



## **TeamUp Project**

*Project 101090417*

*ERASMUS-SPORT-2022-SCP*

## **Work Package 2**

# **Research on the digital training tools in European Football and Basketball(F&B) grassroots clubs**

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## 1. Description - theme, scope, methodology

### About Team Up project

Team Up general objective is to promote education in and through sports more specifically to promote the quality of coaching in grassroots football and basketball (F&B) by setting up a cross-curricular and trans-European network of sports and educational stakeholders to realise a challenging innovative project. The project partners will develop, test, evaluate and disseminate a sustainable European F&B model for increasing the sports organisations capacity in terms of coaches' education and training. Team Up envisages to elaborate for the first time in Europe sports federation - based grassroots coaching educational program based on a new Methodology (concepts overlap or inter sports concept according to which it is recommended to use the techniques from one sport to train the athletes in another sport) aimed at innovative training of the youth in football and basketball. The new methodology will be based on [top-trending scientific methods and strategies focused on the development of physical capacities determinants](#) in athletes, their [good](#) performance and [healthy](#) behaviour. For the methodology, elaboration will be used an athlete-centered approach which is a coaching philosophy underpinned by a set of values and coaching behaviours, where the primary goal of the coach is to help their athletes take responsibility of their sporting behaviours that create their results. Such programs exist in F&B reinforced by the World and European F&B organisations, but they aim at qualifying professional coaches or leaders of grassroots sports initiatives. Team Up will attract experts from the sports, education, science, health, and business sector in preparing the first European football and basketball merged interplay model consisting of one new training methodology and state - of - art [inter-sport](#) coaches' educational modules which will completely change the traditional methods of grassroots F&B training in Project participating countries (PPC) and beyond them after the project end. The greatest challenge at Team Up is the elaboration of inter-sports playing methodology which only recently appeared in scientific sports literature and some professional sports clubs started to apply in youth training. The new Methodology will be focused on the young athletes' overall sports development, raising their knowledge and interest in sports as well as their physical activity level. The inter-sport concept is suitable for this project as the younger sports generations need the development of basic sports and motor culture needed in every kind of sport. Through applying an innovative approach, the project will educate coaches in the most contemporary methods of how to train young sports people from two sports with one methodology and program.

Team Up targets sports F&B coaches, young athletes 9-13 years of age, PE school teachers and young students, as well as sports project-participating sports federations and clubs along with schools. All target groups will include min.50% of women to support the EU Gender equality policies. The project also targets grassroots sports F&B organisations outside of the federations, sports and education stakeholders and communities' administrations – all of them related to the organisation and practice of grassroots F&B.





The successful project implementation will increase the sports federations and clubs' education and training capacity, their collaboration with primary schools, communities and state sports and education authorities, as well as will directly enforce the coaches and athletes with sports-related knowledge and skills, digital and social competences and better development in life. Hence, Team Up follows a holistic approach to cover two main themes in Sports and Education Key Topics in the priority area Protect integrity and values in the sport of the [EU Work Plan for Sport \(2021-2024\)](#) related to sports as a framework of personal development, and Skills and qualifications in sport. By raising the coaches' sports and digital culture as well as scientific knowledge and personal skills Team up indirectly will promote the Dual Careers concept, as stated in the [EU Guidelines on Dual Careers](#): i) ensuring players' engagement in the educational system and ii) fostering their employability potential. Moreover, the project is in synergy with the [EU Guidelines regarding the minimum requirements in skills and competences for coaches](#) (February 2020) recommending blended learning and professional (e.g. the sport, sport science, coaching theory) and soft skills as most important for coaches development.

Specific project objectives are:

1. To study, share and disseminate at the European level the best grassroots sports federation and club practices in using contemporary and effective digital training and sports education tools aimed at increase of the coaches' capacities, and athletes' interest and performance in the F&B sport ;
2. To study and evaluate the existing grassroots football and basketball (F&B) methods for designing and monitoring training programs in the project participating countries (PPC);
3. To elaborate, pilot, monitor and evaluate the Team Up coaches' program (based on the new methodology and hybrid digital tool) for the training of youth basketball and football athletes (9-13 years old) among 90 coaches (min.50% women) and 480 athletes, (min 50% women) from 30 EU sports clubs;
4. To draw conclusions from the pilot actions and draft a Policy Recommendation Report, transferable to any football and basketball or other interested sports club (Transferability Plan);
5. To increase the grassroots football and basketball coaches' competences through producing digital workshops and modules in performance analysis in basketball and football, intending to share and mainstream the potentials and contributions of the current top-trending analytical methods to their daily work as coaches and trainers.
6. To increase the sports, digital, scientific, social and media skills of grassroots athletes in football and basketball through the new F&B training program based on data, science, and media;
7. To draft **EU future blueprint** for grassroots coaching in **basketball** and **football** (EU FB4BF)





## WP 2: RESEARCH, PREPARATION & INTER-PROJECT COACHING FOR ELABORATION OF A METHODOLOGY AND HYBRID DIGITAL TOOL CONTENT

Duration: Jan. 2023 – July 2023 (M1 – M7)

Lead by the Bulgarian Football Union, supported by all partners

### WP Objective:

- 1) to increase awareness in project participating countries in successful grassroots sports club practices in using contemporary and effective digital training and sports education tools aimed at increase of the coaches' capacities, and athletes' interest and performance in the F&B games;
- 2) to raise awareness about existing grassroots football and basketball (F&B) methods for designing and monitoring training programs in the project participating countries (PPC).

### Specific Objectives:

SO1 To study, share and disseminate at the European level the best grassroots sports federation and club practices in using contemporary and effective digital training and sports education tools aimed at increase of the coaches' capacities, and athletes' interest and performance in the F&B sport ;

SO2 To study and evaluate the existing grassroots football and basketball (F&B) methods for designing and monitoring of youth training programs in the project participating countries (PPC).

### Activities:

#### T2.1 Research on digital training tools used in European F&B grassroots clubs as a complimentary coach education

During this activity will be elaborated research to identify existing digital training tools used in European F&B grassroots clubs as a complimentary coach education. The focus will be to review methods and strategies for integrating digital tools in F&B grassroots clubs training, to study the best grassroots sports club practices in using of contemporary and effective digital training and sports education tools aimed at increase of the coaches' capacities, and youth athletes' interest and performance in the F&B games, to analyse the target groups needs and to identify European funded project from the past 5 years related to similar topics. Based on this activity and its SO1 the Team Up experts will elaborate [a framework of criteria for the selection of the most effective digital training resources](#) for [team sports](#), with special attention on F&B (football and basketball) which will be provided to the sports organisations, F&B and team sports federations in PPC and in Europe. The pre-project study showed that there is a lack of such digital tools except for a few F&B grassroots clubs that started using some digital tools due to social isolation and COVID-19 restrictions. Each project partner (Bulgarian Football Union and Bulgarian Basketball Federation

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from Bulgaria) will carry on a qualitative survey, including meetings with stakeholders and expert interviews, to identify the existing digital tools. This will support the analysis of how to produce better digital tools guidelines for F&B training for the target age groups – 9 – 11 and 12 – 13 years old. The research will include as well a detailed analysis of coaches' and athletes' training needs. During the research, an online questionnaire about the use of digital tools and the main target groups' needs in training will be elaborated on and sent through the PPC network to F&B grassroots club coaches and managers.

The country project coordinators will make research on the existing European-funded projects in the past 5 years aiming to increase coaches' competences and improve athletes' training through the use of digital tools. Each country project coordinator will prepare a conclusion minutes and present it at the national seminars for dissemination of the research results. The coordinators will be responsible to invite the coordinators of the European projects with similar topics to take an online part in inter-project coaching activity during the second transnational meeting in July 2023 in Bulgaria to share their experience. The research from the current activity will be ready in April 2023 (M4).

#### T2.2 Study on the existing grassroots football and basketball (F&B) methods for designing and monitoring youth training programs

During this activity, the experts will intensify cross-curricular efforts to study and evaluate the existing grassroots football and basketball (F&B) methods for designing and monitoring of training programs and inter-play sport concepts in the project participating countries (PPC). Interviews with F&B grassroots clubs representatives will be organized and will be focused on the best training practices for PPC coaches, trainers and athletes. The study will curate and gather the best and most up-to-date academic knowledge published in training sciences in F&B grassroots. The study will be ready by the middle of May 2023 (M5).

#### T2.3 Review the top-trending scientific methods and strategies focused on the development of physical capacities determinants to performance in grassroots football and basketball

During this activity the experts will elaborate a review of the top-trending scientific methods and strategies focused on **the development of physical capacities determinants** to performance in grassroots football and basketball. As described in the needs analysis the development and monitoring of the athletes' physical capacities are an important part of the planning and organisation of training sessions in grassroots youth F&B. According to the pre-research of the PPC there is a lack of **such scientific backgrounded approach** in the existing grassroots coaches' practices and methodological programs and there is a weak collaboration between grassroots F&B and scientific and educational sector in training methodological matters. The activity will be finished by June 2023 (M6).

#### T2.4 Integrated report on the research, study, and review –Team Up Report

During this activity the research (T2.1), the study (T2.2.) and the review (T2.3) will be integrated in one document named Team Up Report. The document will be ready in June 2023 (M6).





## T2.5 National seminars for dissemination of research & surveys results

This activity includes the organization of 4 national seminars (1 in Bulgaria, 2 in Italy, and 1 in Austria ) by the country project coordinators at which managers and coaches from local F&B grassroots clubs will be invited and acquainted with the results of Team Up report activities as described above. The national seminars will be one day and will be held in the beginning of July 2023 with an approximate number of 120 participants /30 per country and there will be 4 national seminars conclusion minutes.

## T2.6 Second transnational meeting in Bulgaria

During the second transnational meeting in Bulgaria in the end of July 2023 will be discussed the results of the study, research and review. Two representatives from each partner /10 participants in total/ will take part in the meeting. The provisional program includes a discussion on the summaries of each national seminar and the conclusion minutes of the research of European-funded projects with a similar topic. During the transnational meeting, it will be organized Inter-project coaching activity that will allow Team Up project teams to meet online with other project consortium members working on a similar topic and exchange ideas, and share experiences, and good practices. Thus the inter-project coaching activity will increase the cooperation and collaboration between Erasmus + projects which contributes to the overall improvement of the quality of work and outcomes.

### Deliverables:

D2.1 1 Integrated Team-Up Report

D.2.2 Second transnational meeting in Bulgaria

## 2. Literature review

### 2.1. Coach education description and main philosophies

Coach education as a term lacks definitional clarity and can mean different things, to different people, within different cultural contexts. For example, the term coach education is often used interchangeably or in conjunction with phrases such as coach learning, coach development, coach training, and continuing professional development (Lyle & Cushion, 2017; Piggott, 2015). However, key distinctions can be made to provide some consensus. Coach learning emphasizes the individual and encapsulates how coaches learn idiosyncratically through engaging with various situations, encounters, and activities, such as practical coaching experiences or discussions with colleagues (Lyle





& Cushion, 2017). In contrast, coach education can be considered a subcategory of coach learning (Piggott, 2015), forming one of the many situations, encounters, and activities, which contribute to coach learning. Therefore, coach education as a 'loose' synonym generally refers to learning which occurs within formalized and mediated settings where the primary purpose is learning (Cushion & Nelson, 2013; Piggott, 2015), with typical examples including National Governing Bodies - NGB-delivered certified courses or higher education degree programs.

Much recent coaching research has centred on coach burnout (Raedeke, Lunney & Venables, 2002; Price & Weiss, 2000; Kelley, Eklund & Ritter-Taylor, 1999), why coaches leave their sport (Wahl, Bechtel & Cannella, 2005; Cunningham, Sagas & Ashley, 2001) and various technical and tactical issues particular to specific sports (McNab, 2006; Parker, 2006; Denniston, 2006). Interest and investment in talent identification programmes has grown globally over recent years (Gabbett, Georgieff, Anderson, Cotton, Savovic & Nicholson, 2006; Monsma & Malina, 2005; Helsen, van Winckel & Williams, 2005). The early identification of sporting talent and subsequent development of that talent will not be effective if equal research and investment is not made in the identification, recruitment and development of talented coaches to guide the process.

Effective coaching is complex and multifaceted and occurs within a chaotic, unpredictable, and often uncontrollable environment; that is, it is characterised by an incongruity between intended performance goals and actual results (Jones & Wallace, 2005).

### 2.1.1. Coaching methodologies/ methods in football

Coaches have obligations to help players flourish through football and contribute to both professional and personal development. These developmental outcomes are contingent upon the quality of the coaching experience. Effective football coaches should strive to be lifelong learners to provide football players with quality sporting experiences. In a recent international study, Mallett and Lara-Bercial examined the personality, practices, and development of 17 of the world's most successful coaches, known as Serial Winning Coaches (SWC; Lara-Bercial & Mallett, 2016; Mallett & Coulter, 2016; Mallett & Lara-Bercial, 2016; Lara-Bercial & Mallett, 2016). In the recruitment of these participants, coaches who were consistently successful over many years in winning professional league titles or Olympic gold medals (collectively more than 140 medals/titles) were targeted. *These coaches were* reported as seeing the 'big picture'; they were optimistic, diligent, emotionally stable, and marginally more extroverted performers, who were visionaries and strategic in delivering on those clearly articulated visions. They were also able to create a strong social identity (Haslam, Reicher, & Platow, 2011) for their team by developing confidence in each other and a sense of 'we' through empathy and collaboration; in other words, they were able to harness the relational power of players and support personnel. The athletes reported that, in comparison to other coaches, these coaches were highly competent in the soft skills (i.e. inter-personal skills such as empathy and intra-personal skills such as self-awareness). An overarching principle that fuelled the actions of these highly successful coaches was the concept of driven benevolence (Lara-Bercial & Mallett, 2016). The SWC were highly driven to pursue excellence, which was underpinned by a coherent and grounded personal philosophy. Central





to this philosophy was an 'enduring and balanced desire to considerably support oneself and others' (Lara-Bercial & Mallett, 2016, p. 12). Indeed, in addition to consistently showing benevolence towards athletes and support staff, a unique finding was the compassion coaches felt towards themselves, which buffered them from the stressors associated with high performance coaching. Consequently, they created a functional and adaptive work environment that was consistently high performing and innovative. Based on a review of literature, Côté and Gilbert (2009) proposed the following integrative definition of coaching effectiveness: 'The consistent application of integrated professional, interpersonal, and intrapersonal knowledge to improve athletes' competence, confidence, connection, and character in specific coaching contexts' (p. 316). According to Côté and Gilbert, any definition of coaching effectiveness should include three essential and foundational components:

- Athletes' outcomes (e.g., competence, confidence, connection, and character; impact of coaching);
- Coach's knowledge (e.g., integrated professional, interpersonal, and intrapersonal; coach as learner);
- Coaching contexts (e.g., participation, performance; what is coaches' work).

First, effective coaches should support their players' competence, confidence, connection, and character (4Cs) as key development outcomes. These four Cs are based on the positive youth development (PYD) movement (Larson, 2000) and the work of Lerner and colleagues (2005). Fraser-Thomas and Côté (2009) applied Lerner et al.'s framework to sport. Specifically, Fraser-Thomas and Côté proposed that the focus of sport programmes should be on explicit outcomes that seek to develop positive assets, enhance performance, and foster continued participation in youth sport to thrive through life's experiences. Hamilton, Hamilton, and Pittman (2004) reported the importance of fostering people's strengths to promote adaptive development in youth: [it] enables individuals to lead a healthy, satisfying, and productive life as youth, and later as adults, because they gain the competence to earn a living, to engage in civic activities, to nurture others, and to participate in social relations and cultural activities.

To foster the development of these outcomes (competence, confidence, connectedness, character) from participation in football requires coaches to possess sufficient knowledge. Côté and Gilbert (2009) suggest that coaches' knowledge should be based in three key areas, namely, professional, inter-personal, and intra-personal. Professional or sport specific knowledge includes knowing the sport (rules, technical, tactical, equipment) and sport science (e.g., development, medicine, recovery). Inter-personal knowledge is important to foster quality player relationships with other actors in the sporting context as well as a knowledge and understanding of sport pedagogy. Intrapersonal knowledge relates to a coach's philosophy, leadership, and importantly ongoing learning and reflection.





The study Effective coaching in football<sup>1</sup> (Nash, C & Mallett, C 2019) describes what is effective coaching in football. Effective coaching behaviours are those that result in not only successful team and individual performances but also other positive players' outcomes. These differentiations are important as the effects could impact on the short- and long-term performance of both coach and athlete and may also determine the quality of the ensuing coach-athlete-performance relationship, central to effective coaching. If football coaches are committed to becoming effective, then the following questions may provide some useful information that coaches can take and apply to their own particular circumstances mentioned earlier, i.e., athletes' outcomes, coach's knowledge, and coaching contexts.

Within football there are a number of roles that could essentially involve the same, or similar job. What is the difference between a football manager and a football coach? In some cases, they are very similar but in others they could be markedly different. There are similar semantic and practical differences between assistant coaches, assistant managers, age-group coaches, junior coaches, and player coaches. Some of these positions require a certain level of coach qualification and accreditation; however, in some instances few formal requirements are necessary. This adds to the complexity of the football coaching role and in turn the definition of an effective football coach.

### 2.1.2. Coaching methodologies/ methods in basketball

Basketball coaching serves as a crucial catalyst in developing players' skills, building cohesive teams, and achieving success in the sport. Coaches play a multifaceted role, encompassing leadership, mentorship, strategic planning, and motivation. Their primary objective is to guide players towards reaching their full potential while fostering a competitive team environment.

The core essence of basketball coaching lies in player development. Coaches meticulously assess individual strengths and weaknesses, designing personalized training programs to enhance technical skills, physical fitness, tactical understanding, and mental resilience. Through hands-on instruction, constructive feedback, and purposeful practice, coaches shape players' shooting techniques, passing accuracy, dribbling finesse, defensive prowess, and other foundational basketball skills.

Strategic thinking and game management form another integral component of coaching. Coaches analyze opponents' strengths and weaknesses, formulate offensive and defensive strategies, and make in-game adjustments to exploit advantages or counter adversaries' tactics.

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<sup>1</sup> Nash, C & Mallett, C 2019, Effective coaching in football. in Football Psychology: From Theory to Practice.1st edn, Routledge, pp. 101-116. <https://doi.org/10.4324/9781315268248-9>





They impart knowledge of plays, set pieces, and offensive/defensive systems to optimize team performance. Coaches blend the X's and O's with effective communication, motivating players to execute strategies seamlessly on the court.

The heart of successful coaching lies in team building and dynamics. Coaches foster a positive team culture, where players embrace unity, trust, and effective communication. They create an environment where players uplift one another, value collective goals, and recognize the significance of teamwork. Coaches nurture leadership skills, foster respect for each team member's contributions, and instill commitment and accountability within the team. By defining team values, setting expectations, and enforcing discipline, coaches cultivate a cohesive and resilient unit.

Motivation and mental conditioning play a vital role in basketball coaching. Coaches inspire players to give their best effort, overcome obstacles, and continuously improve. They provide guidance, encouragement, and constructive feedback to help players develop confidence, resilience, and a growth mindset. Coaches instill discipline, focus, and mental toughness, preparing players to navigate pressure situations and perform at their peak. By nurturing the psychological aspect of the game, coaches empower players to overcome challenges and maximize their potential.

In the heat of competition, coaches must exhibit strong game management skills. They make critical decisions during games, including player substitutions, timeouts, and adjustments to the game plan. Coaches analyze game situations, read the flow of the game, and make strategic choices to optimize team performance. They communicate with players on the sidelines, providing instructions, feedback, and motivation to maintain focus and engagement.

Ultimately, the main idea behind basketball coaching is to create an environment that cultivates player development, teamwork, and a genuine passion for the sport. By employing effective coaching methodologies and methods, coaches aim to maximize individual player potential, optimize team performance, and achieve success both on and off the basketball court. Through their leadership, expertise, and mentorship, coaches shape the future of the game by fostering a love for basketball and equipping players with the skills and values to excel.

After establishing the main idea behind basketball coaching, it is essential to delve into the specific methodologies employed by coaches to achieve their goals. Here are some prominent coaching methodologies in basketball:

- **Traditional Coaching:** Traditional coaching methodologies in basketball have long been the foundation of many coaching approaches. Coaches utilizing this methodology typically emphasize the importance of developing fundamental skills, implementing structured plays, and adopting a hierarchical coaching style. While this approach provides





a sense of discipline and structure, some studies suggest that it may limit players' creativity and decision-making on the court (Côté, Baker, & Abernethy, 2003). For example, researchers have found that rigid coaching styles may hinder players' ability to adapt to dynamic game situations, resulting in reduced on-court awareness and versatility.

- **Player-Centered Coaching:** Over the years, player-centered coaching has gained traction in the basketball coaching realm. This methodology places a strong emphasis on the individual player's growth and development. Coaches employing this approach empower players by involving them in decision-making processes, fostering their creativity, and tailoring game plans to align with their unique strengths and abilities. Research has shown that player-centered coaching leads to increased player satisfaction, motivation, and skill development (Cushion, Ford, & Williams, 2012). By focusing on the holistic development of players, including their technical, tactical, physical, and psychological aspects, this coaching style fosters a sense of ownership and empowerment among players.
- **Game-Based Coaching:** Game-based coaching is an approach that immerses players in practice scenarios that closely mimic real game situations. Coaches utilizing this methodology create training environments where players engage in small-sided games, drills, and scrimmages that replicate specific game scenarios. By doing so, players are exposed to decision-making challenges, spatial awareness considerations, and teamwork dynamics. This methodology has been found to be effective in enhancing players' learning and facilitating the transfer of skills from practice to actual game situations (Memmert, 2015). It allows players to develop a deeper understanding of the game through experiential learning and promotes the development of game intelligence.
- **Positive Coaching:** Positive coaching is centered around creating a supportive and encouraging environment for players. Coaches employing this methodology prioritize building player confidence, fostering a love for the game, and promoting a growth mindset. Research suggests that positive coaching significantly impacts player enjoyment, motivation, and overall well-being (Hodge & Lonsdale, 2011). By providing constructive feedback, recognizing effort, and promoting a positive team culture, coaches can enhance players' self-esteem, intrinsic motivation, and commitment to the sport. This coaching style also contributes to better athlete-coach relationships and increased player retention, as players feel valued, supported, and motivated to perform at their best (Mageau & Vallerand, 2003).
- **Progressive Coaching:** Progressive coaching involves breaking down complex skills into smaller, more manageable components and gradually building upon them. Coaches adopting this methodology recognize the importance of establishing a strong foundation before progressing to more advanced techniques and strategies. This approach aligns with the idea proposed by Fitts and Posner (1967) that skill acquisition progresses through distinct stages, from the initial cognitive understanding to the autonomous execution. By systematically developing players' skills and knowledge base, coaches can ensure a solid progression and enhance players' overall performance and development over time.
- **Analytical Coaching:** Analytical coaching leverages data analysis and advanced scouting techniques to inform decision-making in game strategy and player development. With the







advent of technology and advanced analytics in basketball, coaches have access to vast amounts of data that can provide valuable insights into player performance, team tendencies, and opponent analysis. This methodology enables coaches to make data-driven decisions and optimize game plans based on statistical evidence. By leveraging analytics, coaches can gain a competitive edge and maximize their team's potential by making informed adjustments to game strategies, player rotations, and training methods (Lamas, Pardos, & Salmerón, 2021).

It is important to note that these coaching methodologies are not mutually exclusive, and coaches often incorporate elements from multiple approaches based on their coaching philosophy, the needs of their team, and the dynamics of the game. An effective coach understands the importance of adaptability, tailoring coaching methods to the unique characteristics of their players, team, and competitive context. By employing a comprehensive and flexible coaching approach, coaches can optimize player development and team performance in basketball.

### 2.1.3. Academic theories that support the development and monitoring of physical determinants

- Football

Here are several academic theories that support the development and monitoring of physical determinants in Austrian football. Here are a few examples:

[Long-Term Athlete Development \(LTAD\)](#): LTAD is an academic theory that emphasizes the importance of a long-term, holistic approach to athlete development. This theory suggests that physical development should be focused on during certain age ranges, and that there should be a balance between training and competition at each stage of development.

[Dynamic Systems Theory](#): Dynamic Systems Theory is an academic theory that emphasizes the importance of the interaction between the environment, the individual, and the task in determining movement patterns and physical performance. This theory suggests that coaches should create environments that encourage players to explore and experiment with movement patterns to develop physical determinants.

Periodization: [Periodization is an academic theory that emphasizes the importance of planning and organizing training programs to maximize physical performance.](#) This theory suggests that coaches should design training programs that are divided into specific periods, each with a different focus on physical determinants, such as strength, endurance, and speed.

[Ecological Dynamics](#): Ecological Dynamics is an academic theory that emphasizes the importance of creating an environment that is representative of the game to develop physical determinants. This







theory suggests that coaches should design training programs that are based on game-like situations to improve players' physical performance on the field.

These academic theories support the development and monitoring of physical determinants in Austrian football by emphasizing the importance of a long-term approach to athlete development, creating environments that encourage experimentation and exploration of movement patterns, and designing training programs that are tailored to each player's needs and focused on specific physical determinants.

- Basketball

There are several academic theories that support the development and monitoring of physical determinants in basketball in Austria. Here are a few examples:

[Long-Term Athlete Development \(LTAD\)](#): LTAD is an academic theory that emphasizes the importance of a long-term, holistic approach to athlete development. This theory suggests that physical development should be focused on during certain age ranges, and that there should be a balance between training and competition at each stage of development.

[Motor Learning Theory](#): Motor Learning Theory is an academic theory that emphasizes the importance of the learning process for developing motor skills, such as those required in basketball. This theory suggests that coaches should use a variety of teaching methods, such as feedback and practice variability, to help players learn and develop physical determinants.

Periodization: [Periodization is an academic theory that emphasizes the importance of planning and organizing training programs to maximize physical performance](#). This theory suggests that coaches should design training programs that are divided into specific periods, each with a different focus on physical determinants, such as strength, endurance, and speed.

[Ecological Dynamics](#): Ecological Dynamics is an academic theory that emphasizes the importance of creating an environment that is representative of the game to develop physical determinants. This theory suggests that coaches should design training programs that are based on game-like situations to improve players' physical performance on the court.

Overall, these academic theories support the development and monitoring of physical determinants in basketball in Austria by emphasizing the importance of a long-term approach to athlete development, using effective teaching methods to help players learn and develop physical determinants, designing training programs that are tailored to each player's needs and focused on specific physical determinants, and creating game-like training environments to improve players' physical performance on the court.

## 2.2. Digital technologies in European football and basketball coaching practices - general description





Sport, as with most areas of life, has been greatly influenced by the advancement of technology. It is increasingly difficult to imagine sports and sports science without considering the use of technology. Due to the ever-increasing level of performance obtained at major competitions, the coach's work has become increasingly complex and specialized, seeking to transform training for high performance into a more modern and beautiful process. The knowledge and use of specialized equipment and the latest technologies are necessary for those who are involved in the sports phenomenon to be correctly informed so that they can make rational choices regarding the type and use of sports technologies<sup>2</sup>.

It was only a matter of time before some of the world's largest, most profitable, and universally beloved sports in the world such as football and basketball to utilize modern technology for increased efficiency. Football and basketball sports organizers are continuously looking for new ways to improve their game management abilities and coaching education in line with the rapid technological development in sports. However, research to support technology-enhanced learning in coaching is still developing (Stoszowski, Collins, and Olsson 2015). While research (e.g., Stoszowski and Collins 2016) suggests technology is used both as a source of knowledge and as a resource for coaches who "self-medicate" their learning needs, the potential for technology to support and enhance coach learning remains critically underexplored<sup>3</sup>. The document "What Works in coach learning, how, and for Whom? A grounded process of Football coaches' professional learning<sup>4</sup>" (2017) sheds light on recent coaching development. The significance of the work lies in moving on from recycling increasingly diluted general learning theories and building an empirically grounded, substantive coach learning theory, linked to practice, to inform more powerful learning opportunities, improve learning, and enhance coaching.

