

The contribution of modern information systems and technology to sports

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Abstract:

This study deals with the contribution of information systems and modern technology to the world of sport. It aims to clarify and demonstrate the links between technological systems and tools to sport, to highlight the importance they have gained in achieving the desired sporting objectives and to highlight the most important modern technological instruments and programmes used in the field of sports, whether they help to manage teams, clubs, tournaments, sports events or those for sports training.

were addressed in this study, current trends in sports information systems and technology in the first axis. and the most important devices and technologies used in sports training in the second axis

Keywords: Information systems, technology, smart devices, sports performance analysis, modern sports training

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1. INTRODUCTION

In today's world, technological advancement is progressing at an astonishing pace. Information systems have permeated all aspects of society, whether in healthcare, education, or sports. They have brought about radical changes and smart devices have become ubiquitous in modern life. One crucial area impacted by these technological advancements is the realm of sports.

Wearable devices, big data analytics, social media, and sensor technology have revolutionized how sports are practiced, analyzed, and improved. Professional athletes now have access to insightful performance data, enabling them to enhance training methods and elevate their skills. Coaches, too, can explore innovative approaches to reach higher levels of performance and break records.

Information systems provide coaches with easy access to a wealth of athlete-specific data, including skill levels, kinesthetic performance, tactical and strategic execution, and even physical fitness. This wealth of information has led to performance enhancements, skill acquisition, and the motivation to strive for victory, where success often hinges on mere centimeters or fractions of a second.

Moreover, technology has reshaped virtual competition. Virtual reality (VR) technology allows athletes to interact in a simulated environment as they would in the real world. With full control over external conditions, coaches can prevent injuries and study decision-making processes, giving them a competitive edge. The fusion of technology and sports has not only transformed the game but also redefined how athletes and coaches approach their craft.

2. Questions:

- What are the current trends in sports information systems and technology?
- What are the most important devices and technologies used in sports training?

3. Study Objective:

This study aims to address questions related to the intersection of sports and technology. It seeks to clarify and demonstrate the connections between



information systems, technological tools, and sports. Additionally, it highlights the importance these systems and tools have gained in achieving desired sports goals.

4. Significance of the Study:

The significance of this study lies in its ability to showcase trends in information systems within the sports domain. It elucidates for coaches, athletes, and even researchers the devices and technological tools specific to sports. These tools facilitate time and effort savings in reaching set objectives, while also streamlining training processes based on scientific principles.

5. Current Trends in Sports Information Systems and Technology:

5.1. Historical Overview:

The term “sports informatics” first appeared in the Austrian city of Graz during the International Association for Sports Information (IASI) in 1975. (Daniel Link, Martin Lames, 2015) Initially, the term referred solely to “sports information.” It was first proposed by Jürgen Perl alongside Methling. Later, Perl established the Institute of Sports Informatics at the University of Mainz in 1985, where he led a team dedicated to this field. In 1989, he organized the first workshop on this topic with his team in Hochheim, Germany. (Jürgen Perl, 2006)

In 1995, the German Association of Sports Science created a dedicated section for sports informatics. It included 900 sports scientists working in research and education. The main achievement of this association was the establishment of the International Association of Computer Science in Sport (IACSS) in 2002. With international collaboration in research and education, Jürgen Perl became its first president. (Nita Bandyopadhyay, Babita Biswas, 2020) International conferences have been held every two years across various countries and continents. The twelfth International Conference on Computer Science in Sport took place in July 2019 in Moscow, Russia, focusing on “Advancements in Artificial Intelligence and Computing in Sports.” Topics included modeling and simulation, sports data acquisition systems, image and video processing, sports data analytics, visualization, visual analysis, robotics, and virtual reality. (Martin Lames et al, 2019)

5.2. Analysis of Current Trends in Sports Information Systems and Technology:



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After approximately twenty years since its inception, the tools and applications dedicated to sports have become diverse and abundant. From team management software to video games, from performance analysis systems to measurement tools, and even programs to determine whether a ball has crossed the goal line. It is essential to differentiate among these various types of applications to track their developments and classify them according to their functions. The diagram below illustrates these different categories.

5.2.1. Management Applications:

Management applications cover various aspects. They can be related to managing a sports club with all its teams or specific to a particular sports team. They can also be used for organizing sports events or even training sessions. For clubs or teams, managers and coaches increasingly use information technology tools to manage members, players, and event calendars. As for training management, various tools have emerged for both individual sports (such as running) and team sports (like football). For sports events and occasions, computer tools and technological applications have become essential for effective and efficient organization.

