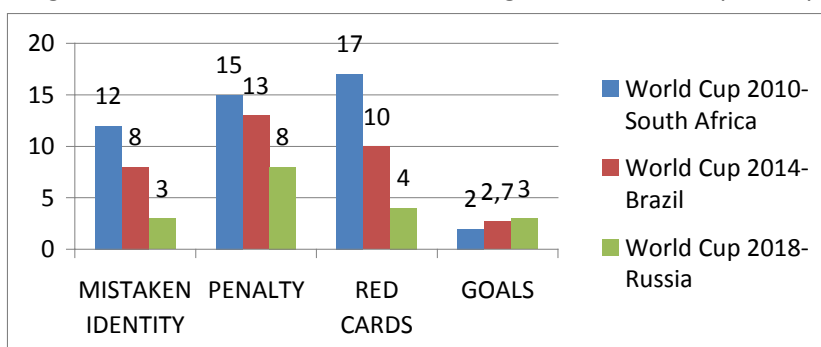


Fig. 1. *The significance of the decisions at the last World Championships*

The differences that appeared, especially in red cards and different mistakes that may occur during a game, are brilliant. There is a difference of 15

penalty kicks in 2010 to just 8 penalty kicks throughout a World Championship in 2018, which leads to say that imprudence in the penalty area was reduced and

brought new techniques of ball dispossession or even controlled attack on the opponent if we think of the defense phase.

For those who want to score goals, place the ball in or near the penalty area, the way of deflection in open angles from the opponents have become "weapons" in the methodical and strategic training for such a Final Tournament. But these will become the subject of another material. So not only the spectacularism, the affluence of viewers or everything that depends on fair play or fairness are influenced by VAR which, of course, attracts both the financial resources, but also the technical part of training of the players and the team in the different phases of the game are influenced by new technologies [16].

For example, to prepare a team for a match against an upcoming other team, one coach needs to analyze or predict the strength of one's team in context of the other team. To this end, the analyst needs ways to define the context in which to do the analysis, for example, on the offensive of defensive sides. Interactive visualization is a key technology to provide adaptive analysis systems [15-16].

So, if at first the surveillance system of the game was based on Hawk-eye (a single camera), since 2016 the introduction of a high-performance system with 14 cameras that cover the entire field becomes more and more efficient and the entire football industry begins to use this system. This approach meant an experience of new attempts in the next two years and, at the 2018 World Cup in Russia, it was a real success and all that followed afterwards was a win for the competition, the fans and football in general. The VAR system takes into

account the 4 categories of mistakes and can validate them - goal or no goal, penalty or no penalty, checking the place where an incident occurred or if it occurred, double checking a red card and the identity of the player who committed the foul, yellow/red cards [28-29].

The communication between the video assistant referees and the central referee on the field can be done through a wireless radio headset such that the information is processed in a few seconds.

There are four types of calls that can be reviewed: goals, penalty decisions, red card decisions, and mistaken identity in awarding a card. The video assistant referee reviews video replays of the event, and where there is a clear error can relay that information to the central referee via wireless radio to a headset worn by the referee.

Video Assistant Referee (VAR) is used for decisions during the matches and, even if it provokes certain reactions and discussions, it proves to be useful in major competitions. Moreover, its data can be used by IT specialists in video analysis of different plays, or in presentations about the tactical analysis for teams and players, maybe students. The game is taught and played step by step, especially regarding the individual positioning of the ball, but also from a group point of view. We can say that today digitalization is no longer a novelty in football. On the contrary, it is a serious argument for turning the game towards achieving the best human results.

#### **4. Conclusion/Discussion**

The major competitions or rather the show around the field, the organizational forces involved today around football have made every movement around it very well analyzed. Video assistance is

useful in all segments, from buying tickets to access to the stadium, but more useful is the digitization that is done with the help of instant video technologies which capture the player and the team in their various forms of tactical placement at different times of the game. All this data transmitted through the internet can achieve a better personalization of the competition.

Professional team managers can offer customized and individualized training solutions depending on the data collected, distance travelled, pace, deficient areas, positioning at different times of the game, individually and as a team. There is something very interesting that a few years ago was only possible by appealing to conviction, namely the awareness of what players do with the help of images and videos in which the live protagonist is the player himself. Football can mean, from tomorrow, a game without mistakes. Could it be possible? With no human interpretation?

Technology has no limits and one day the beauty of football may be overshadowed by the celebration of a goal only after VAR approves. But was it better when the stadium saw the ball past the goal line and only the referee of the game, right? We believe that the few data we report in this article, especially those related to the direct inflow of the final result, the goal, validated or not, the kick penalty area, the red card, so the elimination leads every day to increase the number of spectators on the stadiums England, Germany, Belgium, the Netherlands and another countries.

This makes us believe that the football game will bring even more sponsorship contracts to the goal and marker industry, the spectacular football game. A football

digitized just for the sake of the figures or “because of what the data says” and not the spectators and the mark of the goal would not make sense.

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