Digital technologies are increasingly being used in European football and basketball coaching to improve the performance of players and teams and to allow coaches to optimize player performance and improve team results. Some of the key technologies that are being used include:

- **Wearable technology** - such as smartwatches and fitness trackers, is being used to monitor player health and fitness. This technology allows coaches to track players' sleep, heart rate, and other vital signs, and adjust training programs accordingly. Wearable technology such as GPS trackers and heart rate monitors can provide coaches with real-time data on player performance. This information can be used to optimize training and game strategies. GPS tracking devices are used to track the movement of players during games and training sessions. This technology provides coaches with data on players' speed, distance covered,

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<sup>2</sup> Philip Omoregie. The Impact of Technology on Sport Performance. Available online: <https://www.researchgate.net/publication/>

<sup>3</sup> Christopher J. Cushion & Robert C. Townsend (2018): Technology enhanced learning in coaching: a review of literature, Educational Review, DOI: 10.1080/00131911.2018.1457010

<sup>4</sup> Stodter, A., & Cushion, C. J. (2017). What works in coach learning, how, and for whom? A grounded process of football coaches' professional learning. Qualitative research in sport, exercise and health, 9(3), 321-338.





and other performance metrics that can be used to optimize training programs and improve performance.

- **Video analysis** - coaches use video analysis to analyze player performance and identify areas for improvement. This technology allows coaches to review footage of games and training sessions to identify patterns and trends that can inform coaching decisions. Video analysis software allows coaches to record games and practices and analyze the footage to identify areas where players can improve. It can also be used to create highlight reels for individual players. Machine learning and deep learning algorithms are commonly used in video analysis for football and basketball coaching. Machine learning is a subset of artificial intelligence (AI) that involves training algorithms to learn from data and make predictions or decisions based on that learning. Deep learning is a specific type of machine learning that involves training artificial neural networks to recognize patterns in data. In sports, machine learning and deep learning algorithms are used to analyze large amounts of video footage from games and practices, with the goal of identifying patterns and trends in player behavior. For example, a deep learning algorithm might be used to identify specific movements or actions that are associated with successful shots in basketball, or successful passes in football. These algorithms can also be used to track the movement of players and the ball during a game, which can provide coaches with valuable insights on player positioning and tactics. By analyzing large amounts of video data, machine learning and deep learning algorithms can help coaches develop more effective training programs and optimize game strategies. As conclusion machine learning and deep learning are becoming increasingly important tools in video analysis for sports coaching, providing coaches with valuable insights on player performance and helping to improve overall team performance.
- **Virtual reality** – a technology that is used in football and basketball coaching to provide players with a realistic simulation of game scenarios. This allows players to practice their decision-making and tactical skills in a safe and controlled environment. This technology uses VR headsets to create immersive training scenarios that simulate game situations. This can help players develop skills and improve decision-making in a safe, controlled environment.
- **Performance analysis software** - it is used to track and analyze player performance data. This technology allows coaches to identify strengths and weaknesses in individual players and teams and develop training programs to address them. It can help coaches identify areas where players need to improve and create training plans to address those weaknesses. data analytics is a critical part of performance analysis in sports. The performance analysis involves collecting and analyzing data on athlete performance in order to identify areas where athletes can improve and optimize training programs to enhance overall performance. Data analytics refers to the process of using statistical and computational methods to extract insights from large datasets. In sports, data analytics can be used to analyze a wide range of performance data, including athlete biometrics, match statistics, and sensor data from wearables. This information can be used to create visualizations, dashboards, and reports that provide coaches with a deeper understanding of athlete performance and help identify patterns and trends that may not be apparent from traditional performance analysis. Data analytics can also be used to develop predictive





models that can help coaches anticipate and prevent injuries, optimize game tactics, and improve training programs. By analyzing large amounts of data, coaches can gain a more comprehensive understanding of athlete performance and make more informed decisions about how to optimize their training programs. Data analytics plays a critical role in performance analysis in sports, providing coaches and athletes with valuable insights that can help improve overall performance.

- **Communication apps** - Communication apps like Slack, WhatsApp, or TeamSnap help coaches communicate with players, parents, and other coaches. This technology can also be used to schedule practices and games and share important information.
- **Online training platforms** - These platforms offer online training courses and resources that coaches and players can access anytime, anywhere. They can be a valuable resource for developing skills and learning new coaching techniques.
- **Artificial Intelligence (AI)** - Artificial intelligence (AI) is becoming increasingly popular in coaching as a tool for analyzing player performance and providing insights to coaches. AI is a branch of computer science that focuses on creating machines that can perform tasks that typically require human intelligence, such as learning, reasoning, and problem-solving. In coaching, AI is used to analyze large amounts of data from games and practices to identify patterns and trends that may not be immediately apparent to human coaches. For example, AI can analyze video footage of a game and identify the areas where a player needs to improve their positioning, decision-making, or technique. AI can also be used to develop personalized training plans for individual players based on their performance data. This can help coaches create more targeted and effective training programs that address each player's unique strengths and weaknesses. Additionally, AI can be used to simulate game scenarios and analyze the outcomes of different strategies. This can help coaches make more informed decisions about game tactics and improve their overall performance. AI is becoming an increasingly valuable tool for coaches, providing insights that can help them make better decisions and improve player performance.
- **Electronic Performance Tracking Systems (EPTS)** - these are technology-based systems used to monitor and analyze the performance of athletes in training and competition. They typically include a combination of hardware and software components, and may include the following:
  - Wearable devices: EPTS often use wearable devices such as GPS trackers, accelerometers, and heart rate monitors to collect data on athlete performance during training and competition.
  - Video analysis software: This type of software is used to analyze video footage of games and practices, and can provide insights on player movement, positioning, and technique.
  - Performance tracking software: This type of software is used to track performance metrics such as speed, distance covered, and heart rate. It can help coaches identify areas where athletes need to improve and create training plans to address those weaknesses.





- Communication apps: Communication apps like Slack, WhatsApp, or TeamSnap are often used to facilitate communication between coaches, athletes, and support staff.
- Athlete management software: This type of software is used to manage athlete profiles, track injuries, and monitor progress towards training and performance goals.
- Data analytics software: This type of software is used to analyze the data collected by EPTS and provide insights on athlete performance. It can help coaches make informed decisions about training and game tactics.
- EPTS provides coaches and athletes with a wealth of information on performance, which can help them identify areas for improvement, optimize training programs, and improve overall performance.

## 2.3. Wearable technologies in football and basketball

### 2.3.1. Description of wearable technologies in football and basketball

Wearable technologies in football and basketball typically refer to electronic devices or sensors that athletes can wear on their bodies to track various aspects of their performance and health. Wearable athletic devices are already here in all sizes and shapes, and new ones are continuously on the development horizon. Devices are being seamlessly incorporated into the fabric of sports apparel, built into sports equipment like balls and bats, and worn by athletes as small devices attached to the body in a waistband or skin patch. The devices then link by Bluetooth and GPS technology, relaying real-time data to coaches with laptops or other electronic devices for analyzing, recording, and responding to the information.

In Football, the most common wearable technologies include:

- GPS Tracking: GPS devices can be attached to a player's jersey to track their movement and speed on the field during games and practices.
- Heart Rate Monitors: These devices measure an athlete's heart rate during training and games, allowing coaches and trainers to monitor their fitness levels and adjust their training accordingly.
- Smart Watches: Some football players wear smart watches that allow them to track their workouts, monitor their sleep patterns, and receive notifications on the go.
- Impact Sensors: These sensors can be placed inside a player's helmet to measure the force of impacts to the head during games and practices, helping to identify potential concussions.





## Useful references for wearables used in European football coaching education in the Team Up project participating partners' countries

### 1. "Growth opportunities for football clubs in the digital age"<sup>5</sup>

The research paper concludes that in addition to match data, which allows player data to be tracked and analysed in multiple ways, nearly all professional football clubs also use advanced biometrical, kinetics and position measurement technologies to track and enhance their players' performance. Player performance measurements are based on sophisticated, highly integrated sensor technologies, usually based on a combination of different wearable devices which make up a complete technical ecosystem. The main purpose of player performance measurement is to collect data as a basis for empirically based decisions on performance improvement, to optimise training loads and to track players' activity in order to avoid fatigue problems during the league season. Florian Gschwandtner, the CEO of Runtastic, draws particular attention to the fatigue issue: "More and more football clubs are investigating ways of tracking their players' daily activities, sleep cycles, nutrition habits, etc., in order to monitor their physical and psychological states and optimise their overall condition." Sports regulatory restrictions still prohibit the use of player performance measurement technologies during official matches in football, even though they have been widely adopted in other sports, such as rugby.

The section Consumer wearables provide digital measurement for a quantified self concludes that while the digitalisation and analysis of match statistics and the measurement of players' performances are an established business, it is only recently that self-measurement and data analytics have been widely available in the consumer market. Today, an ever-growing number of wristbands, smart watches, smart shoes and wearable smart textiles is tempting consumers to measure every aspect of their everyday life. Following the announcement of the Apple Watch, this relatively young market is expected to gain substantial momentum, opening up the consumer wearables ecosystem to all kinds of new applications and services. We expect the so-called "quantified self" to become an integral part of our everyday life.

### 2. "Hierarchical PVDF-HFP/ZnO composite nanofiber-based highly sensitive piezoelectric sensor for wireless workout monitoring"<sup>6</sup>

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<sup>5</sup> Dellea, D., Schmid, M., & Zahn, F. (2016). Football's Digital Transformation: Growth opportunities for football clubs in the digital age. Retrieved November, 28, 2019.

<sup>6</sup> Li, GY., Li, J., Li, ZJ. et al. Hierarchical PVDF-HFP/ZnO composite nanofiber-based highly sensitive piezoelectric sensor for wireless workout monitoring. *Adv Compos Hybrid Mater* 5, 766–775 (2022). <https://doi.org/10.1007/s42114-021-00331-z>







The research paper states that the high sensitivity of sensors is extremely significant for precisely monitoring imperceptible changes of motion in real time, which cannot be achieved by traditional piezoelectric devices. Herein, a hierarchical polyvinylidene fluoride hexafluoropropylene (PVDF-HFP)/ZnO composite nanofiber piezoelectric sensor with high sensitivity has been prepared through epitaxial growing ZnO nanosheets on the surface of electrospun PVDF-HFP nanofibers. Moreover, this sensor can precisely detect the imperceptible changes in players' motions to avoid injury from overtraining. Additionally, a Bluetooth-low-energy that tracks the player's workout and transmits the output signals wirelessly to a smartphone app is utilized. The study provides a feasible approach for high-precision detecting and safety monitoring in the fields of medical, rehabilitation medicine, and workout security.

### 3. Inertial Sensor-Based Motion Tracking in Football with Movement Intensity Quantification<sup>7</sup>

The document (Published: 29 April 2020) states that inertial sensor-based measurements of lower body kinematics in football players may improve physical load estimates during training sessions and matches. This paper introduces an easy-to-use inertial-based motion analysis system and evaluates its validity using an optoelectronic motion analysis system as a gold standard. The system was validated in 11 football players for six different football-specific movements that were executed at low, medium, and maximal intensity. Across all movements and intensities, the root mean square differences (means  $\pm$  SD) for knee and hip flexion/extension angles were  $5.3^\circ \pm 3.4^\circ$  and  $8.0^\circ \pm 3.5^\circ$ , respectively, illustrating good validity with the gold standard. In addition, mean absolute flexion/extension angular velocities significantly differed between the three-movement intensities. These results show the potential to use the inertial-based motion analysis system in football practice to obtain lower body kinematics and to quantify movement intensity, which both may improve currently used physical load estimates of the players.

Figure 1 of the above- mentioned study



<sup>7</sup>Wilmes, E., de Ruiter, C. J., Bastiaansen, B. J., Zon, J. F. V., Vegter, R. J., Brink, M. S., ... & Savelsbergh, G. J. (2020). Inertial sensor-based motion tracking in football with movement intensity quantification. *Sensors*, 20(9), 2527.







#### 4. Wearable Football (Football) Sensors That Track Shots, Passes And More - Catapult Vector<sup>8</sup>

In the top end of Wearable Trackers/Sensors (eg Catapult Vector), athletes wear a vest with integrated heart rate sensors and the sensor device (that is inserted into the vest) has the typical 3-axis Accelerometer, 3-axis Gyroscope (angular rate sensor), 3-axis Magnetometer and Antennas for the satellites and the local tracking system. So with these sensors, the clubs/coaches can track:

- The athletes' positions on the field and in relation to other athletes
- The distances they have covered
- How fast they are running (speed) and accelerating, turning, jumping
- How often they are sprinting at various speeds
- If they had any impacts/clashes and how often
- The athletes' heart rate in relation to all that is happening throughout a training session or game

Figure 2 Catapult Vector



<sup>8</sup> <https://www.catapultsports.com/solutions/vector#top>





#### 4. The article [“Wearable Football \(Football\) Sensors That Track Shots, Passes, And More”](#) - Sport technology blog

The article states that basically, any movement of the athlete or more specifically, the athlete’s torso, can be tracked by the Wearable Tracker. Then those movement data combined with analytics (backed by sports science research) produce actionable insights that could lead to better athletic performance and reduce potential risks of injuries. But in terms of specific activities and metrics like the number of shots or passes, stride length, kick/strike speeds etc, any movement specific to the leg/feet cannot be properly tracked/identified by those sensors placed on the upper back of the athlete. Although computer vision and pose estimation algorithms have made it possible to track an athlete’s whole-body movements, we do need proper footage of the athlete without any occlusion, and that is quite impossible to achieve on a football field with 22 players. So quite simply, in order to track a player/athlete’s kicks or passes, the most feasible option is to have sensors on the athlete’s leg or feet. The document provides a description of seven specific football sensors used by coaches and players.

The article describes 7 sensors used in football coaching education as described below.

#### Footbar

Founded back in [2014 in France](#), they have developed a wearable sensor ([Meteor](#)) meant to be strapped to a football player’s calf just below the knee. Although they don’t specify which leg to strap the sensor on, logical thinking would have a player place the sensor on their dominant striking leg. So here are the deets:

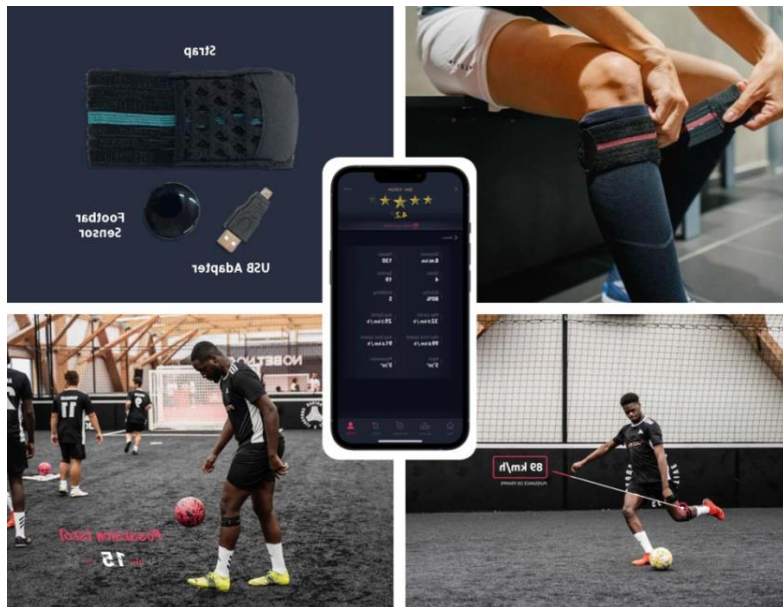
- **Hardware:** 1 x Meteor sensor, Strap, USB Adapter for charging.
- **Connectivity/App:** The Footbar smartphone [app](#) is used to connect to the sensor (via Bluetooth), turn on the sensor, sync the sensor data after each game/session, analyse the data and let the user monitor their progress.
- **Metrics:** The sensor with its smart algorithms identifies the following (Technical and Physical) metrics. In terms of ‘Technical’, there’s the number of shots, speed of the shots (max & average), number of passes, dribbling times, and possession time; then in terms of ‘Physical’, there’s running time, distance covered and sprints statistics.
- **Analytics:** Based on the data, the app is able to identify the user’s playing style, and overall performance, and provide a coach analysis
- **Gamification:** The app allows the user to track their progress over time. On top of that, the user gets their own FIFA style player card with similar attributes, so they can have some friendly competition with their teammates.





- **Team Solution:** For teams/clubs, Footbar provides a web interface to monitor and manage the entire team's performance in terms of technical and physical stats. Teams or clubs who are interested can [reach out to them to find out more](#).
- For accurate tracking of the different activities, the Footbar team states that the strap must be worn just below the knee. That is how they have developed their tracking algorithm. At the time of writing/publishing this, they are predominantly in France and are available at Decathlon stores. They have also partnered with some of their local football clubs/[facilities](#) and event organisers so that players playing at those facilities or events can try out using the sensor. Players everywhere else can simply purchase the sensor directly from their [website](#).

Figure 3 – Footbar



### **Calf Sensor 2: Zepp Play Football**

Zepp was first known for its golf sensor that attaches to a glove and analyses a golfer's swing. Taking the same idea of analysing swings, they took that know-how and applied it to tennis, baseball and softball and had the sensor attach to the bottom of the rackets or bats. Then in 2016, they developed a sensor product to analyse football kicks. Similar to Footbar, they utilise a single sensor unit (with a 3-axis accelerometer and 3-axis gyroscope) and they made a calf sleeve with a pocket to house the sensor. Here are the product specs:

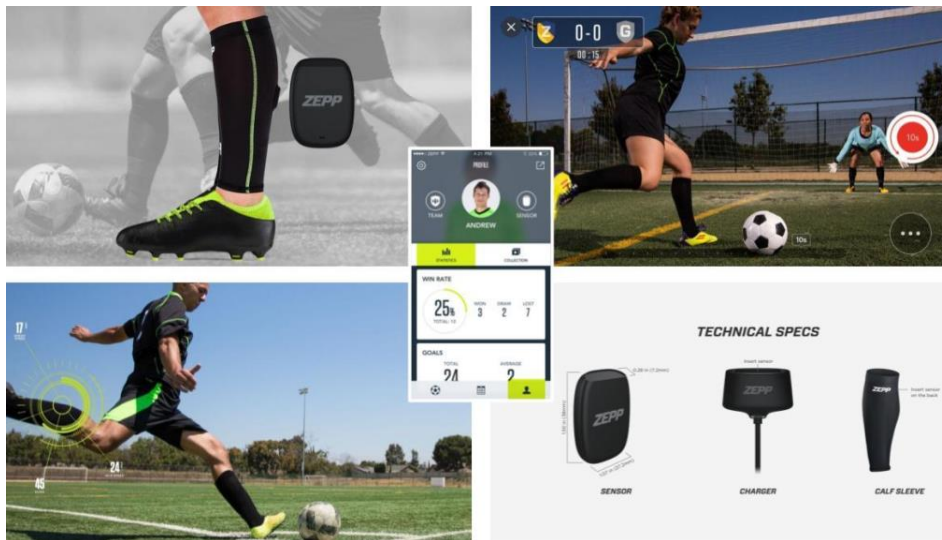
- Hardware: 1 x Zepp sensor, Calf sleeve, Charger.





- Connectivity/App: The Zepp Play Football app connects to the sensor via Bluetooth and users can use the app to sync/manage data from the sensor/s, monitor progress and capture video highlights.
- Metrics: Captured metrics include distance covered, speeds (max), distance at different speeds, number of sprints, number of kicks (on the leg with sensor), kicking speed, and goal conversion rate (requires manual entry of goals) and active time. After each game, the app provides statistics for that session and updates the user's profile with "Personal Best" stats.
- Team feature: For multiple players who have the Zepp sensors, the tracking can be initiated as a team practice or game and have all the data collated. So that at the end of the session, they can see the overall team performance and summary stats.
- Additional Sensor: Users have the option of purchasing another sensor to track the other leg. This can be helpful for training the 'weaker' leg and being able to compare and track the progress.
- Their last update of the app was in 2019.

Figure 4



### Calf Sensor 3: Oliver

Oliver are based in Barcelona, Spain. Starting in 2017, they developed what appears to also be another calf motion sensor with accelerometers and gyroscope, except it also houses a GPS module. So it is basically a GPS tracker but designed to be worn at the calf and is able to track and monitor football

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specific skills. They have developed a user platform (app) for players and there is also one for coaches to manage their players/team and teams can purchase a team version. Here's a look at what's included:

- **Hardware:** For the player – a calf sensor, shin guard covers/sleeves (2 sizes included), charging cable; For the team – number of sensors and sleeves as required, charging case/carrier.
- **Connectivity/Apps:** The sensor can sync and connect with the player/coaches app via Bluetooth (5.0). The player's app allows players to see their own performance and compare with other players on the platform. The coaches' app shows more team metrics and allows the coach to monitor and analyse every player's performance over time.
- **Metrics:** They break down their metrics into 2 categories – Football and Athletics metrics. For 'Football' metrics, they provide the Heat map and interactions with the ball (ball strikes, kick force/power and ball possessions). For 'Athletics' metrics, they consist of activity time, distance travelled, maximum speed, sprints, accelerations and decelerations, jogging and walking distance.
- **Analytics:** Based on the data/metrics collected, the Oliver platform is able to provide the monitoring of loads, external and internal, measuring/calculating the risk of injury and calls to action that prevent injuries up to 45% per season (as claimed on their website).
- **Gamification:** The player's app allows them to compare their performance with other players from all over the world according to type, age and position on the field and challenges them to participate in the constant challenges on the platform.
- **One thing about the Oliver is even though it has got GPS tracking, it is not live.** Sensors collect the data of the players during each session. Then after the session, the app connects to the sensor/s and syncs or downloads the data for analysis. Also, interestingly, the Oliver sensors only capture IMU data (from accelerometers and gyroscopes) at 50Hz while most other sensors do it at 100Hz. Lastly, for coaches who are interested in the team option, there does not seem to be a standard package and interested parties are asked to contact Oliver for more information.

#### Calf Sensor 4: Next11

Next11 is the newest entry in this (Calf sensor) category. Founded in 2018 in Denmark, the Next11 team has developed a sensor that is worn at the player's calf with a calf sleeve (similar to the previous 2). The main difference is the Next11 solution is meant for an entire football team and it not only tracks what each player is doing, but the system also tracks the players' positions, which makes it almost like the GPS team tracking systems. In addition, the Next11 system includes an instrumented







ball that tracks its position on the field and who has the ball, so teams have an accurate picture of ball possession and related stats. Here's a breakdown of what they provide:

Figure 5



- **Hardware:** The system consists of 20 x player sensors in a charging case/station, 20 x calf sleeves, an instrumented ball with a charger, and the Edge (receiver) with a tripod.
- **Connectivity/Apps:** The sensors connect to the Edge (receiver) via a Bluetooth 5.0 Mesh Network and stream motion data and position data/signal in real-time. As this is a team solution, they have developed an iPhone/iPad app for coaches and managers which syncs all the data received by the Edge (receiver) via Bluetooth 5.0, so that they can manage their players. Next11 also developed an app for players to monitor their own performance.
- **Metrics:** Next11 presents the metrics in 3 main categories – Technical, Physical and Tactical. The 'Technical' aspects include the number of (successful & unsuccessful) passes, passing stats (speed, direction, distance, relations/links) and ball possessions. The 'Physical' aspects are simply the number of walks, runs, high-intensity runs, sprints, accelerations and decelerations. Lastly, the 'Tactical' metrics include ball positions, player positions and interceptions. There is a mention of an 'Intensity Indicator' which is summing up the triaxial acceleration values. [It is essentially what Catapult coins as 'Player Load' since they started.]
- **Analytics:** Through the metrics of every player, the system provides a profile of each individual player rating them according to their skills, technique, power, endurance, performance and development progress. It is also able to create a team profile (in the coach's app) by analysing all the data and painting a bigger picture.





- It is also mentioned on their website that they will be launching with the Physical metrics/data only, and the Technical and Tactical metrics will be made available in Q3 of 2022 in addition to that, there is mention of a 4K camera integration in Q4 of 2022. Not quite sure what the camera integration will look like. The position tracking is an interesting one because they are relying on the Bluetooth 5.0 Mesh Network which is quite new and there has not been much reported about its accuracy. Besides the one-time hardware cost, users will be expected to pay a monthly subscription for Cloud access.

### Feet Sensor 1: Jogo

Figure 6



Jogo is a startup based in the Netherlands. Their goal is to have a platform that improves (youth) football player development. They do this by collecting a player's training and performance data on and off the pitch, interpreting that data and identifying areas where individual players can improve or where their strengths are. They also envision the platform to be accessible to scouts, so talented players can be identified should they choose to be. How are the performance data captured? This is by the means of insole sensors and video tracking/analytics. Here's what they aim to provide:

- **Hardware + Connectivity:** 2 x insole sensors (one for each foot), Left and Right insoles that hold the sensors, magnetic charging cord for sensors. The sensors should connect with the Jogo app via Bluetooth. There isn't any mention of real-time data so I presume the data is synced post-session.
- **Sensor Metrics:** As mentioned on their website and their Kickstarter campaign page, the insole sensors will provide the following metrics – Distance (Total, Dribbling, Running, Walking), Time on the ball, Ball touches, Ball received, Shot power, Passes, Leg distribution,







Speed (Average, Sprint), Total sprints, Acceleration & Deceleration, Mechanical work, and Work rate.

- App/Video Analytics: Besides using the sensor, the Jogo app also uses camera tracking on the phone to track a variety of football and fitness workouts. It reminds me of other apps like Dribbleup or BALLN.

Analytics/Coach Use: The analytics part of the app/platform is to take the data collected from the sensors and form a benchmark of the player. Then with subsequent sessions, the players' progress can be tracked and coaches can also use the platform to assign specific exercises, monitor performance and give feedback.

A few things to note about Jogo since they first launched their Kickstarter campaign is, that firstly they have cancelled their Kickstarter campaign for their insole sensors due to some major changes within their company. Secondly (which is likely linked to the previous point), Jogo was acquired by 433 (the largest football social community globally) recently. What is known at this point is that the tech developed by Jogo will become part of 433's platform. It may or may not be in the exact same form but it does appear that 433's goal is to further engage football players (and fans) with tech, and Jogo did say that they intend to continue developing the sensors. So I guess we will see.

### [Feet Sensor 2: Xampion](#)

Figure 7





Xampion is a startup that hails from Finland. They were founded in 2016 by a group called Progda which has experience in developing sensor hardware (IMU) and developing applications to analyse and visualise sensor data. Xampion's feet sensor solution comes in the form of 2 insole sensors (with accompanying insoles) that tracks football motion in both feet. Here are more details of what they offer:

- **Hardware + Connectivity:** 2 x insole sensors (one for each foot), Left and Right insoles (that hold the sensors) designed in cooperation with orthopedical specialists of Respecta of the Ottobock Group, charging cable for sensors. The sensors connect with the Xampion App via Bluetooth. All sensor data captured during a game or training session is synced/downloaded post-session.
- **Sensor Metrics:** The metrics captured by the sensors include – Ball touches on each foot (number of strikes, passes, ball controls and others), Contact points (inside and outside the foot, and the tip of the foot), Speed of ball strikes, Movement data (acceleration, sprint speed, personal tempo, number of sprints, distance travelled) and Intensity levels.
- **Analytics:** Based on the data collected, the app calculates for each session, overall scores in five key Skill Points (Stamina, Movement, Control, Tempo and Activity). It also summarises for each session the count, quality and balance of the ball touchpoints.
- **Coach Platform:** Xampion also developed a web interface (Xampion Coach) for coaches to have a quick overview of all the players' performance, compare sensor metrics in the various categories, set training goals for individual players, manage training plans and schedules, and evaluating training effectiveness.
- **At the time of writing/publishing this,** the sensors can be purchased on their website and they ship to most European countries. They also work with a couple of online retailers outside of Europe including Australia, New Zealand and Japan. Purchasing the insole sensors come with a 12-months subscription for app and sensor firmware updates. After the 12 months, there would be a monthly subscription fee. The Coach web app also requires a subscription.