- **Sports Club and Team Management Applications:**

These applications allow the management of all information and data related to a sports club. This includes managing members, contributions, expenses, dates, and even different field schedules, with the ability to book them online. Consequently, these functions facilitate proper organization for various sports entities. However, team management differs from club management, even though they can be integrated in some cases. Team management applications allow updating all relevant team information, such as adding details like jersey numbers, health status, social status, absences, and test results. Access to this information is easy from a computer or smartphone, regardless of location. (source: Sporteasy)

- **Sports Events Management Apps:**

It has become almost impossible to manage sports events without information systems and computing devices. It is no longer reasonable to manage a race with nearly 35,000 runners without a technological solution that meets their needs. Managing a sports event without strict statistics and an abundance of data to provide real-time information to fans about their favorite teams or athletes during broadcasts has also become unrealistic. Additionally, according to the organizing committee members of the Tour Du Canton race, there are fewer volunteers available for



organizing committees, which further emphasizes the importance of information systems and computing devices for information technology. Today, these tools must compensate for the manual work previously performed by these volunteers.

- **Training Management Applications:**

Training management applications can be divided into two categories: those specific to individual sports such as running, swimming, and cycling, and those specific to team sports like football and basketball. For the first category, these applications resemble real sports coaches more than simple apps. They allow for highly specific training plans and also monitor training loads using various statistics. These information systems have become crucial for all individual sports, as athletes need to continuously improve based on the numbers provided by these applications. As for team sports, training management applications primarily target physical fitness and achieving the necessary strength, speed, and endurance for those sports

5.2.2. Video Games:

- **Video Game Applications Without Physical Activity:**

Video games represent an important part of computer applications or tools related to sports, whether in terms of the number of products sold or the volume of sales. Sports activities have taken an important place in the virtual world. The esports market in France is estimated at 50 million euros according to a CEPHEID Consulting study (2021), which highlights the significant position that the video game industry occupies in the world of sports.

- **Video Game Applications with Physical Activity:**

There are also games that require simulation devices that allow you to perform a real simulation of some sports, such as racing on actual tracks like skiing or Formula One. These simulators can be used by professional athletes themselves “as a training session or as a reminder of the tracks,” as mentioned by Romain Grosjean, the French-Swiss Formula 1 driver, in a report from jeuxvidéo.com. (Romain Grosjean, 2012) Video games are also sources of improvement. Campbell and others found that they improve cognitive abilities such as memory, attention to the visual field, and cognitive control, all of which are associated with activation of the frontal lobe. They added that this improvement could last up to four months after training. (Campbell et al, 2018) Computer science and new technologies have made it possible to create a system from a passing machine aimed at giving you the first touch of the ball. This system, called “Footbonaut,” consists of placing a player in



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a 14-meter square room where red light marks indicate where the ball comes from and the green color where it should be placed. That is, the player receives the ball from different angles and at different speeds and must send it into the illuminated green target. In parallel with the athlete's activity, information and graphs are recorded to know the player's performance (the number of balls that reached the correct target, the number of lost balls, and the wrong balls...) (BUNDESLIGA. 2017. Meet the Footbonaut, the futuristic pass-master currently firing Borussia Dortmund and Hoffenheim).

5.2.3. Virtual Sessions and Video Analysis Applications:

The development of high-speed digital cameras and video processing has sparked interest in the sports field. Many studies have been conducted on sports video analytics (Wang, Parameswaran, 2003). Examples include multi-camera recording and replay (Rui, Gupta, Acero, 2000), ball tracking (Pingali, Jean, Carlbom, 1998), video analysis and summarization (Ekin, Tekalp, Mehrotra, 2003), and many studies for various applications of virtual sessions and video analysis.

One of the main goals of sports video analysis is to assist the coach. The need to analyze playing methods and player performance to reach the required level has increased. Coaches resort to classifying the sequence of play and tactical patterns and recognizing the unknown patterns of the opponent's play. Examples include tactics of many sports such as football (Assfalg et al, 2002). Virtual sessions, augmented reality, or VR technology is an advanced technology that provides users with hearing, touch, vision, etc. When introduced to the world of sports, it offers a simulation of the sports system and attempts to make it a comprehensive and integrated experimental system. Modern system simulation theories and methods are used in combination with sports practice. It allows for the reproduction of the teaching experience of physical education teachers, various coach training, and training and organizational programs and plans. This enables the explanation, analysis, prediction, organization, and evaluation of an athlete's performance. (C.Xianming, 2021)

Augmented Reality: It is a mix of virtual reality and real reality. An athlete can see the real world through special glasses. (Rebenitsch, Owen, 2016)