### [Feet Sensor 3: Playermaker](#)

Playermaker was founded in Israel back in 2016/17. But even before the team at Playermaker developed the football sensor, they actually developed and launched other sensor products for sports. One of them was Motionize for kayaking.

The Motionize sensor tracked paddling motion and gave real-time feedback on the kayaker's technique. Subsequently, they wanted the sensor technology to have a greater impact in sports and so pivoted to football. What resulted was a pair of smart sensors designed to be strapped to the outside of a pair of football boots – one for the left boot and one for the right boot. Let's see what their solution includes:





- **Hardware + Connectivity:** The Playermaker sensor kit (dubbed Uno) consists of 2 sensors (Left and Right), a carrying/charging case, USB-C charging cable, and 2 silicone straps that are also side specific (Left and Right). Like all the sensors covered above, these ones connect to the Playermaker app via Bluetooth and data can be synced/downloaded after each session.
- **Sensor Metrics:** Playermaker breaks down the metrics into 5 different categories. 1) Involvement – number of touches (contact with the ball), ball releases (kicks/shots/passes) and possessions (had control of the ball). 2) Playing Tempo – one-touches, short possessions (1.5secs or less), long possessions (>1.5secs). 3) Technical Balance – touch by leg (%), release by leg (%), receive by leg (%) and max kicking velocity. 4) Speed – max speed, sprints, accelerations/decelerations. 5) Volume – distance covered, sprint distance, work rate.
- **Analytics & Tools:** In terms of analytics, the app provides easy visualisation of the data, from the details to an overview of each session. It allows the player to benchmark their own performance with other elite players. Players can also set goals, track their progress over time, receive coach feedback and compare notes with peers and team mates.
- **Team & Elite Tools:** Teams and coaches can get access to a coaches dashboard where they can get an overview of the team's physical and technical progress over time. Keep players engaged while monitoring their training schedule/load. For the elite players and teams, Playermaker provides a lot more tools on top of the coach dashboard including the ability for deeper analysis and video integration, further development of players, managing team performance and avoiding injuries.

Figure 8





Like many of the other products, Playermaker seems to have a focus on the youth football player market and semi-pro players who want to take their game to the next level. On the other hand, they have also been used by quite a number of professional clubs. The key difference in their product offerings is the apps/software and analytical tools/platform. Regardless of the player’s level, access to the [Playermaker platform](#) requires a monthly subscription which can be paid upfront for 12 months or 24 months. For teams wanting to order at least 10 units, they will have to contact Playermaker to find out more.

Table one provides comparison of football sensor technologies according to The article [“Wearable Football \(Football\) Sensors That Track Shots, Passes, And More”](#) - Sport technology blog.

Table 1

Type	Product	Country of Origin	Method of Securing Sensor/s	General Technical Metrics	General Physical Metrics	Left vs Right	Position Tracking	Individual Monthly Subscription	Team Tracking	Coach Dashboard	Additional Features	Availability
Calf Sensors	Footbar	France	Strap below knee	Yes	Yes	Optional	NA	No	Yes	Yes	NA	Ships Global
	Zepp	US	Calf sleeve with pocket	Yes	Yes	Optional	NA	No	Yes	Unknown	Video highlights	Unknown
	Oliver	Spain	Calf sleeve with pocket	Yes	Yes	NA	GPS	Yes	Yes	Yes	NA	Ships Global
	Next11	Denmark	Calf sleeve with pocket	Yes	Yes	NA	Bluetooth Mesh	Yes	Yes	Yes	Smart ball, Real-time tracking	Pre-order
Feet Sensors	Jogo	Netherlands	Insert into insole	Yes	Yes	Yes	NA	Unknown	Yes	Unknown	Video or camera tracking of workouts	Unknown
	Xampion	Finland	Insert into insole	Yes	Yes	Yes	NA	Yes	Yes	Yes	NA	Europe, Australia & Japan
	Playermaker	Israel	Silicone rubber strap outside boot	Yes	Yes	Yes	NA	Yes	Yes	Yes	Video integration	Ships Global

sportstechnologyblog.com

The article stated above concludes that all the football sensors will at least track the ‘Physical’ and ‘Technical’ metrics during a football game or training session. The general or most common ‘Physical Metrics’ would include distances covered, speeds, sprints, and accelerations/decelerations. Then the general ‘Technical Metrics’ will usually have the number of shots/kicks, the number of passes, touches/dribbling, speed of kicks and some possessions stats. Some of the products will have a little bit more metrics or different metrics and sometimes it is just a slightly different way of presenting them (e.g. number and percentage).





Figure 9 - FIFA and wearable technologies in football

## Wearables technologies in football

On July 8, 2015, just a month before the start of the 2015/16 Premier League season, FIFA sent [this letter](#) to the major leagues around the world. It said that as long as the leagues permitted, teams were allowed to use EPTS devices during matches, providing they adhered to a few stipulations.

Then, in October 2015, [FIFA and IFAB](#)—the committee in charge of the rules of the game—announced they were developing a global standard for wearables in football and invited makers of EPTS devices to present their systems for evaluation.

Following the mandate from the IFAB in 2015 to create global standards for Electronic Performance and Tracking Systems (EPTS), FIFA has sought industry and football expertise to provide solutions for the sport. One axis of this research was the development of a data transfer standard format to make data from different sources and providers comparable without the need for numerous APIs.

### BARIN Sport

Barin Sports PRO 3 system collects over 12,000 data points per player per second and combines this data into over 50 parameters and high-level indicators in real time. The unique tactical tool introduced by the company helps the coaching staff monitor and evaluate the physical condition and performance of the players and make connections to the tactical execution on the pitch. Barin Sport is a powerful instrument for real-time decisions in matchdays, half-time adjustments & tactical instructions, performance – strength, stamina, current peak values, cross-reference analysis medical vs performance vs condition, peak performance – arrange micro and mezzo cycles, non-contact injury prevention, optional Medical assessment – recovery, stimulation, nutrition, hormonal, DNA, and stress assessment, RPE, shorten recovery periods, peak performance management and various data services.





Barin offers accessible web app for advanced analytics and recommendations in real-time for customizable and multi-functional real-time dashboard, color-coded load and performance visualization, personal and team metrics, precise time splits by sub-sessions and player groups, drag-and-drop user interface, preset and fully-customizable analytics capability, actionable insights and threshold alerts, custom and summary reports and data export in PDF (optionally in .CSV)

Figure 10



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In Basketball, the most common wearable technologies include:

- GPS Tracking: GPS devices can be attached to a player's jersey or shoes to track their movement and speed on the court during games and practices.
- Shot Tracking Sensors: These sensors can be attached to a basketball or worn on a player's wrist to track the arc, spin, and accuracy of their shots during games and practices.
- Smart Shoes: Some basketball players wear shoes with built-in sensors that track their movement, speed, and jumping ability on the court.
- Heart Rate Monitors: Similar to football, heart rate monitors can be worn by basketball players to track their fitness levels during training and games.
- Wearable Cameras: Some basketball teams use wearable cameras to record practices and games from a player's perspective, allowing coaches to analyze their performance and provide feedback.

### 2.3.2. Literature Review on wearable technologies in Football and Basketball

Wearables definition - wearable devices, also known as wearable technology, may be defined as advanced computing technologies that the user can wear (Jacobs et. al, 2019), such as smartwatches, smart bands, smart glasses, smart jewelry or any other type of smart clothing equipped with sensors that track and record the users' data (Wang,2015; Ching & Singh, 2016). The first devices of this type were created in the 1960s when Thorp and Shannon created a wearable device for entering and predicting roulette results using an earbud (Thorp, 1998). In the years 2006-2013, several wearables appeared on the market, but the real breakthrough on the market took place in 2014 when the first Apple Watch was introduced. Later, several industry services hailed the year 2014 as "The Year of Wearable Technology" (www1).

As of 2020, the most popular wearable devices across the global market are earwear, smartwatches, and smart bands (www2). Tarabasz & Poddar (2019) pointed out that in the present time, wearable devices combine four significant technological trends such as mobile channel of communication, the Internet of Things (IoT), Augmented Reality (AR), and Big Data. They are, in fact, tiny computers with numerous functions besides showing time (Chuah et. al, 2016).

Based on the research of Ching & Singh (2016), the main characteristics of wearables lie in that they are: unrestrictive (hands-free, enabling the users can do various things at any time);







controllable (the user may control it at any time); attentive (devices with multiple sensors and working modes); observable (providing alerts, reminders or messages which might keep the user's attention); communicative (able to exchange information through a wireless network) and unmonopolizing (the user might be focused on his actions as usage does not require his attention).

The point of wearable technology lies in generating data and analyzing it. Each solution consists of sensors and a user app, and the rest takes place in the cloud. Data generated by sensors is collected and processed in the cloud, and all the insights are available through the user's app. This information brings benefits on all levels, for individual athletes and sports institutions. Individual athletes use these findings mainly for performance monitoring and improvement, while sports clubs rely on the data for decision-making and building training and competition strategies.

#### Real-Life Example: Translating Heartbeat Data into Valuable Insights

Firstbeat Sports is an athlete-monitoring solution from the Finnish company, Firstbeat. It optimizes training and recovery and helps boost performance with comprehensive physiological analytics. The solution is designed for both sports clubs and individual athletes.

The solution consists of a sensor attached to an athlete's body, an app, and a dashboard. The sensor collects heart rate variability data (HRV), training load, and recovery data. Then, this data is analyzed by advanced performance analytics algorithms. Finally, it is displayed in the dashboard and app. Based on HRV-based insights, coaches and athletes make data-driven decisions.

SV Fügen, an Austrian football club, has tried Firstbeat Sports to rise up the ranks. Their primary goal was to reach a new level in terms of endurance and performance. They use Firstbeat Sports in every session.

Since the football club has implemented Firstbeat Sports, they say they have managed to:





- Advance to the third division of the Austrian football league (they were previously in the fifth division)
- Control training load more effectively
- Keep players injury-free

### 2.3.3. Sensors in Football and Basketball

#### Wearable sensors

Wearable sensors: motion sensors and physiological sensors used in soccer and basketball introduced to coaches during education are as described below.

Athlete monitoring technology contains two types of wearable sensors: motion sensors and physiological sensors. Motion sensors include pedometers, accelerometers/ gyroscopes, and global positioning satellite (GPS) devices. Physiological sensors include heart rate monitors, sleep monitors, temperature sensors, and embedded sensors. The obtained data can be used in the design of optimized training programs and to determine potential causes of injuries. There are numerous articles analyzing and evaluating the external and internal training load, highlighting data obtained with microtechnology devices such as the OptimEye X4, and Catapult novations, which is worn by athletes for effort assessment. It has also been investigated how GPS watches, smartphones, commercial activity monitors, and quality wearable sensors can be used for the same purpose. To better understand training fatigue and its effect on the athlete, potential markers are available.

In the last few decades, the scientific community and companies have created several datasets containing heterogeneous signal parameters (e.g., accelerations, angles, pressures, etc.) that were acquired through different approaches (e.g., inertial, optical, piezoresistive, video, etc.), making them publicly available to researchers for developing future applications for rehabilitation and sports performance monitoring. The current wearable sensors for sports tracking still have several limits to overcome, such as the high cost and high energy consumption, as well as poor fitting features and elasticity making them uncomfortable to be worn and hamper the movements during sports activities. However, innovative and challenging solutions have recently been developed in different sports fields, such as combat sports, basketball, volleyball, soccer, running, and weightlifting [1](#), [2](#), [3](#), [4](#), [5](#), [6](#).





1. A novel triboelectric nanogenerator (SC-TENG) based on the sock cloth to harvest mechanical energy. The sock cloth and PTFE film constitute the triboelectric materials of SC-TENG, and the copper foil is used as the conductive electrode. The SC-TENG can not only be used to harvest mechanical energy, but also can be used as a self-powered sensor in the field of intelligent sports.

2. A self-powered biosensor for monitoring the maximal lactate steady state (MLSS) during exercise has been developed for an intelligently assisting training system. It has been presented to create poly (vinylidene fluoride) (PVDF)/Tetrapod-shaped ZnO(T-ZnO) / enzyme-modified nanocomposite film through an efficient and cost-effective fabrication process. This sensor can be readily attached to the skin surface of the tester. Due to the piezoelectric surface coupling effect, this biosensor can monitor/sense, and analyze physical information in real-time under non-invasive conditions and work independently without any battery. By actively outputting piezoelectric signals, it can quickly and sensitively detect body movements (changes in joint angle, frequency relative humidity during exercise) and physiological information (changes of lactate concentration in sweat). A practical application has been demonstrated by an excellent professional speed skater (male). The purpose of this study is to increase the efficiency of MLSS evaluation, promote the development of piezoelectric surface coupling effect and motion monitoring application, and develop an intelligently assisting training system, which has opened up a new direction for human motion monitoring. The maximal lactate steady state (MLSS) is the gold standard to evaluate aerobic (endurance) ability, which reflects the higher the MLSS is, the higher aerobic ability the athlete has, and it is related to the way of energy supply.

3. Herein, a novel material design strategy is developed to fabricate a self-assembled graphene sensing film, in which the conductivity and thickness can be well balanced. As a result, our sensor exhibits unprecedented comprehensive properties with both high sensitivity (1875.53 kPa<sup>-1</sup>) and a wide linear detection range (0–40 kPa). The sensor is also endowed with good stability and high peak signal-noise ratio (78 dB). Taking advantage of these performances, a universal high-accuracy wireless and wearable pulse monitoring system was built. This platform first provides the subtle arterial pulse signal information even under the interference of strong body movement in real-time (during running or cycling), which could not have been realized before. This wearable system is expected to provide more rich and accurate information for personalized diagnostic applications in the future.

4. Compared to most reported graphene pressure sensors, this work realizes the optimization of sensitivity and working range, which is especially suitable for wearable applications. We also demonstrate that the pressure sensor can be applied in pulse detection, respiratory detection, voice recognition, as well as various intense motion detections. This graphene-paper pressure sensor will have great potentials for smart wearable devices to achieve health monitoring and motion detection.

5. Knitted fabric sensors have been widely used as strain sensors in the sports health field and its large strain performance and structure are suitable for human body movements. When a knitted structure is worn, different human body movements are reflected through the large strain deformation of fabric structure and consequently change the electrical signal. Here, the mechanical and electrical properties of highly elastic knitted sweatpants were tested under large





strain. This sensor has good sensitivity and stability during movement. Compared with traditional motion monitoring, this technique divides the walking cycle into two stages, namely, stance and swing phases, which can be further subdivided into six stages. The corresponding resistance characteristic values can accurately distinguish the gait cycle. Analysis on hysteresis and repeatability revealed that the sensor exhibits a constant electrical performance. Four kinds of motion postures were predicted and judged by comparing the resistance characteristic range value, peak value calculation function and time axis. The measured sensor outputs were transferred to a computer via 4.0 Bluetooth. MATLAB language was used to detect the status through a rule-based algorithm and the sensor outputs.

6. A multifunctional piezoelectric biosensor for motion detection and lactic acid analysis is fabricated from ZnO nanowire arrays, and it shows the potential application in the next generation of self-powered wearable athletics monitoring nano-system. The flexible skin-like device can be easily attached to the joints of the athlete, which can real-time detect the running speed, stride frequency and joint angles during exercises by actively outputting a piezoelectric signal (driven by the motion itself). The piezoelectric output voltage can be used as both the energy supply and sensing signal. After decorating lactate oxidase on ZnO nanowires, the device can also detect lactate concentration on athlete skin, and the analysis process is also powered by the motion energy. The sporting skill and physiological status have been discussed based on the experimental data. The change of lactic acid concentration in the sweat of the sports body is positively correlated with running speed, which is in line with the law of physical movement and provides the basis for athletes' selection, performance monitoring, and injury prevention. This multi-discipline research may point out a new developing orientation of sports science and may promote the development of flexible self-powered multifunctional nano-systems.

7. A piezoelectric pressure sensor for a wireless wearable sensing system obtained from the combination of tetragonal-phase BaTiO<sub>3</sub> nanowires and electro-spun PVDF nanofibers was designed and proposed by Guo et al. The research paper "Wearable Sensors and Smart Devices to Monitor Rehabilitation Parameters and Sports Performance: An Overview" fig. 13 presents piezoelectric sensors.

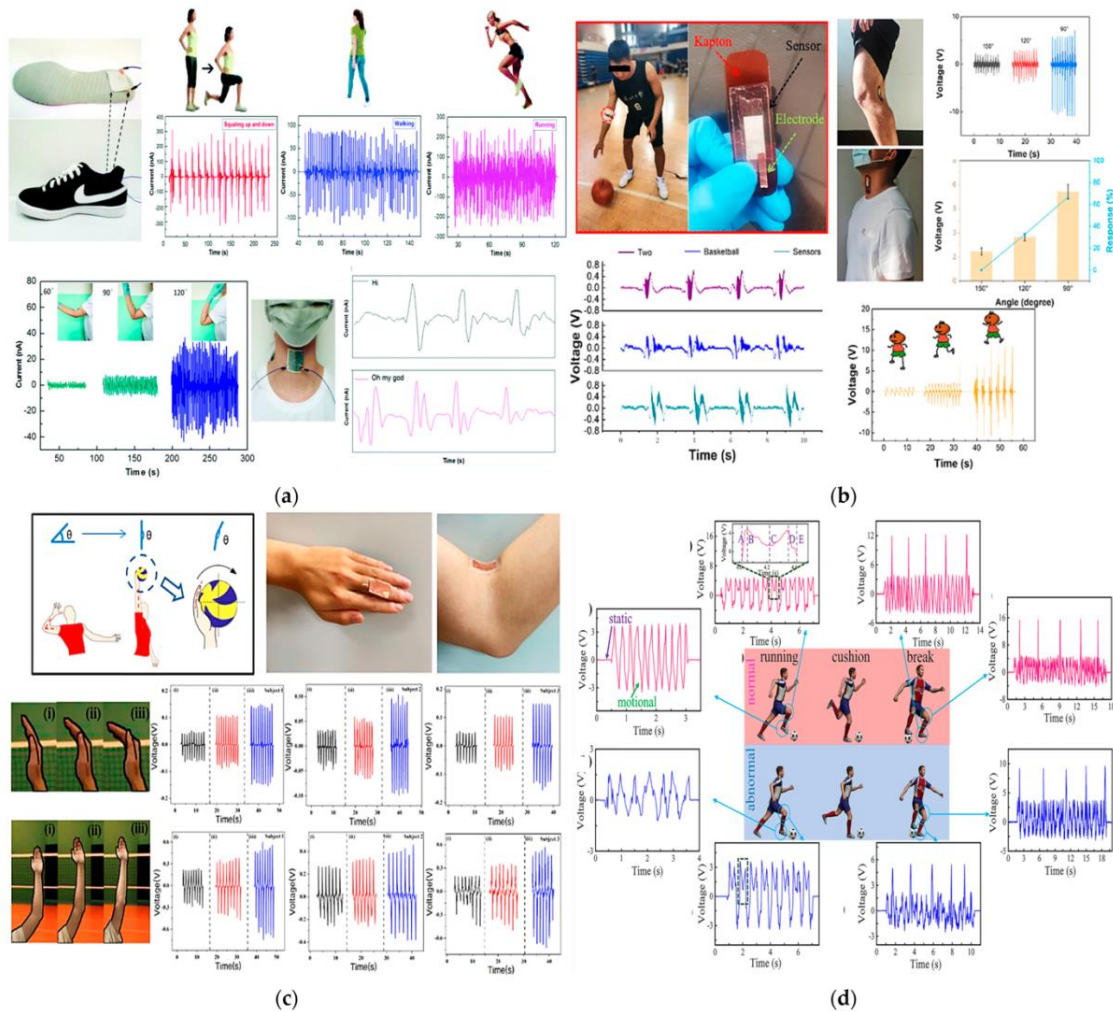
Piezoelectric sensors: PVDF/BaTiO<sub>3</sub>-based sensor integrated into a sole with the corresponding output currents generated during squatting, walking, and running activities, elbow extension and flexion to 60°, 90°, and 120°, and the pronunciation of short sentences (a). PVDF/DMF-based sensor applied on an athlete's elbow and the corresponding voltage signals generated at different bending angles and during different physical activities ) (b). A schematic diagram of different bending angles of the palm during the test of the PVDF sensor. The output piezoelectric voltages of three subjects when finger and elbow bending angle change are also reported (c) Soccer player motion monitoring test using the PVDF-HFP-based sensor (d). Pictures of a soccer player's actions show normal ankle motion, abnormal ankle motion, normal knee motion, and abnormal knee motion. Moreover, the "brake" action of the same motion is also monitored and reported. Still exploiting the piezoelectric effect, Zhao et al. designed a self-powered sensor to monitor basketball players' movements and gestures. The sensor was fabricated starting from a mixture of dimethyl formaldehyde (DMF) and PVDF poured onto a silicone substrate. Then, thin Ag electrodes of 300 nm thickness were applied on both sides of the piezoelectric film. After





wiring it, the sensor was attached to the elbow. Generated voltage spikes of 2.172 V at an angle of 150°, 3.48 V at 120°, 6.052 V at 90°, and 8.08 V at 60° were measured. Moreover, the relative piezoelectric output at different frequencies was also acquired, keeping the same bending angle. Voltages of 5.24 V, 5.24 V, 5.328 V, and 5.32 V were measured at 0.5, 1, 1.5, and 2 Hz, respectively. Finally, the sensor was positioned on the popliteal fossa of an athlete for in vivo tests; the generated voltage during the jumping, walking, and running activities was successfully acquired, showing voltage peaks of 9.387 V, 1.02 V, and 2.04 V, respectively (Figure 13b).

Figure 11 of the above-mentioned study



The research paper “Wearable Sensors and Smart Devices to Monitor Rehabilitation Parameters and Sports Performance: An Overview” fig. 15 presents a radar chart is reported, comparing the



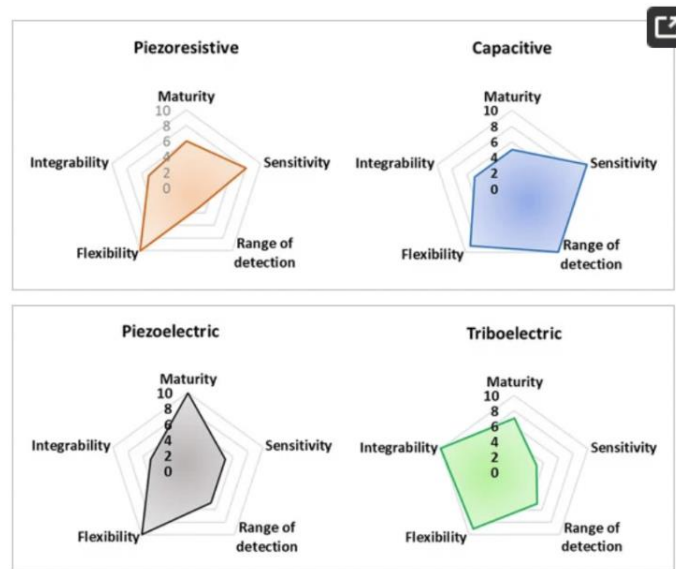




analyzed sensors and devices, both for rehabilitation and sports tracking purposes, according to their technological maturity, flexibility, ability to be completely integrated into clothes and garments, sensitivity, and range of detection.

Figure 12

In Figure 15, a radar chart is reported, comparing the analyzed sensors and devices, both for rehabilitation and sports tracking purposes, according to their technological maturity, flexibility, ability to be completely integrated into clothes and garments, sensitivity, and range of detection.



Wearable technology in professional sports and already at grassroots level comes in all shapes and sizes, from mere fitness bracelets and smartwatches to sensors integrated into sports equipment and skin patches attached to the body. The point of wearable technology lies in generating data and analyzing it on the go. Each solution consists of sensors and a user app, and the rest takes place in the cloud. Data generated by sensors is collected and processed in the cloud, and all the insights are available through the user's app. This information brings benefits on all levels, for individual athletes and sports institutions. Individual athletes use these findings mainly for performance monitoring and improvement, while sports clubs rely on the data for decision-making and building training and competition strategies. Wearable athletic devices are already here in all sizes and shapes, and new ones are continuously on the development horizon. Devices are being seamlessly incorporated into the fabric of sports apparel, built into sports equipment like balls and bats, and worn by athletes as small devices attached to the body in a waistband or skin patch. The devices then link by Bluetooth and GPS technology, relaying real-time data to coaches with laptops or other electronic devices for analyzing, recording, and responding to the information.





## Performance metrics tracked in European soccer by wearable technologies

### 2.3.4. Performance metrics tracked by wearable technologies in Football and Basketball

#### Performance metrics tracked in European football by wearable technologies

Wearable technologies can track a wide range of performance metrics in football, including:

- *Distance covered* - GPS tracking devices can measure the distance covered by each player during training and matches, providing coaches with insights into overall fitness levels and individual player workload.
- *Speed* - GPS tracking devices can also measure the speed of players, both in terms of maximum speed and average speed over a period of time.
- *Acceleration and deceleration* - GPS and accelerometer devices can track the acceleration and deceleration of players, providing insights into changes in direction and agility.
- *Heart rate* - Heart rate monitors can track the heart rate of players during training and matches, providing insights into fatigue levels and cardiovascular fitness.
- *Power output* - Inertial measurement units (IMUs) can track the power output of players, providing insights into explosive movements such as jumping and sprinting.
- *Recovery time* - Wearable technologies can also track recovery time, providing insights into how quickly players recover between training sessions and matches.

By collecting and analyzing data on these performance metrics, coaches and trainers can identify areas for improvement and develop personalized training plans that can help players optimize their performance on the field.

#### Performance metrics tracked in European basketball by wearable technologies

Wearable technologies can track a range of performance metrics in European basketball, including:

- *Distance covered* - GPS tracking devices or accelerometers can measure the distance covered by players during training and games, providing coaches with insights into player workloads and overall fitness levels.
- *Speed* - GPS tracking devices or accelerometers can measure the speed of players, both in terms of maximum speed and average speed over a period of time.
- *Jumping* - IMUs can track the height of jumps, the number of jumps, and the power output during jumping, providing insights into player explosiveness and power.
- *Heart rate* - Heart rate monitors can track the heart rate of players during training and games, providing insights into fatigue levels and cardiovascular fitness.
- *Acceleration and deceleration* - GPS and accelerometer devices can track the acceleration and deceleration of players, providing insights into changes in direction and agility.





- *Shooting accuracy* - wearable technologies can track shooting accuracy by measuring the angle and force of the shot, providing insights into areas for improvement in shooting technique.
- *Defensive performance* - wearable technologies can also track defensive performance, such as the number of steals, blocks, and defensive rebounds, providing insights into defensive effectiveness.

By collecting and analyzing data on these performance metrics, coaches and trainers can identify areas for improvement and develop personalized training plans that can help players optimize their performance on the court.

### 2.3.5. Main advantages of wearable technologies' use in football and basketball coaching education

However, apart from all the positives, the devices have several advantages. As indicated above, one of the main advantages of wearable devices is that they are discrete, and allow users to perform tasks in a discreet manner (Page, 2018). Some of the main advantages of wearable technologies' use in football and basketball coaching education are as follows:

- *Objective measurement of performance* - wearable technologies provide objective data on a player's performance, such as distance covered, speed, heart rate, and acceleration. Such information can be used to assess players' strengths and weaknesses and create personalized training plans to improve their overall performance.
- *Injury prevention* - wearable technologies can help identify injury risk factors by tracking players' movement patterns, fatigue levels, and other indicators. Such information can be used to adjust training loads and reduce the risk of injury.
- *Tactical analysis* - wearable technologies can provide coaches with data on players' positions, movements, and decision-making during games. This can be used to develop game plans and tactics that maximize the team's strengths and exploit the opposition's weaknesses.
- *Real-time feedback* - wearable technologies can provide players with real-time feedback on their performance during training sessions or games. This can help them make immediate adjustments to their technique or tactics and improve their performance.
- *Player development* - wearable technologies can track a player's progress over time, allowing coaches to identify areas for improvement and track progress towards specific goals. This can help players develop their skills and reach their full potential.

The use of wearable technologies in football and basketball can provide valuable insights into player performance, injury prevention, tactical analysis, real-time feedback, and player development. This technology can help coaches and players to optimize their training and performance, leading to better outcomes on the field.





The review “Exploring the Role of Wearable Technology in Sport Kinematics and Kinetics: A Systematic Review<sup>9</sup>” states that data and technology have the potential to be used to predict injury, forming the basis for individualized programs and allowing monitoring over a period of time, as demonstrated by Kiernan et al. (2018) who studied participants over a 60-day period<sup>10</sup>. To fully exploit this potential in injury prevention, however, there is still a need of identifying which biomechanical data obtained from wearable technology is the most useful as a predictor of injury.

### 2.3.6. Main disadvantages in wearable technologies’ use in European football and basketball coaching education

While there are many advantages to using wearable technologies in football and basketball, there are also some disadvantages that should be considered and managed appropriately to ensure that the technology is used effectively and safely.

Here are some of the main disadvantages:

- *Cost* - wearable technologies can be expensive, especially for smaller teams or organizations with limited budgets. This may make it difficult for some teams to access the technology and gain the benefits that it offers.
- *Data overload* - wearable technologies can generate large amounts of data, which can be overwhelming for coaches and players to process. This may make it difficult to identify meaningful insights or actionable recommendations from the data.
- *Privacy concerns* - wearable technologies collect personal data, such as biometric information and movement patterns. This data can be sensitive, and there may be concerns about how it is collected, stored, and shared.
- *Technical issues* - wearable technologies may experience technical issues, such as connectivity problems or sensor malfunctions. This can lead to data inaccuracies or loss of data, which can negatively impact the value of the technology.
- *Over-reliance on technology* - there may be a risk of over-reliance on wearable technologies, with coaches and players relying too heavily on the data generated by the technology rather than using their own judgment and experience.

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<sup>9</sup> Adesida, Y., Papi, E., & McGregor, A. H. (2019). Exploring the role of wearable technology in sport kinematics and kinetics: A systematic review. *Sensors*, 19(7), 1597.

<sup>10</sup> Kiernan D., Hawkins D.A., Manoukian M.A.C., McKallip M., Oelsner L., Caskey C.F., Coolbaugh C.L. Accelerometer-based prediction of running injury in national collegiate athletic association track athletes. *J. Biomech.* 2018;73:201–209. doi: 10.1016/j.jbiomech.2018.04.001





As several researchers have indicated, wearable devices might be vulnerable to cyber threats and privacy issues – this has already been analysed in several studies (H. S. Chang, Lee, & Ji, 2016; Moon, Baker, & Goughnour, 2019). Moon, et. al.(2019) pointed out several security challenges such as “data losses, infection by malware, and unauthorized access to personal data”. The product market analysis of Seneviratne et al., (2017) showed that many devices use Bluetooth Low Energy technology. At the same time, the review made by the researchers indicated that devices using it as a main channel of communication may be affected by eavesdropping, traffic analysis, or the collection of device data, i.e. the PIN code to unlock the phone. Thus, the current types of devices are not yet perfect, but they might still help improve the quality of life and daily activities as well as practicing sports and coaching. Furthermore, using a wireless method to transfer data has the potential for loss of signal during recording time or interference from mobile phones or other devices that may be on the same transmission frequency<sup>11</sup>.

## 2.4. Electronic Performance and Tracking Systems in Football and Basketball

Electronic Performance and Tracking Systems (EPTS), which include camera-based and wearable technologies, are used to control and improve player and team performance. EPTS primarily tracks player (and ball) positions but can also be used in combination with microelectromechanical devices (accelerometers, gyroscopes, etc.) and heart-rate monitors as well as other devices to measure load or physiological parameters.

There are three forms of physical tracking devices used in Football and Basketball:

- Optical-based camera systems
- Local positioning systems (LPS)
- GPS/GNSS systems

### 2.4.1. Optical-based camera systems in Football and Basketball

Optical-based camera systems in football and basketball are technologies used to capture and analyze data from live sporting events. These systems typically use high-speed cameras to track the movement of players and the ball, providing valuable information to coaches, players, and fans. Optical-based camera systems are used in football and basketball for various purposes such as game analysis, performance tracking, referee decision-making, and fan engagement.

Here are some examples of how these systems are used in both sports:

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<sup>11</sup> Reenalda J., Maartens E., Homan L., Buurke J.H. Continuous three dimensional analysis of running mechanics during a marathon by means of inertial magnetic measurement units to objectify changes in running mechanics. *J. Biomech.* 2016;49:3362–3367. doi: 10.1016/j.jbiomech.2016.08.032.





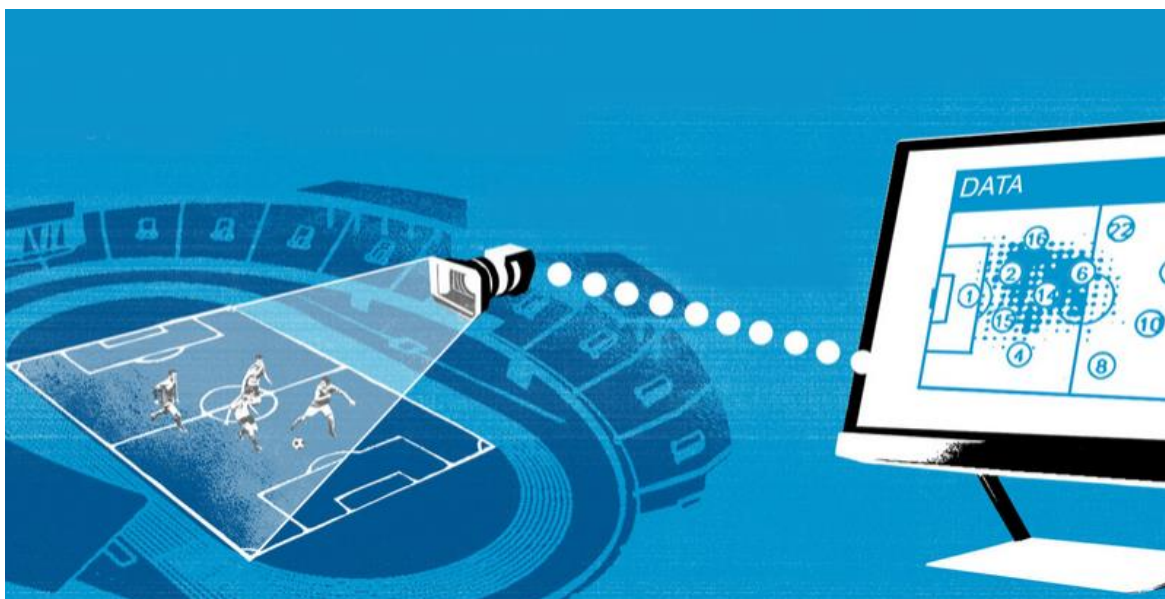
#### In Football:

- Referee Decision Making: The Video Assistant Referee (VAR) system uses multiple high-speed cameras positioned around the field to capture footage of key incidents such as goals, penalties, and red card incidents. The footage is then analyzed by a team of officials who can use it to make accurate decisions.
- Tactical Analysis: Coaches and analysts use camera systems to study the performance of their team and opposition. This helps them identify weaknesses and strengths in their game plan, make adjustments, and prepare for future matches.
- Player Performance Tracking: Optical-based camera systems can be used to track individual player performance during a match. This data is useful for coaches to analyze and make informed decisions about player selection and tactics.

#### In Basketball:

- Player Tracking and Performance Analysis: Optical-based camera systems such as SportVU are used in the NBA to track the movement and performance of players during games. The cameras capture data on player movements, ball movement, and shot attempts, which is then analyzed by teams to identify strengths and weaknesses in player performance.
- Referee Decision Making: Cameras are used in basketball to review and verify certain types of referee decisions, such as buzzer-beating shots and out-of-bounds calls.
- Fan Engagement: Optical-based camera systems are also used to provide enhanced viewing experiences for fans. For example, cameras can be used to capture unique angles and perspectives of the game, providing a more immersive viewing experience.

Figure 13 - Real Life example - Zone 14



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#### Benefits:

- Limited number of measurements
- Tracking occlusions require manual corrections
- Installation time

#### Limitations:

- Non-invasive to players
- Commonly used in the football market
- High sampling rate, ball tracking possible

### 2.4.2. Local Positioning System in Football and Basketball

Local Positioning Systems (LPS) in football and basketball coaching refer to technologies that use wireless sensors to track the movement of players and the ball during training and games. These systems provide coaches and analysts with real-time data on player and team performance, allowing them to make informed decisions and adjust tactics accordingly.

In football, LPS systems typically involve the use of sensors placed in the players' shoes or on their backs. These sensors communicate with a central system that uses triangulation algorithms to calculate the position of each player on the field. This information can be used to track player movements, monitor their physical exertion levels, and identify areas for improvement.

In basketball, LPS systems are used to track player movement and ball possession during games and training. These systems typically involve the use of sensors placed on the players' jerseys or in the ball. The sensors communicate with a central system that uses a combination of radio frequency and infrared technology to track the position of the players and the ball. This data can be used to analyze player movement patterns, track shooting accuracy, and develop game strategies.

The data collected by LPS systems can be analyzed in real-time, allowing coaches and analysts to adjust tactics and make informed decisions during games and training sessions. This technology provides a level of detail and accuracy that was not previously possible, allowing coaches to gain a deeper understanding of their players' performance and make more effective decisions to improve their team's performance.







#### Benefits:

- High number of measurements possible
- Accuracy of measured data in real-time
- Ultra-wide band technology reduces chances of interference in transmission path

#### Limitations:

- Fixed installation
- Installation costs
- Installation time

#### FIFA and EPTS

The FIFA Quality Programme for EPTS devices was initially launched for wearable tracking systems in 2017 with the aim of ensuring that such devices do not pose a danger to the players.

The test criteria were developed following medical and mechanical research and a test protocol reflecting possible injury scenarios that should be avoided. In 2019, the FIFA Quality Programme for EPTS was extended beyond safety tests to include performance tests for both optical and wearable devices, giving systems the chance to receive the 'FIFA Quality' mark. This introduction was made in an effort to provide the end user with more information about the system they are using or intending to use. Providers that have been tested are listed on FIFA website with a publicly available test report which describes, using a ranking system, the accuracy of the system's positioning and velocity data in different velocity brackets.

The Resource Hub is the public database of the FIFA Quality Programme, the aim of which is to endorse products that meet strict quality requirements to improve the game and protect players, clubs and associations. Football stakeholders will find a list on the hub of all FIFA-licensed providers and detailed information about certified products, technologies and playing surfaces. There are 37 EPTS certified by FIFA as follows: 2 broadcast systems, 1 Hybrid - Optical and Wearable system, 10 optical systems and 24 wearable systems. The main providers are Advanced Sport Instruments SA (2), Bepro Group Ltd (2), Catapult Sports (4), ChyronHego AB (2), DEMCON johan sports BV (1) Exelio Srl. (2), Fitogether Inc (4), Footovision (1), Genius Sports SS, LLC (2), Hawk-Eye Innovations Limited (2), Instat Limited (1), K-SPORT WORLD S.R.L. (1), Kinexon Sports & Media GmbH (1), Korea Sport Industry Development Institute (1), MyCoach (1), Pitch Hero Holdings Ltd (1), Polar Electro Oy (1), REALTRACK SYSTEMS SL (1), sanSirro GmbH (1), Sportlogiq





Inc. (1), Sports Performance Tracking Pty Ltd (1), STATSports Group LTD (1), TRACK160 Ltd. (1), Visuallex Sport International Ltd (1), xSENSING Co.,Ltd. (1).

<https://www.fifa.com/technical/football-technology/resource-hub?QualityProgram=6Sshn3qiYsRBq6muymEEtY&Category=21vZTNlv31aveduLGFmDi&Type=Broadcast%20System&Type=Wearable%20System>

### 2.4.3. GPS technologies - tracking devices in Football and Basketball

[Use of GPS in Sports Research Main Data Obtained Source](#)

Table 2

<b>Health maintenance, recovery, and recovery and injury management</b>	
<i>decrease in residual muscle tone ,</i>	<i>Havlucu, H.; Akgun, B.; Eskenazi, T.; Coskun, A.; Ozcan, O. Toward Detecting the Zone of Elite Tennis Players through Wearable Technology. Front. Sport. Act. Living 2022, 4, 240.</i>
<i>pain relief</i>	
<i>monitoring the internal tensions produced on themusculoskeletal tissues</i>	<i>Marshall, A.N.; Lam, K.C. Research at the Point of Care: Using Electronic Medical Record Systems to Generate Clinically Meaningful Evidence. J. Athl. Train. 2020, 55, 205–212.</i>
<i>the elements causing injuries: intrinsic factors, extrinsic factors, and injury prevention, the level of training tasks to increase performance, but with injury prevention</i>	





<i>creating an injury prediction system based on training tasks</i>	<u><i>Cullen, B.D.; Roantree, M.T.; McCarren, A.L.; Kelly, D.T.; O'Connor, P.L.; Hughes, S.M.; Daly, P.G.; Moyna, N.M. Physiological Profile and Activity Pattern of Minor Gaelic Football Players. J. Strength Cond. Res. 2017, 31, 1811–1820.</i></u>
<i>detection of accident-generating factors</i>	

Table 3

<b>Motor quality monitoring</b>	
<i>determining the power of the lower train</i>	<u><i>Weldon, A.; Duncan, M.J.; Turner, A.; Laplaca, D.; Sampaio, J.; Christie, C.J. Practices of Strength and Conditioning Coaches: A Snapshot from Different Sports, Countries, and Expertise Levels. J. Strength Cond. Res. 2022, 36, 1335–1344.</i></u>
<i>measuring linear sprint performance</i>	<u><i>Pitt, T.; Lindsay, P.; Thomas, O.; Bawden, M.; Goodwill, S.; Hanton, S. A Perspective on Consultancy Teams and Technology in Applied Sport Psychology. Psychol. Sport Exerc. 2015, 16, 36–44.</i></u>





<p>knowledge of force, power, and speed variables in horizontal and vertical jumps,</p> <p>determining external and internal training tasks</p>	<p><u><i>Heyward, O.; Nicholson, B.; Emmonds, S.; Roe, G.; Jones, B. Physical Preparation in Female Rugby Codes: An Investigation of Current Practices. Front. Sport. Act. Living 2020, 2, 584194.</i></u></p> <p><u><i>Browne, P.; Sweeting, A.J.; Woods, C.T.; Robertson, S. Methodological Considerations for Furthering the Understanding of Constraints in Applied Sports. Sports Med.-Open 2021, 7, 22.</i></u></p>
<p>monitoring and prescribing resistance training tasks,</p>	<p><u><i>Chambers, R.M.; Gabbett, T.J.; Cole, M.H. Validity of a Microsensor-Based Algorithm for Detecting Scrum Events in Rugby Union. Int. J. Sports Physiol. Perform. 2019, 14, 176–182.</i></u></p>
<p>the association of the external load with the athlete's fatigue</p>	<p><u><i>Browne, P.; Sweeting, A.J.; Woods, C.T.; Robertson, S. Methodological Considerations for Furthering the Understanding of Constraints in Applied Sports. Sports Med.-Open 2021, 7, 22.</i></u></p>
<p>knowledge of physical demands in correlation with the following variables: locomotion speed, body load, and total body load</p>	<p><u><i>Drew, S.A.; Awad, M.F.; Armendariz, J.A.; Gabay, B.; Lachica, I.J.; Hinkel-Lipsker, J.W. The Trade-Off of Virtual Reality Training for Dart Throwing: A Facilitation of Perceptual-Motor Learning with a Detriment to Performance. Front. Sport. Act. Living 20</i></u></p>
<p>tracking running and inertia indicators</p>	<p><u><i>Murray, N.B.; Gabbett, T.J.; Townshend, A.D. The Use of Relative Speed Zones in Australian Football: Are We Really Measuring What We Think We Are? Int. J. Sports Physiol. Perform. 2018, 13, 442–451</i></u></p>





<p>recording information related to force, accuracy, impact over time, and direction of hitting the volleyball ball</p>	<p><i>Wilkerson, G.B.; Nabhan, D.C.; Perry, T.S. A Novel Approach to Assessment of Perceptual-Motor Efficiency and Training-Induced Improvement in the Performance Capabilities of Elite Athletes. Front. Sport. Act. Living 2021, 3, 274</i></p>
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Table 4 - Use of GPS in Sports Research Main Data Obtained Source

<p>Training optimization</p>	
<p>of sports training</p>	<p><i>Nasu, D.; Baba, T.; Imamura, T.; Yamauchi, M.; Kitanishi, Y.; Kashino, M. Simplified Virtual Reality System Can Be Used to Evaluate the Temporal Discrimination Ability in Softball Batting as in the Real Environment. Front. Sport. Act. Living 2022, 4, 149.</i></p>
<p>designing optimized training programs</p>	<p><i>Li, R.T.; Kling, S.R.; Salata, M.J.; Cupp, S.A.; Sheehan, J.; Voos, J.E. Wearable Performance Devices in Sports Medicine. Sports Health 2016, 8, 74–78</i></p>
<p>training and performance optimization</p>	<p><i>Ferrara, F.; Fattore, S.; Pignato, S.; D'isanto, T. An Integrated Mode to Assess Service Volleyball among Power Glove, Video Analysis and Testing. J. Hum. Sport Exerc. 2019, 14, S739–S745.</i></p>





Table 5 - Functional index monitoring

<p>effectiveness of inspiratory muscle training</p>	<p><u><a href="#">Rozek-Piechura, K.; Kurzaj, M.; Okrzymowska, P.; Kucharski, W.; Stodółka, J.; Maćkała, K. Influence of Inspiratory Muscle Training of Various Intensities on the Physical Performance of Long-Distance Runners. J. Hum. Kinet. 2020, 75, 127–137.</a></u></p>
<p>heart ratemeasurement</p>	<p><u><a href="#">van Rooijen, V.; de Voogd-Claessen, L.; Lauche, K.; Jeanne, V.; van der Vliet, R. Poster Session II, July 14th 2010– Abstracts: Development of a New Product for Unrestrained Heart Rate Measurement in Swimming: A User Centered Design Approach. Procedia Eng. 2010, 2, 3469.</a></u></p>
<p>designing optimized training</p>	
<p>training load quantified by heart rate monitoring</p>	
<p>training that takes into account position-specific training in the field</p>	<p><u><a href="#">Lupo, C.; Unquareanu, A.N.; Boccia, G.; Licciardi, A.; Rainoldi, A.; Brustio, P.R. Internal-Training-Load Monitoring, Notational and Time-Motion Analyses, Psychometric Status, and Neuromuscular Responses in Elite Rugby Union. Int. J. Sports Physiol. Perform. 2021, 16, 421–428.</a></u></p>
<p>real-time measurement of the hydration status index</p>	<p><u><a href="#">Rentz, L.E.; Hornsby, W.G.; Gawel, W.J.; Rawls, B.G.; Ramadan, J.; Galster, S.M. Contextual Variation in External and Internal Workloads across the Competitive Season of a Collegiate Women's Soccer Team. Sports 2021, 9, 165.</a></u></p>







<p>energy consumption during competitive periods</p>	<p><a href="#">Cullen, B.D.; Roantree, M.T.; McCarren, A.L.; Kelly, D.T.; O'Connor, P.L.; Hughes, S.M.; Daly, P.G.; Moyna, N.M. Physiological Profile and Activity Pattern of Minor Gaelic Football Players. J. Strength Cond. Res. 2017, 31, 1811–1820.</a></p>
<p>nutritional strategies to ensure sufficient energy availability</p>	<p><a href="#">Bender, B.F.; Johnson, N.J.; Berry, J.A.; Frazier, K.M.; Bender, M.B. Automated Urinal-Based Specific Gravity Measurement Device for Real-Time Hydration Monitoring in Male Athletes. Front. Sport. Act. Living 2022, 4, 921418.</a></p>

Table 6 - Managing training tasks

<p>external acceleration task identification with count-based metrics</p>	
<p>load monitoring and its application in high-performance sport</p>	<p><a href="#">Burgess, D.J. The Research Doesn't Always Apply: Practical Solutions to Evidence-Based Training-Load Monitoring in Elite Team Sports. Int. J. Sports Physiol. Perform. 2017, 12, S2-136–S2-141.</a></p>
<p>managing effort intensity and workload</p>	<p><a href="#">McNamara, D.J.; Gabbett, T.J.; Blanch, P.; Kelly, L. The Relationship between Variables in Wearable Microtechnology Devices and Cricket Fast-Bowling Intensity. Int. J. Sports Physiol. Perform. 2018, 13, 135–139.</a></p>
<p>large clubs could generate and share knowledge about training tasks and player health, more judicious rationalization of the training load to improve performance</p>	<p><a href="#">Houtmeyers, K.C.; Vanrenterghem, J.; Jaspers, A.; Ruf, L.; Brink, M.S.; Helsen, W.F. Load Monitoring Practice in European Elite Football and the Impact of Club Culture and Financial Resources. Front. Sport. Act. Living 2021, 3, 139</a></p>





<p><i>gradually increasing the intensity of training can reduce the risk of injury</i></p>	<p><a href="#"><i>Vanrenterghem, J.; Nedergaard, N.J.; Robinson, M.A.; Drust, B. Training Load Monitoring in Team Sports: A Novel Framework Separating Physiological and Biomechanical Load-Adaptation Pathways. Sports Med. 2017, 47, 2135–2142.</i></a></p>
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Table 7

Benefits of GPS and GNSS systems in Football and Basketball are as follows:

- High number of measurements possible
- Short installation time
- Operator not needed

Limitations:

- Device attached to player and device size issues for matchday usage
- Satellite signal line of sight in stadium
- Accuracy concerns of measured data

Figure 14





## 2.5. Video analysis in Football and Basketball

Recent developments in video analysis of sports have a focus on the features of computer vision techniques which are used to perform certain operations for which these are assigned, such as detailed complex analysis like detection and classification of each player based on their team in every frame or by recognizing the jersey number to classify players based on their team will help to classify various events where the player is involved. In higher-level analysis, such as tracking the player or ball, many more such evaluations are to be considered for the evaluation of a player's skills, detecting the team's strategies, and events and the formation of tactical positions such as midfield analysis in various sports like soccer, basketball, etc., and also various sports vision applications such as smart assistants, virtual umpires, assistance coaches, etc. are applied in coaching education.. A higher level semantic interpretation is an effective substitute, especially in situations requiring real-time analysis and minimal human intervention for exploitation of the delivered system outputs.

### 2.5.1. Video analysis in Football

Soccer is played using football and two teams of eleven players each compete to get the ball into the other team's goal, thereby scoring a goal. The players always confuse each other by changing their speed or direction unexpectedly. Due to their same jersey color, players look almost identical and are frequently involved in possessing the ball which leads to severe occlusions and tracking ambiguities. In such cases, the jersey number must be detected to recognize the player. According to research, the major challenge is to evaluate the performance of the players, find their relative positions at regular intervals, and link spatiotemporal data to extract trajectories.

The studies and articles described below explain the Accurate Tracking of football players' approaches at the theoretical and practical levels.

Table 8

No	Reference	Year
1	Naik, B.; Hashmi, M.F. YOLOv3-SORT detection and	2023





	tracking player-ball in soccer sport. <i>Journal of Electronic Imaging</i> 2023, 32, 011003. doi:10.1117/1.JEI.32.1.011003.	
2	Naik, B.; Hashmi, M.F.; Geem, Z.W.; Dhanraj, B.N. DeepPlayer-Track: Player and Referee Tracking with Jersey Color Recognition in Soccer. <i>IEEE Access</i> 2022, pp. 1–1. doi:10.1109/ACCESS.2022.3161441.	2022
3	Hurault, Samuel, Coloma Ballester, and Gloria Haro. "Self-Supervised Small Soccer Player Detection and Tracking." In <i>Proceedings of the 3rd International Workshop on Multimedia Content Analysis in Sports</i> , pp. 9-18. 2020.	2020
4	Kamble, Paresh R., Avinash G. Keskar, and Kishor M. Bhurchandi. "A convolutional neural network based 3D ball tracking by detection in soccer videos." In <i>Eleventh International Conference on machine vision (ICMV 2018)</i> , vol. 11041, p. 1104120. International Society for Optics and Photonics, 2019.	2019
5	Komorowski, Jacek, Grzegorz Kurzejamski, and Grzegorz Sarwas. "BallTrack: Football ball tracking for real-time	2019





	CCTV systems." In <i>2019 16th International Conference on Machine Vision Applications (MVA)</i> , pp. 1-5. IEEE, 2019.	
6	Kim, Wonjun. "Multiple object tracking in soccer videos using topographic surface analysis." <i>Journal of Visual Communication and Image Representation</i> 65 (2019): 102683.	2019
7	Kamble, P. R., A. G. Keskar, and K. M. Bhurchandi. "A deep learning ball tracking system in soccer videos." <i>Opto-Electronics Review</i> 27, no. 1 (2019): 58-69.	2019
8	Baysal, Sermetcan, and Pinar Duygulu. "Sentioscope: a soccer player tracking system using model field particles." <i>IEEE Transactions on Circuits and Systems for Video Technology</i> 26, no. 7 (2015): 1350-1362.	2015
9	Choi, Kyuhyoung, and Yongduek Seo. "Automatic initialization for 3D soccer player tracking." <i>Pattern Recognition Letters</i> 32, no. 9 (2011): 1274-1282.	2011
10	Liu, Jia, Xiaofeng Tong, Wenlong Li, Tao Wang, Yimin Zhang, and Hongqi Wang. "Automatic player detection, labeling and tracking in	2009





	broadcast soccer video." <i>Pattern Recognition Letters</i> 30, no. 2 (2009): 103-113.	
11	Naidoo, Wayne Chelliah, and Jules Raymond Tapamo. "Soccer video analysis by ball, player and referee tracking." In <i>Proceedings of the 2006 annual research conference of the South African institute of computer scientists and information technologists on IT research in developing countries</i> , pp. 51-60. 2006.	2006

Four studies concentrate on the detection of multiple players as well as balls in real time.