6. The Most Important Devices and Technologies Used in Sports Training:

6.1. Smart Device Classifications:



The International Electrotechnical Commission divides smart devices into the following types: near-body electronics, on-body electronics, internal electronics, and electronic textiles. (Global Electronics Council, 2021) Tesla, on the other hand, divides them into 14 categories: smartwatches, fitness trackers, hearables, smart clothing, smart shoes, smart glasses, smart jewelry, wearable cameras, body sensors, tracking devices, head-mounted displays (smart helmets), exosuits, gesture control devices, and wearable devices. (D.Mikhalchuk, 2017)

As for those related to sports, Smart Sport company has divided them into 4 branches: digital assistance systems, motion tracking and analysis systems, data analysis tools, sports equipment, and innovative technologies. (S.Stöger et al, 2019)

6.2. Smart Devices and Sports Information Systems:

6.2.1. Smart Devices:

Glasses:

Cognitive skills (anticipation and decision-making) are essential in sports and can be examined using eye tracking through the use of virtual reality (VR) and augmented reality (AR) to analyze the anticipatory signals that athletes respond to. (Ida, 2015) This program provides realistic, safe, and standardized educational environments and offers maneuvers that are not possible in reality. VR devices and eye tracking can also be paired by using VR glasses with devices that include eye tracking to analyze decision-making in sports games. (Farrow, Raab, 2018)

Virtual and augmented reality provide a realistic tool for visualization and interaction in a specific sporting manner. Coaches can use it for tactical training, and athletes can interact with virtual opponents or teammates and learn new movements in safe conditions because it does not provide real collisions. (Craig, 2013) Eye tracking devices are also commonly used for analysis to discover areas of interest and measure attention. (Kredel, Vater, Klostermann, Hossner, 2017).

Tracking Devices:

Fitness tracking devices are increasingly popular; they are small in size, inexpensive, and provide quick access to data, greatly aiding in training improvement by tracking the information they display. In addition to displaying distance, speed, and calories, they also show heart rate, allowing one to maintain a consistent running speed, accurately determine the distance to be covered, or even specify the necessary heartbeats for the exercise, enabling us to determine the training load and avoid overtraining. (Mueller, Winter, Rosenbaum, 2010)



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Smart Watches:

Smart watches provide athletes who spend a lot of time training with all the information they need on their wrist, replacing smartphones in sports environments but with more functions. They contain acceleration sensors to measure all accelerations and calculate the number of steps, and even at night, they can detect the amount of movement and its intensity, giving a result for sleep quality. Heart rate is also monitored by an optical sensor that looks for the alternating volume of the arteries, and they contain GPS units that work with satellites to measure the time differences between several satellites and give the precise location, which is useful in tracking the distances covered, and also provide data on energy consumption, in addition to many other features. (Vermaat et al, 2017)

Ear Devices:

In the era of wireless communication, some devices that are placed directly in the ears have emerged, the most common being music headphones. However, new systems are now capable of measuring some interesting data, such as temperature, which can be measured by some small thermistors. There are also those that allow for electrocardiography where some graphene-coated sensors are used, (Celik et al, 2017) as the pulse rate is a reliable factor in showing the athlete's training condition and gives a good hint about programming the next session. (Cole et al, 1999) Moreover, measuring heart rates is more accurate with ear-based devices compared to wrist-based sound devices.

Smartphones:

Smartphones have become tools integrated into people's daily routines and are even used in physical activities and sports training, where applications in this field have begun to provide many information systems that offer a large amount of data that help in sports analysis (time, distance, speed, intensity, number of repetitions...). They provide the possibility of using the smartphone's GPS sensor, and they can also link the smartphone with many sports technologies and use it as a dashboard, such as connecting it with heart rate monitoring devices, smart bands and shoes, or with a smart ball, for example.

6.2.2. Wearable Devices:

Wearable smart technology can be incorporated into clothing, such as shirts, pants, socks, and smart shoes. In addition to military, medical, and health applications, this technology can also be used in sports applications. Wearable clothing is mostly



multi-layered systems, consisting of an inner layer (in contact with the skin) and an outer layer, with electronic circuits. (Kumar, Vigneswaran, 2016)

Many vital signs such as electrocardiography, heart rate, electromyography, respiratory rate, skin temperature, and humidity can be monitored by integrated sensors and the data is transmitted to a smartphone app during exercise or rest periods (Heartin, 2018)