Table 9

No	Reference	Year
1	Komorowski, Jacek, GrzegorzKurzejamski, and GrzegorzSarwas. "FootAndBall: Integrated player and ball detector." <i>arXiv preprint arXiv:1912.05445</i> (2019).	2019
2	Leo, Marco, Pier Luigi Mazzeo, Massimiliano Nitti, and Paolo Spagnolo. "Accurate ball detection in soccer images using probabilistic analysis of	2013







	salient regions." <i>Machine vision and applications</i> 24, no. 8 (2013): 1561-1574.	
3	Mazzeo, Pier Luigi, Marco Leo, Paolo Spagnolo, and Massimiliano Nitti. "Soccer ball detection by comparing different feature extraction methodologies." <i>Advances in Artificial Intelligence</i> 2012 (2012).	2012
4	Pallavi, V., Jayanta Mukherjee, Arun K. Majumdar, and Shamik Sural. "Ball detection from broadcast soccer videos using static and dynamic features." <i>Journal of Visual Communication and Image Representation</i> 19, no. 7 (2008): 426-436.	2008

The systems which evaluate the player or team's performance have the potential to reveal aspects of the game that are not obvious to the human eye. Such systems can successfully evaluate the activities of players such as distance covered by players, shot detection, number of sprints, player's position and their movements, player's relative position concerning other players, possession of the soccer ball, and motion/gesture recognition of referee], predicting player trajectories for shot situations. The generated data can evaluate individual player performance, and occlusion handling by detecting the position of the player, action recognition, predicting and classifying the passes, key event extraction, the tactical performance of the team, and analyzing the team tactics based on the team formation, generating highlights. Table 8 summarizes various proposed methodologies to resolve various challenging tasks in football sport with their limitations.





Table 10

Studies in Football				
Ref.	Problem Statement	Proposed Methodology	Precision and Performance characteristics	Limitations and Remarks
B. Thulasya Naik et al. 2022 [291]	Player and ball detection and tracking in soccer.	YOLOv3 and SORT	Methodology achieved a tracking accuracy of 93.7% on multiple object tracking accuracy metrics with a detection speed of 23.7 FPS and a tracking speed of 11.3 FPS.	This methodology effectively handles challenging situations, such as partial occlusions, players, and ball, reappears after a few frames but fails when the players were severely occluded.
B. Thulasya Naik et al. 2022 [292]	Player, referee and ball detection and tracking by jersey color recognition in soccer.	DeepPlayer-Track	Model achieved a tracking accuracy of 96% and 60% on MOTA and GMOTA metrics respectively with a detection speed of 23 FPS.	The limitation of this method is that when the player with the same jersey color is occluded, the ID of the player is switched.





G Paul et al. 2021 [72]	Tracking soccer players to evaluate the number of goals scored by a player.	Machine Learning and Deep Reinforcement Learning.	Performance of player tracking model measured in terms of mAP and achieved 74.6%.	The method failed to track the ball at critical moments such as pass at the beginning and shot.  It also failed to overcome the identity-switching problem.
H Cho et al. 2021 [89]	Extracting ball events to classify the player passing style.	Convolutional Auto-Encoder	Methodology evaluated in terms of accuracy and achieved 76.5% for 20 players.	Concatenation of auto-encoder and extreme learning machine techniques will improve the events classification performance.
K Ali et al. 2021 [96]	Detecting events in soccer sport.	Variational Auto-encoder and EfficientNet	Achieved an F1-score of 95.2% event images and Recall of 51.2% on images not related to soccer at a threshold value of 0.50.	Deep extreme learning machine technique which employs an auto-encoder technique may enhance the event detection accuracy.
Anthony et al. 2020 [77]	Action spotting soccer video.	YOLO-like encoder	Algorithm achieved mAP of 62.5%.	-- ----





S Kusmakar et al. 2020 [73]	Team performance analysis in soccer	SVM	Prediction models achieved an overall accuracy of 75:2% in predicting the correct segmental outcome of the likelihood of a team making a successful attempt to score a goal on the used dataset.	The proposed model failed in identifying the players that are more frequently involved in match states that end with an attempt at scoring i.e., a “SHOT ” at goal which may assist sports analysts and team staff to develop strategies suited to an opponent’s playing style.
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### 2.5.2. Video analysis in Basketball

Basketball is played by two teams of five players each. The object of the game is to score more points than opponent. The ball is passed, thrown, bounced, batted, or rolled from one player to another. Physical contact with an opponent can result in a foul if the contact impedes the desired movement of the player. The advent of computer vision techniques have effectively replaced manual analysis of tennis sports with fully automated systems. Recognizing the player action and classifying the events in basketball videos helps to analyze the player performance. Player/ball detection and tracking in basketball videos is carried out in but fails in assigning specific identification to avoid the identity switching among the players when they crossed. By estimating the pose of the player, the trajectory of the ball is estimated from various distances to the basket. By recognizing and classifying the referee signals [38], player behaviour can be assessed and highlights of the game can be extracted. The behaviour of a basketball team can be characterized by the dynamics of space creation presented in that works to counteract space creation dynamics with defensive play presented in. By detecting a specific location of the player and ball in the basketball court, the player movement can be predicted and the ball trajectory can be generated in three-dimensional which is a complicated task. It is also necessary to study the extraction of basketball players’ shooting motion trajectory, combined with the image feature analysis method of basketball shooting, to reconstruct and quantitatively track the basketball players’ shooting





motion trajectory. However, it is difficult to analyze the game data for each play such as the ball tracking or motion of the players in the game, because the situation of the game changes rapidly, and the structure of the data should be complicated. Therefore, it is necessary to analyze the real-time gameplay. Table 9 summarizes various proposed methodologies to resolve various challenging tasks in basketball sport with their limitations.

Table 11

Studies in Basketball				
Ref.	Problem Statement	Proposed Methodology	Precision and Performance Characteristics	Limitations and Remarks
L Long 2021 [29]	Recognition technique.		coefficient, and Root MeanSquared Error and achieved 0.921, 0.803, 0.932, and 1.03 respectively.	The accuracy of action recognition can be improved with a deep convolutional neural network.
Bertugli A etal. 2021 [51]	Multi-future trajectory prediction in basketball.	Conditional Variational Recurrent Neural Networks (RNN) - TrajNet++	The proposed methodology was tested on Average Displacement Error and Final Displacement Error metrics. The methodology is robust if smaller the number is and it has achieved 7.01 and 10.61.	The proposed methodology fails to predict the trajectories in case of uncertain and complex scenarios. As the behaviour of the basketball/players are dynamic in nature, belief maps cannot steer future positions. Training the model with a dataset of different events can rectify the failures of predictions.





<p>Y Wang et al. 2021 [56]</p>	<p>Predicting line-up performance of basketball players by analyzing the situation of the field.</p>	<p>RNN + NN</p>	<p>At the point guard (pg) position 4 candidates were taken and at the center (c) position 3 candidates were taken. The total score of pg candidates is 13.67, 12.96, 13.42, 10.39, and the total score of candidates is 10.21, 14.08, and 13.48 respectively.</p>	<p>-----</p>
<p>Xubo Fu et al. 2020 [30]</p>	<p>Multiplayer tracking in basketball videos</p>	<p>YOLOv3 + Deep-SORT Faster-RCNN + Deep-SORT YOLOv3 + DeepMOT Faster-RCNN + DeepMOT JDE</p>	<p>Faster-RCNN provides better accuracy than YOLOv3 among baseline detectors. Joint Detection and Embedding method perform better in accuracy of tracking and computing speed among multiobject tracking methods.</p>	<p>Tracking in specific areas like severe occlusions and improving detection precision and improves accuracy and computation speed. By adopting frame extracting methods, in terms of speed and accuracy, it can achieve comprehensive performance, which may be an alternative solution.</p>
<p>Julius Žemgulys et al. 2020 [38]</p>	<p>Recognizing the referee signals from real-time videos in the basketball game.</p>	<p>HOG + SVM LBP + SVM</p>	<p>Achieved an accuracy of 95.6% for referee signal recognition using local binary pattern features and SVM classification.</p>	<p>In case of a noisy environment, a significant chance of occlusion, unusual viewing angle, and/or variability of gestures, the performance of the proposed method is not consistent. Detecting with jersey colour and eliminating all other detected elements in the frame can be the other solution to improve the accuracy of referee signal recognition.</p>





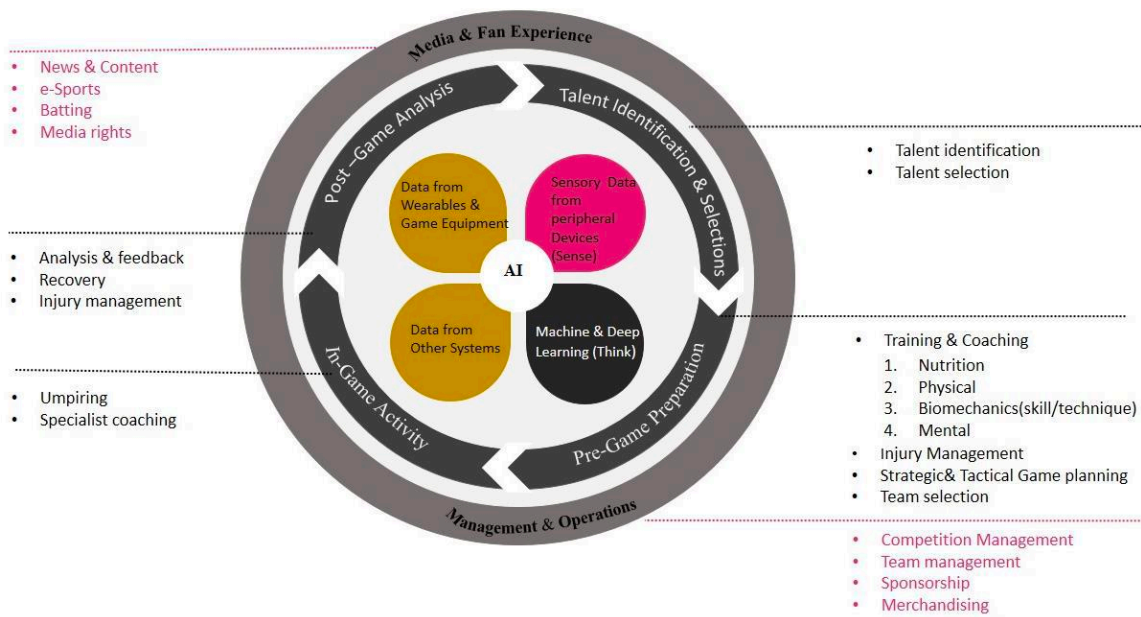


## 2.6. Artificial Intelligence and Virtual Reality in Football and Basketball

### 2.6.1. Artificial Intelligence in football and basketball

Artificial intelligence has given a new impetus to one of the world’s most popular, extreme, and unmatched industries — sports. This is supported by the following stats of the sports market research: the global AI in sports market is predicted to reach \$19.2 billion by 2030, and grow at a CAGR of 30.3% from 2021 to 2030. AI is steadily seeping through all areas of the sports sector and industry, gaining traction across post-game analysis, in-game activity, and fan experience. Implementing AI is also a viable strategy for enhancing players’ performance and advanced sports data analytics. AI can identify the maximum potential of the player, as well as the areas that still need improvement.

Figure 15 - Picture / Artificial intelligence in sports industry



AI is used the European sports Training & Coaching.



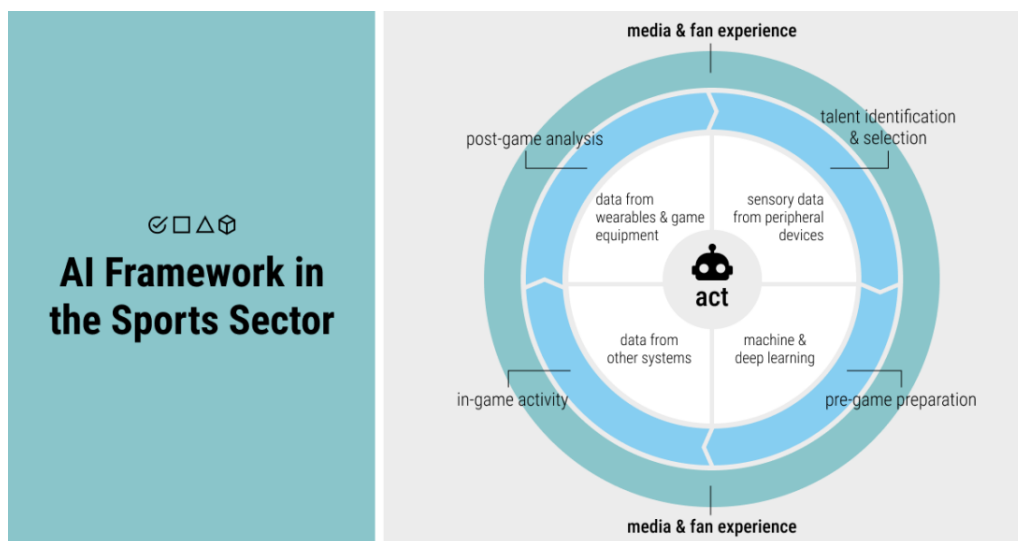


Preparing for a single game requires a significant amount of time and effort on the part of the players. It also requires a great deal of effort on the part of the coaches. With the advent of advanced technology in the sports sector, it has become much easier for athletes and coaches to train, track performance, and prepare the entire team for the upcoming game. Over the last few years, the number of AI-powered applications for tracking and evaluating physical activity, such as wearable tech or digital coaches, has increased, bringing AI closer to sports. ML algorithms will soon be able to utilize performance data and generate recommendations based on the target goals, including better biomechanics, nutrition, and customized training. Other possibilities of AI for smart training and coaching are enabled by CV techniques like human pose estimation for human pose detection in real-time.

Football, aka soccer in the US and Canada, is arguably the most popular sport in the world. Advanced game statistics play a fundamental role in how the football sector operates in today's fast-paced world. It also shapes the current recruitment process in this area. But of course, analytics is not without data.

In football settings, the sprint pace, the number of passes, or the number of shots are the main factors to consider to get the right data for game analytics. This data is useful for coaches, who can use it to decide how to organize players on the field or make changes to a game plan for the most rewarding results of a football match. However, the process of integrating AI-powered technology into football has only recently been optimized with the introduction of tablets in the field for real-time data analysis.

Figure 16 - Artificial framework in the sports sector





How artificial intelligence is used in football?

- Goal-Line Technology (GLT): If the ball crosses the goal line, GLT accurately detects human errors and alerts the referee through vibration to his watch.
- Video Assistant Referee (VAR): Improves the game's efficiency by assisting referees in making better choices during football games using video footage and a headset connected to a video operation room. VAR was originally utilized at the 2018 FIFA World Cup, however, it's currently used in every Champions League game.
- Near Field Communication (NFC): Telstar's NFC AI-driven chip was introduced at the 2018 FIFA World Cup, allowing users to interact with the ball using their smartphones for a more personalized fan experience.

AI is an umbrella term for the [multitude of high-tech solutions](#) that are applied in sports today. This includes sophisticated [CV systems](#) used for smart ticketing, automated video highlights, and optimized security cameras, as well as [complex ML algorithms](#) used to predict the success or failure of the game. We'll discuss these solutions in more detail very soon.

### 2.6.2. Artificial Intelligence in basketball

Basketball uses AI. The sophisticated technologies help measure the pass distances or even the player's speed. This way, AI in basketball augments the work of coaches, players, and sports commentators. It also allows for a deeper understanding of the basketball game through big [data](#).

Basketball teams have mastered AI much sooner than the football teams. For instance, NBA players reap the benefits of AI through a CV-based app called [HomeCourt](#). It helps players improve their basketball skills by tracking the ball, the players, and providing the shooting stats. Another company, Stats, was among the first ones to deploy a [SportVu camera system](#) in NBA arenas to track the players' movements. However, the abundance of sports data in basketball required more complex systems to extract meaningful information from it, which is why [ML algorithms](#) were soon applied to this type of sport.

AI also helps to deal with the language barriers among the NBA players using [NLP technology](#). Case in point, the Sacramento Kings' chatbot called [KAI](#) (King's Artificial Intelligence) was used to engage with fans and answer their game-related questions in real-time.

### 2.6.3 Machine learning in football and basketball





As a subset of AI, machine learning established a whole new, data-driven reality for the sports industry. People can obtain data from their bodies and movements to get a deeper understanding of their performance and physical endurance, and also get insights into their favorite sports games. Players, coaches, and referees benefit from ML solutions as well, which we've already discussed above. But there's so much more that machine learning has brought to sports!

ML can provide valuable information to improve player recruitment, as well as their performance on the field. Most importantly, machine learning enables technical support towards automation and digitization, which in turn, contributes to the sports market expansion. Since ML dominates the classification and prediction domains, it's commonly used for its unmatched predictive capabilities in sports, like injury prediction (supervised ML) or fan segmentation (unsupervised ML).

In general, sports analytics applies supervised ML algorithms, like Naive Bayes, decision trees, linear regression, and neural networks, as well as unsupervised ML algorithms, like K-means clustering and association rules. All these algorithms use sports data to generate insights on player performance and team efficiency. In addition, here's the list of the main sports areas where machine learning has left its mark:

- Player scouting and development
- Player projection
- Injury prediction
- Player performance prediction
- Game strategy optimization
- Enhanced decision-making
- Fans engagement analysis
- Ticket pricing

There are multiple ways to classify, detect, and track objects to analyze the semantic levels involved in various sports. It paves the way for player localization, jersey number recognition, event classification, trajectory forecasting of the ball, etc., in a sports video with a much better interpretation of an image as a whole.

The study "A Comprehensive Review of Computer Vision in Sports: Open Issues, Future Trends and Research Directions"<sup>12</sup> figures 8, 9 and 10 show block diagrams of road maps to machine

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<sup>12</sup> Naik, B. T., Hashmi, M. F., & Bokde, N. D. (2022). A comprehensive review of computer vision in sports: Open issues, future trends and research directions. *Applied Sciences*, 12(9), 4429.





learning architecture selection and training, deep learning architecture selection and training and overview of Deep Learning Algorithms of classification/detection, tracking and trajectory prediction.

Figure 17 - Block diagram of road map to machine learning architecture selection and training

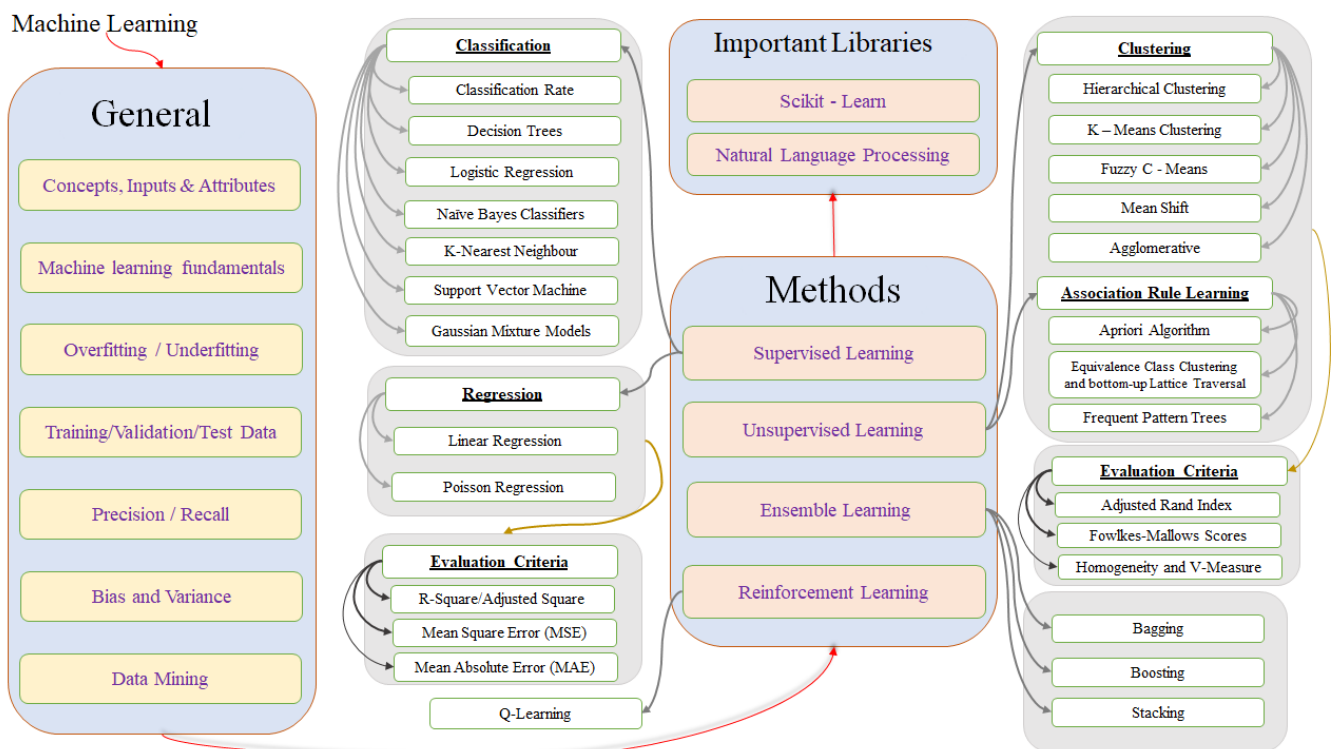


Figure 18 - Block diagram of road map to deep learning architecture selection and training

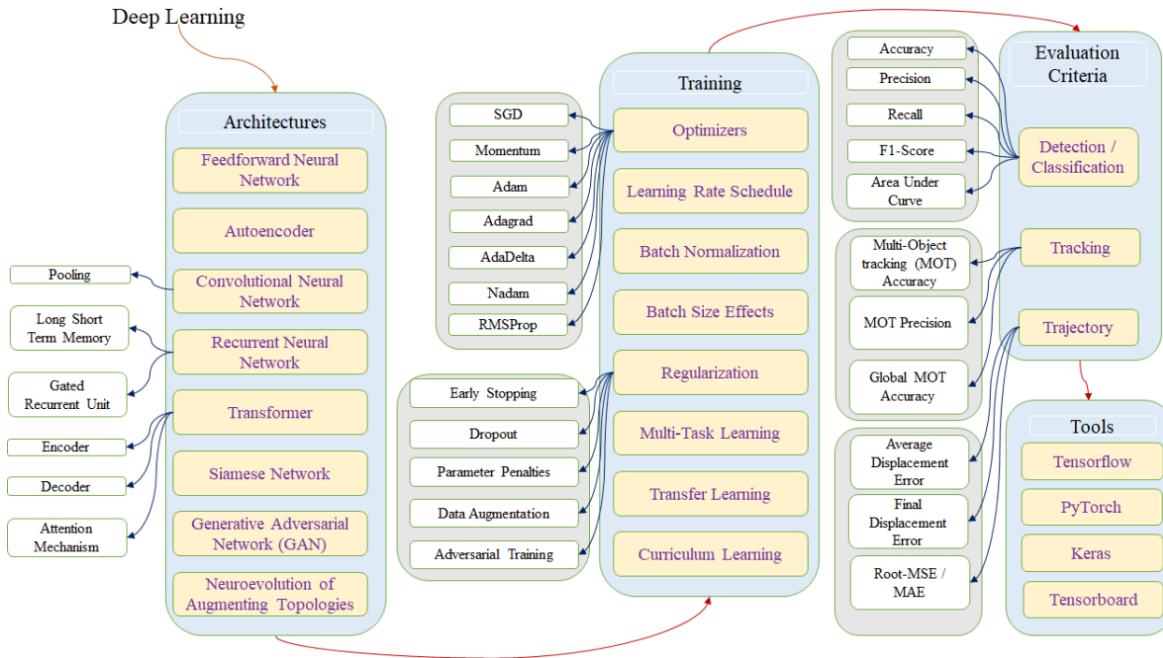
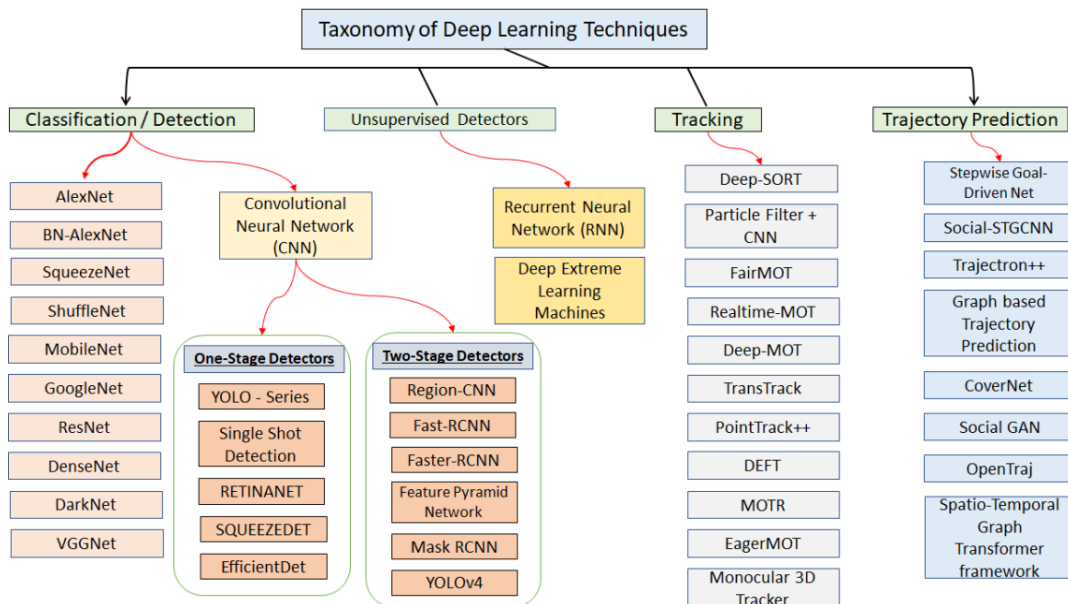


Figure 19 - Overview of Deep Learning Algorithms of classification/detection, tracking and trajectory prediction







The selected AI algorithm is better if it is tested and benchmarked on the different data. For that to evaluate the robustness of AI algorithms some metrics are required, which measures the performance of particular AI algorithm to enable better selection. Figure 8 depicts the road map of the machine learning algorithms' general information, methods, and evaluation criteria for a particular task and required libraries/tools for training the model. Whereas Figure 9 depicts the roadmap of the deep learning algorithm selection, training, and evaluation criteria for a particular task and required libraries/tools for training the model. Figure 10 shows taxonomy of various deep learning techniques of classification, detection algorithms, unsupervised learning, tracking], and trajectory prediction. Since various tasks in sports such as classification/detection, tracking, and trajectory prediction show great advantages in various sports. Several studies well explain the ML and DL in sports such as:

Table 12

Studies	Year
Howard, Andrew G., Menglong Zhu, Bo Chen, Dmitry Kalenichenko, Weijun Wang, Tobias Weyand, Marco Andreetto, and Hartwig Adam. "Mobilenets: Efficient convolutional neural networks for mobile vision applications." <i>arXiv preprint arXiv:1704.04861</i> (2017).	2017
Krizhevsky, Alex, Ilya Sutskever, and Geoffrey E. Hinton. "ImageNet classification with deep convolutional neural networks." <i>Communications of the ACM</i> 60, no. 6 (2017): 84-90.	2017
Simonyan, Karen, and Andrew Zisserman. "Very deep convolutional networks for large-scale image recognition." <i>arXiv preprint arXiv:1409.1556</i> (2014).	2014
Szegedy, Christian, Wei Liu, Yangqing Jia, Pierre Sermanet, Scott Reed, Dragomir Anguelov, Dumitru Erhan, Vincent Vanhoucke, and Andrew Rabinovich. "Going deeper with convolutions." In <i>Proceedings of the IEEE conference on computer vision and pattern recognition</i> , pp. 1-9. 2015.	2015
He, Kaiming, Xiangyu Zhang, Shaoqing Ren, and Jian Sun. "Deep residual learning for image recognition." In <i>Proceedings of the IEEE conference on computer vision and pattern recognition</i> , pp. 770-778. 2016.	2016





<p>landola, Forrest N., Song Han, Matthew W. Moskewicz, Khalid Ashraf, William J. Dally, and Kurt Keutzer. "SqueezeNet: AlexNet-level accuracy with 50x fewer parameters and &lt; 0.5 MB model size." <i>arXiv preprint arXiv:1602.07360</i> (2016).</p>	<p>2016</p>
<p>Howard, Andrew G., Menglong Zhu, Bo Chen, Dmitry Kalenichenko, Weijun Wang, Tobias Weyand, Marco Andreetto, and Hartwig Adam. "Mobilenets: Efficient convolutional neural networks for mobile vision applications." <i>arXiv preprint arXiv:1704.04861</i> (2017),          Yu, Cunjun, Xiao Ma, Jiawei Ren, Haiyu Zhao, and Shuai Yi. "Spatio-temporal graph transformer networks for pedestrian trajectory prediction." In <i>European Conference on Computer Vision</i>, pp. 507-523. Springer, Cham, 2020.</p>	<p>2017, 2020,</p>
<p>Murthy, Chinthakindi Balaram, Mohammad Farukh Hashmi, Neeraj Dhanraj Bokde, and Zong Woo Geem. "Investigations of object detection in images/videos using various deep learning techniques and embedded platforms—A comprehensive review." <i>Applied sciences</i> 10, no. 9 (2020): 3280.</p>	<p>2020</p>
<p>Zaremba, Wojciech, Ilya Sutskever, and Oriol Vinyals. "Recurrent neural network regularization." <i>arXiv preprint arXiv:1409.2329</i> (2014), Jiang, X. W., T. H. Yan, J. J. Zhu, B. He, W. H. Li, H. P. Du, and S. S. Sun. "Densely connected deep extreme learning machine algorithm." <i>Cognitive Computation</i> 12, no. 5 (2020): 979-990.</p>	<p>2014, 2020</p>
<p>Zhang, Yifu, Chunyu Wang, Xinggang Wang, Wenjun Zeng, and Wenyu Liu. "Fairmot: On the fairness of detection and re-identification in multiple object tracking." <i>arXiv preprint arXiv:2004.01888</i> (2020).</p>	<p>2020</p>
<p>Wojke, Nicolai, Alex Bewley, and Dietrich Paulus. "Simple online and realtime tracking with a deep association metric." In <i>2017 IEEE international conference on image processing (ICIP)</i>, pp. 3645-3649. IEEE, 2017.</p>	<p>2017</p>
<p>Hu, Hou-Ning, Yung-Hsu Yang, Tobias Fischer, Trevor Darrell, Fisher Yu, and Min Sun. "Monocular Quasi-Dense 3D Object Tracking." <i>arXiv preprint arXiv:2103.07351</i> (2021).</p>	<p>2021</p>
<p>Kim, Aleksandr, Aljoša Ošep, and Laura Leal-Taixé. "EagerMOT: 3D Multi-Object Tracking via Sensor Fusion." <i>arXiv preprint arXiv:2104.14682</i> (2021).</p>	<p>2021</p>





Chaabane, Mohamed, Peter Zhang, J. Ross Beveridge, and Stephen O'Hara. "Deft: Detection embeddings for tracking." <i>arXiv preprint arXiv:2102.02267</i> (2021).	2021
Zeng, Fangao, Bin Dong, Tiancai Wang, Cheng Chen, Xiangyu Zhang, and Yichen Wei. "MOTR: End-to-End Multiple-Object Tracking with TTransformer." <i>arXiv preprint arXiv:2105.03247</i> (2021).	2021
Wang, Zhongdao, Liang Zheng, Yixuan Liu, Yali Li, and Shengjin Wang. "Towards real-time multi-object tracking." In <i>Computer Vision—ECCV 2020: 16th European Conference, Glasgow, UK, August 23–28, 2020, Proceedings, Part XI 16</i> , pp. 107-122. Springer International Publishing, 2020.	2020
Gupta, Agrim, Justin Johnson, Li Fei-Fei, Silvio Savarese, and Alexandre Alahi. "Social gan: Socially acceptable trajectories with generative adversarial networks." In <i>Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition</i> , pp. 2255-2264. 2018.	2018
Amirian, Javad, Bingqing Zhang, Francisco Valente Castro, Juan Jose Baldelomar, Jean-Bernard Hayet, and Julien Pettré. "Opentraj: Assessing prediction complexity in human trajectories datasets." In <i>Proceedings of the Asian Conference on Computer Vision</i> . 2020.	2020
Wang, Chuhua, Yuchen Wang, Mingze Xu, and David J. Crandall. "Stepwise Goal-Driven Networks for Trajectory Prediction." <i>arXiv preprint arXiv:2103.14107</i> (2021).	2021

### 2.6.3. Virtual reality in Football and Basketball

#### 2.6.3.1. Virtual reality in Football

Virtual reality (VR) technology has become increasingly popular in sports training and coaching, including football in Europe. Here are some examples and theories of how VR is being used in European soccer coaching:

- Tactical analysis: VR can be used to create virtual simulations of real game scenarios, allowing coaches to analyze and assess players' decision-making, positioning, and tactical awareness. For example, the Dutch soccer club PSV Eindhoven uses VR to train





their youth academy players, creating realistic game scenarios that help young players develop their game intelligence.

- Injury prevention: VR can also be used to simulate high-risk game situations, such as tackles or collisions, allowing players to practice how to avoid injuries. The German national team used VR simulations to help players avoid injury during the 2018 FIFA World Cup.
- Mental preparation: VR can also be used to help players mentally prepare for big games, allowing them to practice visualizing and imagining game situations. For example, the French national team used VR simulations to help players prepare for the 2018 World Cup final.
- Fan engagement: VR can also be used to create immersive experiences for fans, allowing them to experience the game from a player's perspective. For example, the English Premier League club Arsenal FC created a VR experience that allows fans to take a virtual tour of the team's stadium and experience game highlights from a player's point of view.

In theory, VR can provide soccer coaches and players with a more immersive and interactive training experience, allowing them to practice and develop their skills in a realistic and safe environment. VR can also provide coaches with new insights into player performance and decision-making, helping them to develop more effective training and coaching strategies. However, VR technology is still relatively new in soccer coaching, and its long-term benefits and limitations are still being explored.

#### 2.6.3.2. Virtual reality in Basketball

Virtual reality (VR) technology is also being used in European basketball for various applications, including training, game analysis, and fan engagement. Here are some examples:

- Player training: VR can be used to create realistic game scenarios, allowing players to practice their skills and decision-making in a controlled environment. For example, the French basketball team, ASVEL, uses VR to train their players by simulating game situations such as defensive drills, pick and roll scenarios, and shooting exercises.
- Game analysis: VR can provide coaches with a new way to analyze games and players' performance. For example, the Spanish basketball team, Real Madrid, uses VR to analyze game footage and provide their players with visual feedback on their positioning, movement, and decision-making.
- Fan engagement: VR can also be used to provide fans with an immersive experience of the game. For example, the German basketball league, BBL, has created a VR experience that allows fans to experience a game from a player's perspective, providing them with a unique view of the court and the action.
- Injury prevention: VR can be used to simulate high-risk game situations, allowing players to practice how to avoid injuries. For example, the Italian basketball team, Olimpia Milano, uses VR simulations to train their players on how to avoid collisions and prevent injuries.





In theory, VR technology can provide basketball coaches and players with a more immersive and interactive training experience, allowing them to practice and develop their skills in a realistic and safe environment. VR can also provide coaches with new insights into player performance and decision-making, helping them to develop more effective training and coaching strategies. However, similar to football, VR technology in basketball is still relatively new, and its long-term benefits and limitations are still being explored.

## 2.7. Performance analysis software and online training platforms in Football and Basketball

Performance Analysis in football states that consequently isolated positional tactical conditioning drills may provide an effective conditioning supplement to more generic training practices (e.g. small sided games), and should be considered when planning conditioning drills (Bradley et al.,2019). Working alongside a coach to plan and implement these drills is not only key to help blend the art of coaching with the science of conditioning, but also to create crucial buy-in.

Data is more powerful with context – understanding what the data is really telling the sports coaches. Unpacking the physical demands of the game in relation to tactical outputs provides greater depth to our understanding of positional demands.

Greater contextual understanding can enhance the specificity of training prescription, drill creation and session design. The development of a drill library that can develop tactical, technical & physical targets in conjunction with each other is highly recommended.

### Pivot Analysis Is Fast Tracking Data Analytics In Basketball

Statistics in basketball games have moved way beyond the number of points/score, number of rebounds, assists, steals, blocks, turnovers, 3-pointers etc. For the coaching team, they would want to visualise the data and see the percentages, make comparisons between players and understand which players have better synergy or which line-up is most effective when playing against different teams. Although game data can be readily available in various leagues, the hard work is in crunching all that data to derive useful metrics and present them in a (visually digestible) format for analysis.

Pivot Analysis (PA) is a start-up that has done all that hard work so that subscribers can jump straight into the value-adding the task of analysis. The PA team built a platform that collects all the publicly available data from the various basketball leagues (NBA, WNBA, NCAA men's & women's, Euro cup, Euro league, and G League), and creates metrics and graphs for every game. Some of their key features include:

- Detailed team/player/game/line-up reports,
- Full play-by-play and line-up tracking and interactive analysis,
- Matchup predictions and metrics,
- Single-player and two-player line-up analytics.





- Incorporating metrics from the Four Factors of basketball success as coined by Dean Oliver.

### Conclusions:

Performance analysis in soccer and basketball involves the use of data and video analysis to evaluate and improve the performance of individual players, teams, and entire leagues. The aim of performance analysis is to identify areas for improvement and to provide data-driven insights that can be used to make strategic decisions.

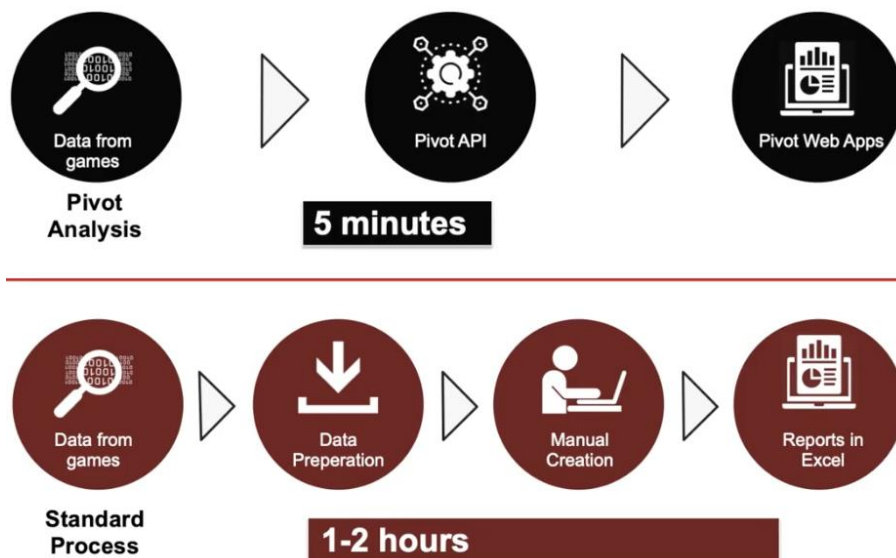
In soccer, performance analysis may involve analyzing data on player movement, passing accuracy, shots on goal, and other performance metrics. This data can then be used to evaluate individual players and the team as a whole, identify areas for improvement, and develop strategies for future games.

In basketball, performance analysis may involve analyzing data on shooting accuracy, ball handling, assists, rebounds, and other performance metrics. This data can then be used to evaluate individual players and the team as a whole, identify areas for improvement, and develop strategies for future games.

Both soccer and basketball also make use of video analysis, which involves analyzing game footage to identify patterns and trends in player behavior. This can be used to gain insights into player performance, tactics, and game strategy.

Overall, performance analysis is a critical component of soccer and basketball coaching and management, and can help teams to improve their performance and achieve their goals.

Figure 20 - Comparison of pivot and standard players' analysis in basketball







## 2.8. Communication apps in Football and Basketball

Effective communication is essential for success in team sports such as football and basketball. To streamline information sharing, coordinate schedules, and foster collaboration, teams rely on communication apps designed specifically for their needs. These apps provide coaches, players, and staff with powerful tools for seamless communication, ensuring everyone stays connected, informed, and aligned towards common goals.

In football and basketball, several communication apps have gained popularity for their features and functionality. Examples include Slack, which offers versatile channels and integrations for efficient collaboration. TeamSnap serves as an all-in-one team management app, facilitating practice schedules, game updates, and player availability tracking. WhatsApp, a widely used messaging app, enables quick and direct communication through group chats and media sharing.

Microsoft Teams provides comprehensive communication and collaboration capabilities, including video conferencing and document sharing. TeamLinkt simplifies team coordination, allowing coaches to send announcements, coordinate schedules, and communicate updates. SportsYou offers messaging, scheduling, and file sharing features tailored for sports teams.

In addition, Teamer facilitates team-wide announcements, training session coordination, and instant messaging. BAND provides group chats, event planning, and file sharing for effective team communication. Teamstuff streamlines communication by enabling team-wide messaging, schedule sharing, and attendance tracking.

These communication apps play a vital role in enhancing team communication, collaboration, and organization. They simplify information sharing, streamline coordination, and ensure that coaches, players, and staff are on the same page. With features like messaging, file sharing, schedule coordination, and attendance tracking, these apps empower teams to stay connected and informed, ultimately leading to improved performance and success on the field or court.

By leveraging communication apps designed specifically for football and basketball, teams can foster a cohesive and informed team environment. These apps provide the necessary tools to facilitate efficient communication, coordinate schedules, share important updates, and enhance collaboration among team members. In the dynamic world of team sports, effective communication is a key ingredient for success, and these apps serve as valuable resources for achieving that goal.

Here are some concrete examples about applications that can be used for communication purposes for both basketball and football:

- **Slack**<sup>13</sup>: Slack is a versatile communication app used in various sports, including football and basketball. It allows teams to create channels for different topics, such as game

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<sup>13</sup> <https://slack.com/>





strategies, training sessions, and team announcements. Coaches, players, and staff can communicate through direct messaging, share files, and integrate other tools like Google Drive or Trello. Slack promotes seamless collaboration, efficient communication, and easy access to information.

- **TeamSnap**<sup>14</sup>: TeamSnap is an all-in-one team management app that includes robust communication features. It is widely used in both football and basketball teams. Coaches can share practice schedules, game updates, and important announcements with players and parents. The app also allows players to indicate their availability for upcoming events, facilitating efficient planning and coordination. TeamSnap simplifies team communication and ensures everyone stays informed.
- **WhatsApp**<sup>15</sup>: WhatsApp is a widely used messaging app across sports, including football and basketball. Coaches, players, and staff can create group chats for team communication. It enables coaches to share training videos, game analysis, and tactical instructions through text messages, voice notes, or media files. WhatsApp's simplicity, accessibility, and widespread use make it a convenient option for quick and direct communication.
- **Microsoft Teams**<sup>16</sup>: Microsoft Teams is a comprehensive collaboration platform used in various sports, including football and basketball. It provides communication, file sharing, and video conferencing capabilities. Coaches can organize virtual meetings, share presentations, and conduct video analysis sessions. Teams also offers a centralized location for team documents, resources, and schedules. Its integration with other Microsoft tools makes it a powerful communication platform for teams.
- **TeamLinkt**<sup>17</sup>: TeamLinkt is a team management app that offers communication features suitable for football and basketball teams. Coaches can send team-wide announcements, coordinate practice schedules, and communicate updates. The app allows players to indicate their availability for upcoming events and provides real-time messaging capabilities for team communication. TeamLinkt simplifies team coordination and enhances communication efficiency.
- **SportsYou**<sup>18</sup>: SportsYou is a communication app designed specifically for sports teams. It offers features for team messaging, schedule coordination, and file sharing. Coaches can easily communicate with players and parents, share training materials, and coordinate team activities. The app also provides event reminders and attendance tracking, helping teams stay organized and ensuring effective communication between coaches, players, and parents.

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<sup>14</sup> <https://www.teamsnap.com/>

<sup>15</sup> <https://www.whatsapp.com/>

<sup>16</sup> <https://www.microsoft.com/en/microsoft-365/microsoft-teams/group-chat-software>

<sup>17</sup> <https://www.teamlinkt.com/>

<sup>18</sup> <https://www.sportsyou.com/>





- **Teamer**<sup>19</sup>: Teamer is a popular communication app used in football teams. It allows coaches to send team-wide announcements, coordinate training sessions, and communicate important updates. The app also includes features for player availability, event RSVPs, and instant messaging. Teamer simplifies team communication and ensures everyone stays connected and informed.
- **BAND**<sup>20</sup>: BAND is a versatile team communication app used in various sports, including football and basketball. It offers features such as group chats, event planning, file sharing, and calendar integration. Coaches can easily communicate with team members, share important updates, and coordinate team activities. BAND simplifies team coordination and enhances communication efficiency.
- **Teamstuff**<sup>21</sup>: Teamstuff is a team management app that includes communication features tailored for football and basketball teams. Coaches can send team-wide messages, share schedules, and coordinate game details. The app also provides features for player availability, attendance tracking, and reminders. Teamstuff simplifies team communication and organization, ensuring everyone has access to the necessary information.

In conclusion, the integration of digital technologies and communication apps has significantly transformed the landscape of coaching and team management in basketball and football. European companies have pioneered innovative solutions that enhance player development, team performance analysis, and coaching strategies. These technologies, such as player tracking systems, training apps, virtual reality platforms, smart training equipment, team management platforms, and basketball analytics software, provide valuable insights, personalized training resources, immersive experiences, and efficient team organization.

Furthermore, communication apps have revolutionized how teams communicate, collaborate, and coordinate activities. Examples such as Slack, TeamSnap, WhatsApp, Microsoft Teams, TeamLinkt, SportsYou, Teamer, BAND, and Teamstuff offer various features for streamlined communication, schedule coordination, file sharing, and team-wide announcements. These apps have become indispensable tools for coaches, players, and staff, fostering effective communication, improving organization, and maximizing team performance.

By embracing these digital technologies and communication apps, basketball and football teams can optimize their coaching methodologies, enhance player development, streamline team communication, and achieve improved performance on the field or court. These advancements

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<sup>19</sup> <https://teamer.net/>

<sup>20</sup> <https://band.us/>

<sup>21</sup> <https://www.teamstuff.com/>





have provided coaches and players with valuable resources, data-driven insights, and streamlined communication channels, enabling them to make informed decisions, refine their skills, and work collaboratively towards common goals.

In the dynamic and competitive world of team sports, staying connected, informed, and organized is crucial. The integration of digital technologies and communication apps empowers coaches, players, and staff to enhance their coaching methodologies, streamline operations, and achieve success. Whether it's analyzing player performance, sharing training resources, coordinating schedules, or fostering effective team communication, these technological advancements have revolutionized the way basketball and football are played, coached, and managed, ultimately leading to improved outcomes and success for teams.

### 3. Most recent innovations

**Adidas GMR** - this is an innovation from Adidas, EA SPORTS FIFA Mobile and Jacquard™ by Google, creating a new experience for players by connecting physical football and digital gaming. Adidas GMR is a unique collaboration between three of the world's leading brands in sports, gaming and technology. Adidas GMR is the new way to play connected - The Google-powered Jacquard™ Tag and specially designed insole slip into any footwear detects players on-pitch moves and actions (including measuring kicks, shot power, distance and speed), then sync and display them as stats in the GMR app on the players' mobile. This innovation enables players to impact virtual performance with real-world play.

The connection to FIFA Mobile allows players to complete unique challenges and hit milestones each week, including improving their Ultimate Team Overall (OVR), unlocking in-game rewards and ranking in global leaderboards. The more they play in the real world, the better their EA SPORTS FIFA Mobile Ultimate Team™ becomes. Through the support of FIFA eFootball & Gaming, the GMR project is able to enhance the experience for players of FIFA Mobile around the world, becoming an innovation that leverages technology to improve the experience of football fans.

Figure 21



Co-funded by  
the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.



## 4. European digital technologies in Football and Basketball – case studies

### 4.1. European digital technologies in Football

#### ***Bundesliga***<sup>22</sup>

Earlier this year, the Bundesliga announced it was the world's first soccer league to establish a cooperation with Amazon Web Services (**AWS**). As its official technology provider, over the coming months the Amazon-owned company will begin delivering more in-depth insights into every live broadcast of Bundesliga games and enable new personalised fan experiences. This will utilise AWS machine learning (ML), artificial intelligence (AI), analytics, storage, database and compute services, delivering real-time statistics which predict future plays and game outcomes as well as recommending personalised match footage across mobile, online, streaming and television broadcasts.

Since 2006, the league has been working to cover the full value chain of German soccer. Over the years the Bundesliga has repeatedly introduced innovative technologies, such as Spidercams in 2007 and launched the world's largest digital soccer archive in 2011. This archive comprises over 33,000 matches, 150,000 hours of video content and over 180,000 files, including all the historical data since the beginning of the Bundesliga – every goal, every change, every warning – since 1963-64. Furthermore, the Bundesliga pioneered the launch of an eFootball competition in 2012 – the Virtual Bundesliga – which now sees over 120,00 participants every season. In addition, the Bundesliga continued to innovate, implementing goal-line technology in 2015, began broadcasting in UHD in 2016 and was a frontrunner in the introducing VAR in 2017. Virtual advertising was first used in Germany in 2018 and since last year, the Bundesliga has been using AI to analyse more than 4,500 actions per matchday to create highlight clips tailored to select groups of fans through a partnership with WSC Sports, an Israeli technology company that applies this technology to sports highlights. Earlier this season, in partnership with one of the world's most innovative mobile communication companies, Vodafone, the Bundesliga equipped a stadium with 5G technology, providing a glimpse into the future of in-stadium fan engagement. For the first time, a new spectator experience was showcased with real-time data through AR via smartphones, giving insights into players and match statistics such as the live running speed, number of shots and 3D formations. This concept recently won a prestigious DreamlandXR Award for 'Best Sports Project' at the 2020 Consumer Electronics Show in Las Vegas, ahead of other entries from the NBA, WWE and several other extreme sports.

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<sup>22</sup> <https://www.sportspromedia.com/insights/opinions/guest-blogs/bundesliga-dfl-startups-investment/>







Thanks to another partnership with Germany's Axel Springer Bild Group, AR had already been implemented in 2018. Through specially marked newspaper photos, fans can access videos of modern-day and historical match scenes and bring the printed paper to life.

Bundesliga has specific focus on innovation. Partnerships with leading academic institutions, including the Harvard Business School, Massachusetts Institute of Technology and the WHU – Otto Beisheim School of Management, help the Bundesliga identify changing consumer trends. In a study called 'Future Study Bundesliga Consumption: Generation Z', many of these trends are summarised. This enables the league to keep an eye on the latest trends in tech and new developments in the sports industry.

In addition to academic research, data being gathered by Bundesliga subsidiary DFL Digital Sports has given the league a comprehensive understanding of how fans consume soccer. It offers insights into which platforms fans use, how often, and what kind of content they enjoy most – data which enables the Bundesliga to continuously future-proof its strategy in a fast-paced and ever-changing environment.

Putting this into practice, Bundesliga subsidiary Sportec Solutions records almost four million pieces of data from every game, with more than 40,000 data points collected every minute of play. Tailored to the personal preference information collected by DFL Digital Sports, this data can then be used to deliver personalised content that inspires and creates deeper connections with fans, enabling the Bundesliga and its clubs to build its fanbase with a tailored approach in key markets.

At SportsInnovation 2020, over 50 exhibitors and more than 1,000 guests came together to explore the role of technology in the development of the sports industry. At the summit, exhibitors presented their innovative applications and services to the sports industry and associates. Attendees included representatives of German and international soccer clubs and associations, media partners, sports venue operators and academics.

Umbrella Software Development GmbH presents its Soccerbot360 at the SportsInnovation 2020 and shows how this technology optimizes the training operations of top clubs through data analysis.

“The leaders of the German and Austrian Bundesliga have been using our Soccerbot360 in their daily training for several years. The Soccerbot360 trains cognitive abilities in a football specific way and thus has a direct effect on the decision-making ability of the players in competitive matches. In addition, analysts gain new insights into the game and injured players have the opportunity to better prepare their comeback.

At the technology platform, SAP SE presents its services for ticketing, payment systems, data collection and data visualisation. EVS Broadcasting Equipment SA from Belgium, deltatre AG,







Quantiphi Inc. from the USA and SBG Sports Software from the UK are further exhibitors in the fields of Digital Services and Broadcasting.

The following provides an overview of the focal points at SportsInnovation 2020:

- **Broadcasting:** Live broadcast technologies; enhancing and transmitting signals; Media Asset Management systems (MAM).
- **Stadium Experience:** Fan entertainment; applications and advertising media; ticketing; payment systems; safety, security and technology.
- **Match Analysis:** Data collection, enhancement and visualisation; electronic recording systems; evaluation of performance, position and vital data.
- **Matches & Tournaments:** Radio systems; goal-line technology and video referee systems; sports medicine and physiotherapy; equipment and appliances.
- **Digital Services:** E-sports; streaming solutions, apps and cloud-based micro services that can be used in all subject areas.

### *Football in the state league in North Rhine-Westphalia<sup>23</sup>*

A young coach in Brilion suggested to use a GoPro in cooperation with Coaching Eye. "It records the game from a bird's eye view, which gives us as coaches a better rating of the game afterwards. Because you always have a one-dimensional opinion about the game from the outside. The player also has an opinion, I think in retrospect it's important to see it without emotion. Then you can recognize one or the other game setup mistake a little better. It's good for that."

The camera is waterproof and shockproof - so very durable. Can be used in almost any weather. It is equipped with a super wide-angle lens that captures the entire pitch. The entire game is recorded in the digital memory - and Fröhlich can then watch and analyze it afterwards.

The bird's-eye view gives the trainer completely different perspectives. That brings a lot tactically, says Fröhlich. How did the players move on the field? Were the gaps between defensive and midfield correct? How were the strikers' runs?

"The coach's view is always reduced to the side view, to what is happening at the moment. Especially as a team tactical tool, where do we stand, how close are we together, that is very

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<sup>23</sup> <https://www.deutschlandfunkkultur.de/digitale-analyse-im-amateurfussball-high-tech-in-der-100.html>





important nowadays because many clubs also work professionally, although we already have a pioneering role in this league.”

Previously, the professionals had this technique exclusively. It was simply too expensive for an amateur club. Prices are now lower: a camera system costs around 1,300 euros.

A few classes higher, it has long been standard. Fröhlich comes from Lippstadt, from a top division club. There he was the assistant to Daniel Farke, who now coaches Norwich in the English Premier League. Alongside Liverpool's Jürgen Klopp, one of the very few coaches whose team beat Pep Guardiola's Manchester City in a league game this season.

Landesliga coach Fröhlich is benefiting from these experiences under Farke today: "Back then it was the Oberliga, so it was absolutely necessary to draw conclusions, including our own coaching work: What do we work on during the week and what is still implemented on the match day. And since it was essential. Due to the cost reduction, this is now also totally manageable for a state league team.”

#### *Track routes via GPS*

In 2015, there was still a long discussion at Borussia Dortmund about the training methods that the then new coach Thomas Tuchel brought with him from Mainz. Game observation from a dizzy height has long been state of the art in professional football.

But Tuchel went one step further. He also had the players' routes checked via GPS – i.e. satellite data. The players trained with a transmitter that transmitted the data to the training program on the computers. In this way, the transparent player became a reality.