Smart shoes are often used in sports biomechanics to analyze the interaction between the foot and the ground and the distribution of the body's center of mass. This data can be taken to analyze posture and balance, which are fundamental requirements for good sports performance. By using these systems, performance can be improved, injuries prevented, and investigations into gait design, posture, and balance can be conducted, as well as detecting lower limb problems. (Razak, Zayegh, Begg, Wahab, 2012)

6.2.3. Non-Wearable Devices:

A- Assistance Systems:

Assistance systems for play are used in most current sports competitions, where they are applied frequently to minimize referee errors. An example is the “Hawk-eye” system, which relies on visual images and timing data provided by several high-speed video cameras located at different positions, (Li & Shi, 2014). The ball tracking system, as well as the Goal-line Technology (GLT), which is based on electrical and magnetic fields that form a network inside the goal area in addition to placing a negative electronic circuit in the ball, causes variations in the magnetic field whenever the ball crosses behind the goal line. These changes can be measured by this system and used to accurately determine the ball's position, and once the system detects that the ball is behind the goal line, the referee receives a wireless signal on the watch attached to his wrist. (Ahmadi & Niloufar, 2014)

B- Biofeedback Sensors:

These are sensors that are attached to the athlete's skin, providing all the data related to body metrics. The most important information they provide includes: the degree of muscle activity, body temperature and sweating rate, respiratory rate, heart rate, recovery rate, and blood flow. (Dupee, Forneris, Werthner, 2016)

6.2.4. Motion Tracking and Analysis Systems:

A- Motion Analysis Applications and Software:



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There are many programs for motion tracking and kinematic analysis, ranging from expensive commercial software (Simi Motion, Dartfish, utilius, TEMPLO) to cheaper or free programs. These programs allow for the input of video clips and display them frame by frame at different speeds, comparing each frame to the ideal performance using tools such as angle measurement, distance, acceleration, force, trajectory...

B- Applications with Sensors:

In the early stages of sports science, it was only possible to collect these parameters in the laboratory using stationary equipment. However, now, due to technological advancements, it is possible to use athlete monitoring tools in the field because of small and lightweight sensors. This allows the athlete to participate naturally in their sport and also share important data with the team coach or researchers. (James, Petrone, 2016)

An example is the Golfsense sensor: a small sensor unit that is attached to the back of a golf glove. It transmits data such as hand speed, position, swing rhythm, and ball trajectory via Bluetooth to a mobile device, which can then be analyzed by an application. (McGrath, Scanail, 2014)

C- GPS Technology:

The Global Positioning System is a technology originally invented in the 1970s for military use. This system uses more than 30 satellites to provide precise tracking. Each satellite is equipped with an atomic clock that continuously transmits information about the exact time. A GPS receiver compares the signal and timestamp of multiple satellites and calculates the distance the signal has traveled. By calculating the distance to at least four satellites, it can determine the precise location. In sports, there are dedicated devices that have the ability to provide a comprehensive analysis of a player's tactical position through various data they offer, such as heat maps, running distances, top speed, total distance covered, number of accelerations, and many other metrics that enable you to improve play and performance.

The International Federation of Association Football (FIFA) has amended its rules to allow the use of GPS technology in competitive play, creating the opportunity to estimate many metrics during the match (FIFA, 2021).

7. General conclusion:



This study presented the trends of information systems in the sports field, where we observed that it has become impossible to do without them in some directions, the most prominent of which is the management of sports events. As for the direction of sports training, several classifications have emerged, which have provided new and advanced features that were not available with traditional sports equipment. We have noticed a tremendous development in smart devices and sports performance analysis systems, which have been introduced to artificial intelligence and have become characterized by an automatic motion detection system, such as the tactics and strategies used in play and measuring team organization. Virtual reality technology has also entered sports training, giving a strong boost, and it has become possible to embody realistic, safe, and standardized training environments and provide maneuvers that are not possible in reality.

CONCLUSION:

Computer science is a well-established field of research and development, and provides many links to sports science, as it tries every time to provide the latest technology, to address the problems of coaches and athletes, provide optimal solutions and facilitate the training process. With the tremendous progress, it has become difficult to become familiar with all the available devices and technology, which has led to the emergence of... Several fields, the most prominent of which are those used in sports management and those used in sports training and performance analysis, and even in the latter, several divisions of these tools and technology have emerged, such as wearable devices, sensors, and analytical tools, which forced athletes to use them to reach the desired level, where the importance of using analytics became clear. Data from these devices is used to produce information that will improve the performance of athletes, teams and clubs.

The use of technology and information systems has become necessary today for professionalism, breaking records, and organizing sporting programs and events. It has created many competitive advantages in the sports field and has had a major impact on all areas of sports.

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