In the Sauerland, Stefan Fröhlich mostly trusts what he sees. His assumption that the use of the camera also has great advantages in the lower leagues has been confirmed: the system has helped the team.

"I try to help the players to broaden their horizons," says Fröhlich, "because it's often the case that the players don't see the complete solution, especially when it comes to setting up the game. You usually see the next solution. But this also gives the opponent the chance to press, because the ball is usually only played briefly to the next station. The coaching team wants to show the lads that we have more chances by playing deeper or by shifting the game, for example to move forward.”

#### *Motivation for young players*





Broaden your horizons: This is also a motivation in an amateur league. The players can gain a lot from the tool. There is new impetus, explains Benedikt Brühne from SV Brilon. The experiences have been “very positive so far, because we have been using it for game analysis in training so that we can constantly develop. Also for individual players, but also within the team for the entire team.”

Brühne welcomes this: "That's why we see it as a good investment for us. The trainer usually sends us individual items. We then look at it ourselves and then discuss it again internally with him, then again extra, that he then gives us one or two things and we can then look over it again and maybe see a few things ourselves . That's why it's going really well."

It brings something to the individual themselves, says Brühne. Because you can't see the entire situation in the game. "That's why it's a great motivation, especially for us young players, in terms of seeing ourselves - and then being able to reduce and eliminate our own mistakes."

For Fröhlich, it is only logical to use the new method. As a qualified coach who even has an A license, he wants to keep up with the development: "If football or the technical aids for it didn't continue to develop, then you would train exactly as you did 30 years ago. Then as a coach you would throw your bibs in the air in the amateur field, choose two teams and let them kick. It used to work too."

Because coaches and the coaching team always wanted to improve, the training work and game preparation had to go along with it. In addition, the players are more dynamic than before, at least in this area.

However, it is not just about permanent improvement. The use of moving images is also helpful because the players have become more critical and mature than in the past, explains Fröhlich: "Because today's generation in particular, the young players, also question a lot. When my coach used to tell me: 'Yes, you're doing it wrong', then I believe him. But now it's like this: 'I don't think so. Yes, show me. I don't see it that way.' You have at least one more tool to convince the players of your idea of playing football."

In case of doubt, the pictures are also a means by which the coach can underpin his authority. Because the use of technology has changed the work of the amateur trainer - and enormously so. It has become more precise because the technology enables unimagined insights.

Camera images as an analysis tool: This is one way to get results - and it is an important one. But there is also the method that Thomas Tuchel used to amaze Dortmund journalists almost five years ago: the exact tracking of player performance using GPS. Even if it sounds futuristic: There are also amateur clubs that are already training with this method. They prepare their games professionally in a way that was previously unthinkable.





Another coach explains how the transmitter and receiver communicate with each other as follows: "The boys get a chest strap with a GPS tracker on it. You put it on your chest or around your waist, the thing doesn't slip either. It's firmly in the saddle, you hardly feel it at all. Then it is turned on once before the game and turned off once after the game. The performance is immediately transferred to the iPad and you have the analysis."

Pulse rate, meters run and sprints - this can be recorded using the method. But that's not all: With the help of GPS, the trainer can create exact movement profiles for his kickers on the pitch: "You mapped a pitch on the iPad. With the GPS tracker on the chest, it shows you in red where he's moved," Arslan explains.

"You can really see that. The red areas on the playing field are the areas where the player stayed most often. He stayed less in the brighter places. Then there are completely white areas where the player was not visible at all. You can really see that on the tablet," enthuses the young coach. "Then there is a playing field. The colors tell you where he moved most often. Very interesting. It's really interesting, I think it's great."

The coach beckons a centre-back: "It looks then that in the case of the player, he is a centre-back, he directs his game more towards trying to read the game; that he avoids getting into sprint situations because he's not quite sure he can pick up the pace from the forward; not quite sure of his speed. However, we saw from the stats that it has a top speed of over 30 km/h, which shows that it has good speed, which is really, really good. That way you can also show him that he can bravely defend from the front, that he can sometimes stand higher, that if we play it well, he can run the balls with his speed."

So the data shows: The central defender can do it very differently than he thought he could. A success for the coach. By analyzing the data, he has expanded his defender's repertoire to such an extent that the team's game benefits enormously.

The player himself got a completely different picture of himself: "After seeing that my top speed is 30 km/h," says the player, "I'm definitely more self-confident and can accept the sprint duels with the strikers. Because of this, I definitely became more self-confident. It also confirms that you are ready for more. You also see the state of affairs, but you have to keep in mind that it's just the data, you also have to keep other things in mind that you have to train on - in the tactical area. That's another thing."

So you can say without further ado: With the help of the data, the identity of the player has changed here. On the other hand, the coach has a powerful tool in his hands when he has to discuss performance with his players – and that is quite similar to that of the coach from Biron.





"If you have a player who thinks he played outstandingly and doesn't understand that he's on the bench, then maybe you can show in black and white that he ran far too little, that his Movement was not good, or that he misjudged a game. "

But what happens when modern technology finds its way into a popular sport like amateur football? How does this data affect us? Uwe Vormbusch is an expert on such questions. He is Professor of Sociology at the Fernuniversität Hagen.

For Vormbusch, there is no question that numbers have an enormous impact on football. But so far, it has mostly been based on professional football. But now it's about amateur sport.

"I think that depends a lot on which league we're talking about," says Vormbusch. "When we talk about the Bundesliga and the second division, then these are professional actors, professional players who are now used to not only being watched on the pitch - by a large audience, but also to having cameras running in the background and Pedometers and GPS trackers run along, which then produce gigabytes of data that trainers and the coaching staff then have to deal with afterwards."

#### *Critical look at the data*

The situation is different in amateur sport. Even there, says another coach, the use of technology will change the way the game is viewed. But the conditions are very different.

"It's different, it's - let's say it - scientifically related, what I'm actually doing there. It's no longer just eleven friends standing on the pitch, it's a concentrated analytical, scientific structure that is used there," says the coach.

"The activity of the trainer is shifting, for example," says the coach. "It's not just about coaching people on the pitch anymore. Maybe the coach then sits half the night analyzing game data that is difficult to do with at first. It may also give him a new perspective on his players. The question is: is that necessarily the better view? Is that a real look? You have to say: the association, the connection of numbers with objectivity, that what I'm looking at when I'm looking at the numbers is something real - that's highly problematic. It is important to reflect very critically on this in sport as in all other areas."





### ***Interview with Tim Frohwein the "Microcosm of Amateur Football" project of the Bavarian State Center for Political Education<sup>24</sup>***

Tim Frohwein is a science communicator, sociologist and football journalist. He also heads the "Microcosm of Amateur Football" project of the Bavarian State Center for Political Education. Techtalkers editor Juliana Diener spoke to him about the current status of digitization in amateur football clubs.

Diener: Mr. Frohwein, as is well known, professional football is digitized from A to Z. How is it in the amateur field?

Frohwein: First of all, you have to define amateur football. The 4th and 5th leagues also officially belong to the amateur sector, but very professional structures often already prevail there. This also applies to digitization, which sometimes takes on the same dimensions as in the professional sector. The lower the league, the more unprofessional and "undigitized" it becomes.

*For example, how is a club from the neighboring village that plays in the district league digitized? What is the purpose of digitization there?*

Digitization is finding its way into clubs to about the same extent that it is penetrating society. The members bring knowledge from outside, for example from work and everyday life, into the association. In addition to the standards such as WhatsApp groups, which are a matter of course in everyday life, club managers in the lower leagues use apps for team management. A survey of students at the Munich University of Applied Sciences that I supervised showed that around 80 percent of the more than 100 amateur football clubs surveyed use them. Players and coaches can organize training sessions, arrange meeting points and share information in such apps.

In addition, almost all clubs now use social media channels. A social media presence is useful for gaining awareness, building networks and recruiting new players and sponsors. The function that social media has in other areas of society and the economy is also used in amateur football. Another aspect of digitization in amateur football are so-called "wearables", i.e. digital technologies that are used to measure vital functions and the performance of the players. For example, there is a tracking system that shows how many kilometers the defender ran during a game.

*What about conducting video analytics?*

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<sup>24</sup> <https://techtalkers.hm.edu/digital/digitalisierung-im-amateurfussball/>







Video analysis has also found its way into the lower leagues. Cameras can now be set up at the edge of the field at low cost. These are controlled by artificial intelligence and automatically follow the gameplay. The club only has to invest once and can then record and analyze every game.

*How do the clubs finance this digitization?*

All these possibilities arise from the fact that the costs for the technologies have become cheaper over time and are therefore also affordable for amateur clubs. Of course, this does not apply to every club. Some of the football associations also support digitization.

For example, suppose the live streams of amateur games became so popular that nobody came to the soccer field anymore. The entire atmosphere, the sense of community, and the - sometimes exaggerated - emotionality were completely lost. But football thrives on that. This also applies if you were to replace team meetings with zoom meetings, real social interactions would be lost. I am also critical of the total measurement of footballers – keyword: “transparent amateur”. In the professional field it is already a reality.

### ***AI SportsWatch<sup>25</sup>***

AI SportsWatch is a new digital platform that combines advanced technology, cloud and artificial intelligence (AI), making it easy to broadcast amateur football games in the future. An innovation that has become reality in Ticino thanks to the collaboration between FC Agno and adesso Schweiz AG.

The AI SportsWatch is a win-win situation for football clubs and fans.

The soccerwatch.tv business idea satisfies precisely this need. The start-up, in which the consulting and IT service provider has a significant stake, has set itself the goal of digitizing amateur football. His business idea is the widespread transmission and marketing of amateur football games. To this end, the company has developed a fully automatic camera system that records games from the floodlight mast with a 180-degree angle of view and broadcasts them live via the Internet platform. Today, the platform already includes more than 300 installed camera systems, and the trend is rapidly increasing. Thanks to its innovative technology, matches become visible to a wide audience, allowing fans of amateur teams to follow their favorite team via live video transmission. The developed platform combines state-of-the-art cameras with cloud and AI-based software to film games and produce the necessary content in a fully

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<sup>25</sup>[https://www.itmagazine.ch/artikel/71600/Amateur-Fussball\\_im\\_Netzbrdank\\_adesso\\_und\\_Kuenstlicher\\_Intelligenz.html](https://www.itmagazine.ch/artikel/71600/Amateur-Fussball_im_Netzbrdank_adesso_und_Kuenstlicher_Intelligenz.html)





automated mode. This automation and the resulting low resource requirements make the production and distribution of content affordable even for an amateur club.

The platform combines the following innovations:

- AI-based software makes it possible to automate a complex task, such as recording a sports event;
- Cloud architecture industrializes and scales, simplifying content distribution;
- State-of-the-art optical technology offers a level of image quality that was difficult to achieve just a few years ago;

The Adesso Schweiz AG as a digital business partner.

The Adesso Schweiz AG, initiated from its new office in Lugano, launched the first soccerwatch.tv project in Switzerland together with the FC Agno club. From March 2020, all of the club's games will be filmed and broadcast as part of a pilot project using state-of-the-art technology.

The soccerwatch.tv concept is now not only used in soccer, but has also been transferred to various other sports with the launch of AISportsWatch. The goal is to provide a Switzerland-wide digital platform for the distribution of amateur sports content at national level.

AISportsWatch is a prime example of the opportunities that digital transformation offers to design new business models in a disruptive way. It also shows that tailor-made AI solutions can be used profitably in many industries.

### ***German digital football projects*** <sup>26</sup>

Short digital training courses was established and further expanded. In addition, in 2020 the DFB Junior Coach courses were held in blended learning format for the first time. The girls' soccer project "Everyone kicks along" also offers interactive training courses and instructional videos on its website. DFB Junior Coach 2020 completed with face-to-face appointment. The DFB Junior Coach courses were successfully completed with the presentation of the certificate on Friday, October 9, 2020 in the Pos tstudio.

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<sup>26</sup> <https://www.berliner-fussball.de/news/detail/News/technologiestiftung-legt-report-digital-im-verein-vor/>





## **DFB Academy<sup>27</sup>**

### *Big data for training control*

Position data has long since found its way into game analysis. What role do they play in training control? A survey of British coaches, experts in the team behind the team and players explores this question. A total of 176 people were interviewed. The result: the time-consuming analysis of GPS data is worthwhile. However, they must be evaluated more specifically and communicated better.

Heart rate, speed, sprint distance, intensity: the performance of top athletes is constantly measured. In addition to medical performance values, physical data is increasingly being collected using GPS. Many football clubs are working flat out to make this data usable. Bundesliga soccer club SV Werder Bremen, for example, recently worked with Jacobs University Bremen to systemize the evaluation of the data collected. In the cooperation project, data for the U23 team was first cleaned and standardized. "In the second step, connections were established, for example, between training content, the dosage of the training and the frequency of injuries," explains Stefan Kettemann, Professor for Complex Systems at Jacobs University Bremen, about the joint data engineering project.

The advantage: From the combination of position data and performance values, patterns can be identified that can help coaches to give players more well-founded feedback and to make more targeted decisions for individual training control. A gain in knowledge for the club that helps to load each player individually, says Nico Hruby, Chief Digital Officer of SV Werder Bremen.

### *How important is GPS data in training practice?*

According to the survey results, coaches, experts on the coaching staff and players expect the greatest benefits from training data for player fitness, injury prevention and performance diagnostics. Experts and players also named the benefits for training planning as "very important". Differences can be seen in the importance of training data for reflection and performance analysis: While the professionals consider data as a "very important" basis, trainers only consider it "somewhat important".

## **Validation of a Video-Based Performance Analysis System (Mediacoach®) to Analyze the Physical Demands during Matches in LaLiga<sup>28</sup>**

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<sup>27</sup> <https://www.dfb-akademie.de/studie/big-data-fuer-die-trainingssteuerung/-/id-15000234>

<sup>28</sup> <https://www.mdpi.com/1424-8220/19/19/4113>





Contemporary tracking technologies help monitor physiological and physical loads during matches, and this in turn helps adapt training sessions according to the match demands<sup>29</sup>. Among these systems, the Global Positioning System (GPS) is considered a valid instrument to collect physiological parameters in elite football<sup>30</sup> during training and matches, with computerized semi-automatic tracking systems also being used to collect physical performance variables<sup>31</sup>. However, different professional leagues use different tracking systems, and not all tracking systems were validated against a gold-standard instrument. Since 2011, the Spanish Professional Football League (Liga de Fútbol Profesional, LaLiga™) has used the Mediacoach® system (LaLiga™, Madrid, Spain) to provide semi-automatic tracking of players for all matches in the first and second divisions. There are limited match-analysis studies performed with this system<sup>32</sup>, and this system is not yet validated against a gold-standard instrument. This validation is very important, considering that Spanish clubs have dominated continental and European football over the last decade; and playing tactics vary based on leagues and, as a consequence, so do the match performance data. Hence, the aim of the above mentioned study was to assess the accuracy of the multi-camera tracking system (Mediacoach®) to track elite football players' movement in real time.

## 4.2. European digital technologies in Basketball

Basketball is evolving with the integration of digital technologies that enhance player development, coaching strategies, and team performance. European companies have been at the forefront of these innovations, introducing cutting-edge solutions that leverage player tracking, training apps, virtual reality, smart training equipment, team management platforms, and basketball analytics software. These technologies provide valuable insights, personalized

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<sup>29</sup> Stevens, T. G., de Ruiter, C. J., Twisk, J. W., Savelsbergh, G. J., & Beek, P. J. (2017). Quantification of in-season training load relative to match load in professional Dutch Eredivisie football players. *Science and Medicine in Football*, 1(2), 117-125.

<sup>30</sup> Mallo, J., Mena, E., Nevado, F., & Paredes, V. (2015). Physical demands of top-class soccer friendly matches in relation to a playing position using global positioning system technology. *Journal of human kinetics*, 47, 179.

<sup>31</sup> Castellano, J., Alvarez-Pastor, D., & Bradley, P. S. (2014). Evaluation of research using computerised tracking systems (Amisco® and Prozone®) to analyse physical performance in elite soccer: A systematic review. *Sports medicine*, 44, 701-712.

<sup>32</sup> Rivilla-García, J., Calvo, L. C., Jiménez-Rubio, S., Paredes-Hernández, V., Muñoz, A., Van den Tillaar, R., & Navandar, A. (2019). Characteristics of very high intensity runs of soccer players in relation to their playing position and playing half in the 2013-14 Spanish La Liga season. *Journal of human kinetics*, 66, 213.





training resources, immersive experiences, and efficient team management tools, revolutionizing the way basketball is played and coached.

Player tracking and performance analysis systems, offered by companies like Catapult Sports, enable coaches to collect and analyze real-time data on player movement, workload, and performance metrics. Training and skill development apps, such as HomeCourt, utilize artificial intelligence and computer vision to provide personalized feedback and training programs for refining shooting technique. Virtual reality platforms, exemplified by EON Sports, create immersive simulations for players to practice decision-making and improve court awareness. Smart training equipment, like those provided by Senaptec, enhance visual and cognitive skills critical to basketball performance.

Team management and communication platforms, including TeamSnap, streamline administrative tasks, facilitate effective communication, and promote collaboration among players, coaches, and staff. Meanwhile, basketball analytics software platforms like InStat offer comprehensive analysis of game footage and player statistics, empowering coaches to make data-driven decisions and optimize team performance.

European digital technologies in basketball revolutionize the way players train, teams operate, and coaches make strategic decisions. By embracing these innovations, basketball players and coaches gain a competitive edge, refine their skills, and achieve improved outcomes on the court. These advancements not only enhance player development but also foster a deeper understanding of the game, facilitate efficient team management, and drive success in the dynamic world of basketball.

Some more concrete examples of digital technologies used in basketball in the European continent are as follows:

- **Player Tracking and Performance Analysis:** European companies have developed cutting-edge player tracking systems that utilize wearable sensors and cameras to capture detailed movement data during games and practices. For example, Catapult Sports<sup>33</sup>, a UK-based company known for its advanced player tracking solutions, offers wearable GPS trackers that collect data on player speed, distance covered, acceleration, deceleration, changes of direction, and even physiological metrics like heart rate. This data is then analyzed using powerful software platforms to provide coaches with valuable insights into player performance, workload management, injury prevention, and even tactical decision-making. By leveraging this technology, coaches can make data-driven adjustments to training regimens and game strategies, optimize player performance, and reduce the risk of injuries.

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<sup>33</sup> <https://www.catapultsports.com/>





- **Training and Skill Development Apps:** European basketball technology companies have created mobile applications that provide comprehensive training resources and skill development programs. These apps offer a wide range of features, including instructional videos, interactive drills, training plans, and progress tracking. For instance, HomeCourt<sup>34</sup>, a Finnish app, has gained popularity for its use of artificial intelligence and computer vision to analyze shooting technique. It allows players to record their shooting sessions and provides real-time feedback on various aspects such as shooting form, accuracy, release time, and shot arc. The app offers personalized training programs and tracks progress over time, enabling players to refine their skills and improve shooting proficiency with precise guidance.
- **Virtual Reality and Simulation:** European companies are at the forefront of utilizing virtual reality (VR) technology to offer immersive basketball training experiences. These VR platforms create realistic simulations of game scenarios, enabling players to practice decision-making, spatial awareness, and situational awareness. For example, EON Sports<sup>35</sup>, a UK-based company, provides VR training solutions specifically designed for basketball. Their VR software allows players to engage in interactive simulations that replicate game situations, such as defending against opponents, executing plays, and improving court vision. Through realistic and immersive experiences, players can develop cognitive skills, enhance basketball IQ, and improve their ability to read and react to in-game situations with greater effectiveness.
- **Smart Training Equipment:** European manufacturers have introduced smart training equipment integrated with advanced technology to optimize player performance and skill development. Senaptec<sup>36</sup>, a UK-based company, offers sensory training tools that target specific visual and cognitive skills critical to basketball performance. Their products incorporate interactive exercises, visual stimuli, and proprioceptive challenges to enhance various aspects such as reaction time, hand-eye coordination, depth perception, peripheral vision, and cognitive processing speed. By utilizing these tools, players can improve their sensory processing capabilities, which in turn positively impacts on-court performance, decision-making, and overall game awareness.
- **Team Management and Communication Platforms:** European software developers have created digital platforms specifically tailored for basketball teams to enhance communication, streamline team logistics, and analyze performance. One example is TeamSnap<sup>37</sup>, originally from Sweden, which offers a comprehensive team management solution. Coaches can create practice plans, track player attendance, share game footage, and communicate important updates to players and staff members seamlessly through a centralized platform. The software simplifies administrative tasks, promotes efficient

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<sup>34</sup> <https://www.homecourt.ai/>

<sup>35</sup> <https://www.eonsportsvr.com/>

<sup>36</sup> <https://senaptec.com/>

<sup>37</sup> <https://www.teamsnap.com/>







collaboration, and enhances organization within basketball teams. Coaches can efficiently communicate schedule changes, distribute game plans, and analyze performance data, enabling streamlined operations and effective team management.

- **Basketball Analytics Software:** European companies have developed advanced basketball analytics software that revolutionizes performance analysis and decision-making processes. InStat<sup>38</sup>, a Belarus-based company, offers comprehensive basketball analytics platforms used by professional teams and leagues across Europe. These platforms allow coaches and analysts to analyze game footage, track player statistics, generate customized reports, and gain valuable insights into various aspects of team performance, opponent tendencies, and player contributions. Coaches can examine detailed statistics such as shooting percentages, shot locations, defensive impact, and efficiency ratings. By leveraging this data, coaches can make data-driven decisions regarding game strategy, player rotations, and performance optimization, ultimately leading to improved team performance and a competitive edge.

## 5. Questionnaires analysis

### 5.1. Austrian football & basketball

#### 5.1.1 General review of digital tools used in Austrian football grassroots clubs

##### ***Types of digital tools used in Austrian football grassroots clubs***

Austrian football clubs use various digital technologies (training tools) in coaching to enhance their training methods and improve player performance. Some of the common digital technologies used by these clubs include:

1. GPS Tracking: Austrian football clubs use GPS tracking devices to monitor the movement and performance of their players during training sessions and matches. The data collected can be used to analyze player performance, optimize training programs, and prevent injuries.

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<sup>38</sup> <https://instatsport.com/>





2. **Video Analysis:** Video analysis is a widely used digital technology in coaching. Austrian football clubs use video analysis software to capture and analyze footage of training sessions and matches. Coaches can use this data to identify areas where players need to improve and create customized training plans.
3. **Virtual Reality:** Virtual reality technology is also being used in coaching by Austrian football clubs. This technology allows players to experience different game scenarios and improve their decision-making skills. It can also be used to simulate match situations and help players develop their tactical awareness.
4. **Wearable Technology:** Austrian football clubs use wearable technology such as fitness trackers and heart rate monitors to monitor player performance and fitness levels. This data can be used to optimize training programs and prevent injuries.
5. **Performance Analysis Software:** Performance analysis software is used by Austrian football clubs to analyze player performance data collected from various sources such as GPS tracking devices, video analysis, and wearable technology. Coaches can use this data to identify patterns and trends in player performance and adjust training programs accordingly.
6. **Mobile apps:** Mobile apps are used to communicate with players and parents, provide training schedules, and track player attendance.

To conclude, the Austrian football clubs are using a range of digital technologies in coaching to enhance player performance, optimize training programs, and improve tactical awareness.

### ***GPS tracking devices***

The GPS tracking devices that Austrian football clubs use when coaching young players are the most used digital technology in coaching practices.

The exact GPS tracking devices used by Austrian football clubs to coach youth may vary depending on the specific club and its resources. However, some commonly used GPS tracking devices that are suitable for youth players include:

- Many football clubs all over the world use Catapult Sports, which is a well-known GPS tracking system. It provides real-time data on player performance and movement, including distance covered, speed, and heart rate.
- Statsports: This is another GPS tracking system that is commonly used by football clubs, including youth teams. It provides similar data to Catapult Sports, including distance covered, speed, and heart rate, but also includes additional metrics such as acceleration and deceleration.





- GPSports: This is a GPS tracking system that is designed specifically for football. It provides data on player movement, including distance covered, speed, and changes of direction, as well as information on the intensity of the activity.
- Playertek: This is a GPS tracking system that is designed for use by individual players. It includes a wearable GPS tracking device that can be worn on the player's body to provide data on their performance and movement during training and matches.

To conclude, these GPS tracking devices can provide valuable data for coaches and players to optimize training programs and improve player performance, and many Austrian football clubs, including youth teams, are using them as part of their coaching programs.

### ***Video analysis software***

Video analysis software that Austrian football clubs use to capture and analyze footage of training sessions and match to gain insights into player and team performance are very popular and gain momentum in coaching practices.

Here are the steps that clubs typically follow:

- Recording: The first step is to record the training session or match. The footage can be captured from various angles, including stationary cameras, handheld devices, and drones.
- Uploading: The recorded footage is then uploaded to the video analysis software. There are several video analysis programs available, such as SportsCode, Hudl, and Nacsport, that allow coaches to analyze the footage.
- Tagging: The software allows coaches to tag different events in the footage, such as goals, shots, passes, and tackles. Coaches can also tag individual players and create a timeline of events.
- Analysis: Coaches can analyze the tagged footage using various tools provided by the software, such as slow-motion playback, zooming, and highlighting. They can identify patterns in player and team performance, including strengths and weaknesses.
- Feedback: Based on the analysis, coaches can provide feedback to individual players and the team as a whole. They can identify areas for improvement and create customized training plans.
- Sharing: Coaches can also share the analyzed footage with players and other coaching staff, allowing for collaboration and discussion.

Overall, video analysis software is a valuable tool for Austrian football clubs to capture and analyze footage of training sessions and matches. It provides coaches with valuable insights into player and team performance, enabling them to make data-driven decisions to improve their team's performance.

There are several video analysis software options available for Austrian grassroots football clubs, and the most used software can vary depending on the club's resources and preferences.





However, here are some of the most popular video analysis software used by Austrian grassroots football clubs:

- **SportsCode:** A lot of Austrian football clubs use the well-known video analysis program SportsCode. It provides coaches with various tools to analyze player and team performance, including tagging, timeline creation, and advanced analysis features.
- **LongoMatch:** LongoMatch is another popular video analysis software used by Austrian grassroots football clubs. It allows coaches to tag events and create custom templates to analyze player and team performance.
- **Kinovea:** In Austria, amateur football clubs frequently use Kinovea, a free video analysis program. It provides coaches with various tools to analyze player performance, including frame-by-frame analysis and slow-motion playback.
- **Nacsport:** Numerous amateur football clubs in Austria use Nacsport as their video analysis tool. It allows coaches to tag events, create customized templates, and analyze player and team performance using advanced analysis features.
- **Dartfish** is a well-liked video analysis program that many amateur football clubs in Austria use. It provides coaches with various tools to analyze player and team performance, including tagging, timeline creation, and advanced analysis features.

These are some of the most commonly used video analysis software options for Austrian grassroots football clubs. However, the choice of software usually depends on the club's needs and budget.

### ***Virtual reality technology***

Virtual reality software is becoming increasingly popular in the world of football, including at Austrian football clubs. While the specific virtual reality software used can vary depending on the club's resources and preferences, here are some commonly used options:

- **Rezzil** is a virtual reality football training program that many football clubs use worldwide, including some in Austria. It offers various training scenarios, such as penalty kicks and passing drills, and provides real-time feedback to players.
- **Beyond Sports** is yet another piece of virtual reality software that some Austrian football clubs use. It offers a range of virtual training scenarios and matches that allow players to improve their decision-making skills and game sense.
- **Virtex Arena:** A few Austrian football clubs use the virtual reality training program Virtex Arena. It allows players to practice their skills and techniques in a virtual environment and provides feedback on their performance.
- Some football clubs in Austria use the virtual reality training program known as **Mi Hiepa Sports**. It offers a range of virtual training scenarios, including dribbling drills, and provides real-time feedback to players.





- Sense Arena is a piece of virtual reality software that some Austrian football clubs use. It offers a range of training scenarios and games that allow players to improve their skills and decision-making abilities.

As a conclusion, these virtual reality software options are becoming increasingly popular in the world of football, including in Austrian football clubs. They provide players with a unique and immersive training experience, allowing them to improve their skills and decision-making abilities in a safe and controlled environment.

### ***Wearable technologies***

Wearable technologies have become increasingly popular in the world of football, including in Austrian football clubs. These technologies provide coaches and players with valuable insights into player performance, allowing them to make data-driven decisions to improve their team's performance. Here are some of the most commonly used wearable technologies in Austrian football clubs:

- GPS tracking devices: GPS tracking devices are commonly used in Austrian football clubs to track player movement and physical exertion during training sessions and matches. These devices can provide coaches with data on player speed, distance covered, and energy expenditure, allowing them to monitor player fitness and adjust training plans accordingly.
- Heart rate monitors: Heart rate monitors are another wearable technology commonly used in Austrian football clubs. These devices can track players' heart rates during training sessions and matches, allowing coaches to monitor player fitness and adjust training plans accordingly.
- Accelerometers: Accelerometers are small sensors that can be attached to players' clothing or equipment to track their movements during training sessions and matches. These devices can provide coaches with data on player acceleration, deceleration, and change of direction, allowing them to monitor player performance and adjust training plans accordingly.
- Smart clothing: Smart clothing is a relatively new wearable technology that is starting to be used in Austrian football clubs. This clothing is embedded with sensors that can track player movement, heart rate, and other physiological data. This technology can provide coaches with valuable insights into player performance, allowing them to make data-driven decisions to improve their team's performance.





- Inertial Measurement Units (IMUs) and microelectromechanical sensors (MEMS), containing a combination of magnetometers, accelerometers, and gyroscopes. In soccer, IMUs can be attached to a player's body or to the ball to track their movements, acceleration, and changes in direction. This information can be used to analyze the player's technique, detect weaknesses in their performance, and design personalized training programs. IMUs can also be used to track the ball's movement and speed during a match, providing coaches and players with valuable insights into the game. For example, they can be used to analyze the trajectory of a shot on goal or to track the movement of the ball during a pass.

Overall, these wearable technologies are commonly used in Austrian football clubs to monitor player performance and improve training plans. They provide coaches with valuable insights into player fitness and performance, allowing them to make data-driven decisions to improve their team's performance.

### ***Performance analysis***

Performance analysis software is an essential tool for football coaches and analysts to analyze player and team performance. The specific software used can vary depending on the club's resources and preferences. Here are some of the most commonly used performance analysis software in Austrian football clubs:

- SportsCode: A lot of Austrian football clubs use the well-known performance analysis program SportsCode. It provides coaches and analysts with various tools to analyze player and team performance, including tagging, timeline creation, and advanced analysis features.
- Hudl Sportscode: Hudl Sportscode is a more recent version of SportsCode that is specifically designed for football performance analysis. It provides similar features to SportsCode and offers additional tools to analyze player and team performance.
- OptaPro: OptaPro is a performance analysis software that provides coaches and analysts with detailed statistics and data on player and team performance. It uses advanced algorithms and data analysis tools to provide coaches with valuable insights into player performance.
- Catapult: Catapult is a performance analysis software that uses wearable technology to track player movement and physical exertion during training sessions and matches. It provides coaches with data on player speed, distance covered, and energy expenditure, allowing them to monitor player fitness and adjust training plans accordingly.







- Nacsport: Numerous football clubs in Austria use Nacsport as a performance analysis tool. It allows coaches and analysts to tag events, create customized templates, and analyze player and team performance using advanced analysis features.

Overall, these performance analysis software options are commonly used in Austrian football clubs. They provide coaches and analysts with valuable insights into player and team performance, allowing them to make data-driven decisions to improve their team's performance.

The Austrian football clubs are definitely using some form of digital technology in their coaching and performance analysis but some clubs are more digitally oriented than others. Here are a few examples of clubs that are known for their use of digital technologies in Austria:

1. Red Bull Salzburg: Red Bull Salzburg is a club known for its innovative use of technology in football. They have implemented various digital technologies in their training and performance analysis, including GPS tracking devices, heart rate monitors, and video analysis software. They also have a dedicated performance analysis department that uses data-driven insights to improve player and team performance.
2. Rapid Vienna: Rapid Vienna has been an early adopter of digital technology in Austrian football. They have invested in a state-of-the-art training center that includes advanced technologies such as virtual reality training and performance analysis software.
3. FK Austria Vienna: FK Austria Vienna has also been a pioneer in the use of digital technology in Austrian football. They have implemented GPS tracking devices and heart rate monitors in their training sessions and have a dedicated team of analysts that use data-driven insights to improve player and team performance.
4. LASK Linz: LASK Linz has made significant investments in their infrastructure, including their digital technology capabilities. They have implemented advanced performance analysis software and have a dedicated team of analysts that use data to improve player and team performance.

### ***Mobile apps for communication***

The use of mobile apps for communication in Austrian football clubs may vary depending on the club's preferences and resources. However, here are a few examples of mobile apps that are commonly used by Austrian football clubs:

1. WhatsApp: Numerous football clubs in Austria use the well-known messaging app WhatsApp. Coaches can use the app to communicate with players, share training schedules, and provide updates on team activities.





2. TeamSnap: TeamSnap is a sports team management app that is commonly used by Austrian football clubs. The app allows coaches to manage team schedules, communicate with players and parents, and track player availability and attendance.
3. Slack: Some Austrian football clubs use Slack, a messaging and collaboration app, for team communication. Coaches can use the app to create channels for different team activities, share training resources, and communicate with players and staff.
4. Trello: Trello is a project management app that some Austrian football clubs use to organize team activities and communicate with players and staff. Coaches can create boards for different team activities, assign tasks to team members, and share training resources.

To conclude, these mobile apps are commonly used by Austrian football clubs to improve communication and team management. However, it's important to note that each club has different needs and preferences, so the specific apps used vary from club to club.

### 5.1.2 General review of digital tools used in Austrian basketball grassroots clubs

#### Kind of digital tools used in Austrian basketball grassroots clubs

The use of digital tools vary depending on the size and level of the club, as well as the specific needs and preferences of coaches and players.

There are several digital tools that are commonly used in grassroots basketball clubs in Austria:

1. Wearable technology for optimizing the training and game strategy.
2. Team management software: Tools such as TeamSnap, Teamer, or Heja are often used by coaches to manage their teams' schedules, player availability, and communication.
3. Video analysis software: Programs such as Hudl, Synergy Sports, or Krossover are commonly used by coaches to analyze game footage and provide feedback to players.
4. Social media platforms: Clubs may use social media platforms such as Facebook, Twitter, or Instagram to promote their team, share updates and game highlights, and engage with fans.
5. Online training resources: There are many online resources available to coaches and players, including YouTube channels, online coaching courses, and instructional websites that provide drills and exercises.





6. League management software: Some grassroots basketball clubs may use league management software such as League Republic or SportMember to manage their leagues, fixtures, and results.

### Wearable technology

Wearable technology has been increasingly adopted in sports and basketball coaching in Austria. Some examples of wearable technology that may be used in basketball coaching include:

1. Smartwatches and fitness trackers: These devices can track the physical activity and performance of players, including heart rate, steps taken, and calories burned.
2. GPS tracking devices: These devices can track the movement and speed of players during practice and games, providing valuable data for coaches to analyze.
3. Biometric sensors: These sensors can track a variety of physiological parameters, such as muscle activity, fatigue, and recovery.
4. Inertial Measurement Units (IMUs) and microelectromechanical sensors (MEMS), containing a combination of magnetometers, accelerometers, and gyroscopes are used in basketball training to track player movements and analyze performance.
5. Smart basketballs: Some companies have developed basketballs that can track shooting accuracy, ball speed, and other metrics.

Wearable technology can provide coaches with valuable data and insights into the performance of their players, helping them to optimize their training and game strategies. However, it's important to note that the use of wearables may also raise privacy and ethical concerns, such as the collection and use of personal data.

### Smartwatches and fitness trackers

The Austrian basketball clubs usually use the following smartwatches and fitness trackers:

1. Apple Watch: The Apple Watch is a popular smartwatch that is widely used in sports and fitness tracking. It offers a variety of features, including heart rate monitoring, GPS tracking, and activity tracking.
2. Fitbit: Fitbit is a popular fitness tracking device that offers features such as heart rate monitoring, sleep tracking, and workout tracking.



3. **Garmin:** Garmin produces a range of fitness tracking devices, including GPS watches and activity trackers. They offer features such as heart rate monitoring, GPS tracking, and advanced training metrics.
4. **Samsung Galaxy Watch:** The Samsung Galaxy Watch is a smartwatch that offers features such as heart rate monitoring, GPS tracking, and activity tracking.
5. **Polar:** Polar is a brand that produces GPS watches and heart rate monitors designed for sports and fitness tracking. Their devices offer features such as heart rate monitoring, GPS tracking, and advanced training metrics.

It's important to note that the specific smartwatches and fitness trackers used in Austrian basketball clubs vary depending on the specific needs and preferences of coaches and players, as well as the budget and resources available to the club.

### ***GPS tracking devices***

**GPS sensors:** GPS (Global Positioning System) sensors can be used to track an athlete's position, speed, distance covered, and acceleration during training and games. This information can be used to monitor an athlete's performance and identify areas for improvement.

Some popular GPS tracking devices that are commonly used in Austrian sports and coaching include:

1. **Catapult:** Catapult is a sports technology company that produces GPS tracking devices designed for team sports, including basketball. Their devices can track metrics such as distance, speed, acceleration, and deceleration.
2. **STATSports:** STATSports is another sports technology company that produces GPS tracking devices for team sports. Their devices offer features such as real-time tracking, heat mapping, and performance analysis.
3. **Polar Team Pro:** Polar Team Pro is a GPS tracking system designed for team sports, including basketball. It allows coaches to track the performance of their players in real-time and provides detailed data analysis.
4. **VX Sport:** VX Sport is a GPS tracking device designed for sports and fitness tracking. It offers features such as GPS tracking, heart rate monitoring, and advanced data analytics.





5. PlayerTek: PlayerTek is a GPS tracking system designed for team sports, including basketball. It offers features such as real-time tracking, performance analysis, and customizable metrics.

It is important to note that the specific GPS tracking devices used in Austrian basketball clubs vary depending on the specific needs and preferences of coaches and players, as well as the budget and resources available to the club.

#### Biometric sensors

1. EMG sensors: EMG (Electromyography) sensors can be used to measure muscle activity and fatigue in athletes. These sensors can be attached to the skin or clothing to track muscle activity during training and games.
2. ECG sensors: ECG (Electrocardiography) sensors can be used to measure heart rate and heart rate variability in athletes. These sensors can be attached to the skin or clothing to track heart rate during training and games.
3. EEG sensors: EEG (Electroencephalography) sensors can be used to measure brain activity in athletes. These sensors can be used to track cognitive function and attention during training and games.
4. Respiration sensors: Respiration sensors can be used to measure breathing patterns and respiratory rate in athletes. These sensors can be attached to the skin or clothing to track breathing during training and games.
- 5.

#### Inertial Measurement Units (IMUs) and microelectromechanical sensors (MEMS)

In basketball, IMUs can be used to track player movements, such as their speed, acceleration, and changes in direction. This information can be used to analyze a player's performance, detect areas for improvement, and design personalized training programs.

IMUs can also be used to track the ball's movement during a game, providing coaches and players with insights into the game. For example, they can be used to analyze the trajectory of a shot or to track the movement of the ball during a pass.

Some popular manufacturers of IMUs and MEMS sensors used in sports include Xsens, Inertial Sense, and STMicroelectronics, among others.

#### Smart basketballs



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Smart basketballs are basketballs that are equipped with various sensors and technologies that allow them to collect data about the ball's movements and other metrics during play. This data can then be transmitted to a connected device, such as a smartphone or tablet, where it can be analyzed and used to improve performance.

Some examples of the sensors and technologies that may be included in a smart basketball include:

1. **Motion sensors:** These sensors can detect the ball's movements, such as dribbling, shooting, and passing.
2. **Accelerometers:** Accelerometers can measure the ball's acceleration and deceleration during play.
3. **Magnetometers:** Magnetometers can detect changes in the ball's magnetic field, which can be used to track the ball's rotation.
4. **Pressure sensors:** Pressure sensors can measure the force with which the ball is being held, dribbled, or shot.
5. **Bluetooth connectivity:** Smart basketballs may be equipped with Bluetooth technology that allows them to connect to a smartphone or tablet, where the data collected by the sensors can be analyzed and used to improve performance.

Some smart basketballs that are available on the market and are used in Austria include:

1. **Wilson X Connected Basketball:** This smart basketball uses a sensor inside the ball that can detect the ball's movement, which is then transmitted to a smartphone app via Bluetooth. The app provides real-time feedback on shooting percentage and makes drills more engaging.
2. **Spalding Shot Tracker:** This system uses a sensor that attaches to the net to track shots made and missed during games or training sessions. The data is sent to a smartphone app where coaches and players can review shot charts and statistics.
3. **DribbleUp Smart Basketball:** This ball has a unique pattern that allows it to be tracked by a smartphone camera. The DribbleUp app uses augmented reality to provide coaching feedback and track progress during dribbling drills.
4. **94Fifty Smart Sensor Basketball:** This smart basketball has sensors inside the ball that track a variety of metrics including shot arc, shot speed, dribble speed, and spin rate. The data is transmitted to a smartphone app where it can be analyzed to improve performance.







5. Infomotion Smart Basketball: This ball uses sensors and an infrared camera to track the ball's movement and provide real-time feedback on shooting accuracy, dribbling, and passing.

It's important to note that the specific smart basketballs used in Austria vary depending on the preferences of coaches and players, as well as the budget and resources available to the club.

#### Team management software

Some popular team management software used in Austrian basketball grassroots clubs include:

1. TeamSnap: TeamSnap is a popular team management app used by many sports teams worldwide, including basketball clubs in Austria. It allows coaches to manage their teams' schedules, player availability, and communication.
2. Heja: Heja is another team management app that is popular among grassroots basketball clubs in Austria. It provides features such as scheduling, attendance tracking, messaging, and photo sharing.
3. Sportlyzer: Sportlyzer is a team management and training software that is used by many basketball clubs in Austria. It provides features such as player management, attendance tracking, game scheduling, and video analysis.
4. Teamer: Teamer is a free team management app that is used by many grassroots basketball clubs in Austria. It provides features such as team scheduling, attendance tracking, and messaging.
5. OneTeam: OneTeam is a team management and communication app that is used by many sports teams worldwide, including basketball clubs in Austria. It provides features such as messaging, scheduling, and attendance tracking.

#### Video Analysis Software

Some of the most popular video analysis software used in basketball coaching worldwide and in Austria include:

1. Sportscode: Sportscode is a video analysis software that is widely used in basketball coaching. It allows coaches to tag specific events during games or practice sessions, and then review and analyze the footage to identify areas for improvement.
2. Hudl: Hudl is a popular video analysis software that is used by many basketball coaches at all levels, from grassroots to professional. It allows coaches to capture, analyze, and share video footage with players and other coaches.





3. Synergy Sports Technology: Synergy Sports Technology is a comprehensive video analysis software used by many professional basketball teams. It provides in-depth statistical analysis of game footage, as well as the ability to create scouting reports and share video with players and coaches.
4. Nacsport: Nacsport is a video analysis software that allows coaches to analyze and tag specific events during games or training sessions. It also includes a range of tools for creating reports and sharing video with players and other coaches.
5. Dartfish: Dartfish is a video analysis software that is used by many basketball coaches to analyze footage and create customized training programs. It includes a range of tools for tagging events, creating highlights, and sharing video with players and other coaches.
6. It's important to note that the specific video analysis software used in Austrian basketball may vary depending on the preferences of coaches and the resources available to the club.

## Social media platforms

Social media platforms that are commonly used in context of coaching youth in Austrian basketball grassroots clubs include:

1. Facebook: Facebook is a popular social media platform that can be used by basketball coaches to communicate with parents, players, and other coaches. They can share updates about games, practices, and events, as well as post photos and videos.
2. Instagram: Instagram is a photo and video-sharing social media platform that is popular among younger people. Coaches can use it to share photos and videos from games and practices, as well as provide motivational quotes and tips.
3. Twitter: Twitter is a micro-blogging platform that can be used by coaches to share real-time updates about games and practices, as well as provide tips and insights.
4. YouTube: YouTube is a video-sharing platform that can be used by coaches to share game highlights, instructional videos, and motivational clips.
5. TikTok: TikTok is a short-form video-sharing app that is popular among younger people. Coaches can use it to share motivational clips, practice drills, and other basketball-related content.



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It's important to note that the specific social media platforms used by Austrian basketball coaches for youth may vary depending on the preferences of the coaches and the age group of the players.

#### Online training platforms

Some online training resources that may be commonly used in this context include

1. **FIBA Europe Coaching Website:** The FIBA Europe Coaching Website is an online resource that provides a wide range of coaching resources for basketball coaches at all levels, including youth coaches. The site offers drills, plays, and other coaching resources that can be used to develop young players.
2. **Basketball For Coaches:** Basketball For Coaches is a website that offers a range of resources for basketball coaches, including training drills, plays, and practice plans. The site also includes articles and videos that provide coaching tips and insights.  
**Breakthrough Basketball:** Breakthrough Basketball is an online resource that offers training drills, plays, and other coaching resources for basketball coaches. The site also offers coaching clinics and camps.
3. **Better Basketball:** Better Basketball is an online resource that provides training drills, plays, and other coaching resources for basketball coaches. The site also offers coaching clinics and camps.
4. **CoachTube:** CoachTube is an online platform that provides video-based coaching resources for basketball coaches. The site offers a range of courses and videos that cover topics such as coaching philosophy, player development, and X's and O's.

The specific online training resources used in Austrian basketball for coaching youth may vary depending on the preferences of the coaches and the resources available to the club.

#### League management software

Some popular league management software used in Austrian basketball include:

1. **TeamSnap:** TeamSnap is a popular league management software that can be used to manage teams, schedules, rosters, and communication. It also has a mobile app that allows coaches and team managers to manage their team on-the-go.





2. SportsEngine: SportsEngine is another popular league management software that can be used to manage teams, schedules, rosters, and communication. It also has a mobile app that allows coaches and team managers to manage their team on-the-go.
3. LeagueApps: LeagueApps is a league management software that provides tools for registration, scheduling, and communication. It also has a mobile app that allows coaches and team managers to manage their team on-the-go.
4. Teamer: Teamer is a league management software that provides tools for scheduling, communication, and attendance tracking. It also has a mobile app that allows coaches and team managers to manage their team on-the-go.
5. Bonzi: Bonzi is a league management software that provides tools for registration, scheduling, and communication. It also has a mobile app that allows coaches and team managers to manage their team on-the-go.

The specific league management software used in Austrian basketball vary depending on the preferences of the league organizers and the resources available to the clubs.

Case studies

Case study 1

The Vienna D.C. Timberwolves offer a variety of basketball programs for youth players of all ages and skill levels. Here are some examples:

1. Basketball Camps: The club organizes basketball camps during school breaks where youth players can learn from experienced coaches, work on their basketball skills, and have fun playing the game. The camps are usually held during summer, Easter and Christmas breaks.
2. Training sessions: The club offers regular training sessions for youth players that focus on fundamental skills such as shooting, dribbling, passing, and defense. The coaches use a progressive and age-appropriate approach, adapting the drills and exercises to the skill level of each player.
3. Leagues: The club organizes leagues for youth players of different ages and skill levels. These leagues provide an opportunity for players to compete against other teams and put their skills into practice in a game setting.
4. Tournaments: The club also participates in tournaments throughout the year, both locally and internationally. These tournaments provide a chance for players to compete against teams from other regions and countries and gain valuable experience.
5. Individual training: The club offers individual training sessions for players who want to work on specific areas of their game. These sessions are tailored to the needs and goals

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of each player and focus on developing skills such as shooting, ball handling, footwork, and conditioning.

The Vienna D.C. Timberwolves offer a comprehensive range of basketball programs for youth players, with a strong focus on player development and providing a fun and supportive environment for young athletes to learn and grow.

### Overview of digital tools used by Vienna D.C. in youth programs

Here is some general examples of how digital tools can be used in youth basketball programs.

1. Digital tools can be used to enhance the coaching and training experience for youth players by providing additional feedback, analysis, and tracking capabilities. Some examples of digital tools that can be used in youth basketball programs include:
2. Here is some general examples of how digital tools can be used in youth basketball programs.
3. Video analysis software: Video analysis software can be used to capture and analyze game footage, as well as individual player performances. Coaches can use the software to break down game situations, identify areas for improvement, and provide personalized feedback to each player.
4. Performance tracking apps: Performance tracking apps can be used to track player progress and measure key performance metrics such as shooting accuracy, speed, and endurance. These apps can also provide personalized training programs based on the individual needs and goals of each player.
5. Communication tools: Digital communication tools such as team apps or communication platforms can help coaches stay in touch with players and their families, providing regular updates on schedules, training plans, and other important information.
6. Social media platforms: Social media platforms such as Instagram, Twitter, and Facebook can be used to showcase player achievements, share training tips, and promote upcoming games and events.

As a conclusion while digital tools can be valuable resources for youth basketball programs, they should not replace the importance of face-to-face coaching, communication, and personal interaction. The use of digital tools should be integrated in a way that complements and enhances the overall coaching and training experience for youth players.





## Zone 14<sup>39</sup>

More and more often, fans complain that football has lost touch with the grassroots. Players' salaries are in the millions, billions in TV money flowing in, and transfer sums beyond 100 million euros. The fan is often seen only as a consumer. The gap is widening.

Although the financial resources in grassroots football are much lower compared to professional football, the desire for analysis from TV, professionalization and constant development is greater than ever among clubs. Zone14 helps coaches and analysts to focus on their core competencies - improving their teams and finding creative solutions and tactics - without much effort, using state-of-the-art technology and user-friendly tools. Clubs can offer their fans an even better experience through beautiful and successful football. They offer Video analysis and evaluation that have never been easier in football. The users get a perfect video of every game with the tools to mark and categorize crucial scenes quickly and efficiently. In addition, Zone 14 develops intelligent AI algorithms that recognize players, running routes, and all events on the pitch and present the statistics to you in a clear way. Zone 14 captures matches and does tracking with simple one-time installation of the Plug&Play camera system. The 4K cameras cover the entire field at all times and the optimal image section is determined automatically. The matches are easily scheduled via the calendar and the intelligent system records by itself, without a cameraman. Thanks to the 180-degree image, every player can be analysed at any time during the entire match. So you will never miss an important scene again.

Thanks to Zone 14 tagging app, decisive scenes are already marked live during the match on a smartphone or tablet. This saves you valuable time during the video analysis. After the match, the video is available for analysis directly on our web platform. With a few clicks mark scenes and sort them directly into playlists. The digital tool improves training and tactics in football. The football clubs can create your own video database and share the most important scenes with your team either directly or via compact video analysis units. Players benefit from an objective view of the game scenes and tactical implementations can be analysed even more precisely. Furthermore, football video analysis facilitates the development of new tactics and the setting of training priorities. Zone 14 have 50 systems in Austria and work 200 coaches as their network.

### 5.1.3 Austrian Survey football and basketball

#### The Participants

A total of 10 responses were obtained after dissemination.

The questionnaire was completed by 100 % male respondents.

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<sup>39</sup> <https://zone14.ai/en/zone14/>







The ages involved varied: 60.0 % involved people between 30 and 45 years old, 30.0 % covered those in the 18-29 age group, and the smallest percentage grouped those aged 46 and older (10.0%).

Those who filled out the questionnaire the most came mainly from Vienna (50.0 %) and Lower Austria (40.0%) while others were situated in Burgenland.

Among those who joined, 50.0 % play soccer while the remaining 50.0 % play basketball.

### Coaches Training and Management within the Clubs

Most (90.0%) say that coach training in Austria occurs informally/internally - carried out by clubs or sports associations (Federations, Association, Union) with one respondent selecting formal/university based coaches training.

When asked what digital and/or non-digital methods and tools are used in coach training (slides, online videos, online and offline meetings, jam boards...), various answers were given with a large portion of people voting for the use of slides (5) and video lectures (5). Further answers included educational courses (online or in person) (4), Meetings (online or in person) (3), dual career (1) and annual further training (1). One participant described the educational courses of the respective federation to include theoretical and practical methods of education and another respondent mentioned practical demonstrations and tasks in books.

Four respondents (40.0 %) increase the level of qualification of their coaching staff (including coaching courses at national and international levels) through coaching courses and three mentioned Coach-Clinics (30.0%). Further answers included:

- Communicating with other coaches & officials and visiting events like congresses, conferences, etc. (1)
- Club internal coaching courses (1)
- Internet (1)
- Exams for the federations coaching licence (1)
- Increasing understanding and increasing focus by decreasing boredom through variation (1)
- Combining theory and praxis (1)

The question on the number of coaches with “voluntary basis, monthly salary, contract, etc.” within the club was only answered by single number ranging from 3 to <100+ but mostly around 10-20. The distribution of coaches on played or voluntary basis can therefore not be evaluated.

The question if coaches work with specific age groups of athletes might have been misleading as the following question which asks for specification contained answers like 8-85 years or “different groups” although 100% stated for a specialization. The age groups of the athletes in the follow-up question vary: 8-19, 8-10, 16-19 and various subgroups.





## Training Methods and Goals

The types of digital tools used in the training process of children, youth and teenagers (8-13 years old) are Video analysis (4) WhatsApp (2), PPT-Presentations (2), Videoclips of the stars e.g. goal scenes, tricks (1), Online tools for training processing (1), Stats programs (1), none(1).

Coaches see potential to improve their training (cognitive, emotional, sensory, motor, etc.) in all 4 suggested topics (2), emotional (2), cognitive(3), mental (1) and motor (1) skills, on their capacities for data processing (“enough data but too little time for analysis” 1) and one participant stated no need of improvement for the training of under 13 year olds.

Goals during the training process of children, youth and adolescents are related to soft skills (mentioned by 70% of the participants) and emotions – with attributes like fun, social development and discipline and equally (also mentioned by 70% of the participants) athletic goals like development of motor skills, poly sportive training, to have many ball contacts.

All but one participant state that coaches/trainers focus on the development of soft skills for personal growth through sports during the process of training children, youth and adolescents. Their methods are to:

- create a “WE”-feeling, that individuals subordinate to the common goals of the team.
- promote cooperative forms of play, training design and travel to tournaments and training camps
- promote togetherness (3), e.g. by letting kids demonstrate their skills to others, train together, seek for agreements
- explain social conditions and relations
- promote team skills
- promote cooperation (2), responsibility, conflict resolution in the group, putting egoism behind...
- conduct team building (2)

80 % apply an impact assessment method (to track athletes' development/measure progress).

The training needs of coaches and trainers (for better qualification in their work) and their goals are:

- In athletic training,
- Wide range of training
- in the mental area.
- Social skills(2), being able to relate to children, speaking German.
- Pedagogy (2)
- reflective view on the training
- To get qualified trainers who are up to date (scientifically) and can complement their own experiences with new ones
- Lack of practice - it should be less about theory





- Recognition; ego; love; money; making a difference....

The training needs of children and youth for sports growth are:

- From “I” to “WE” feeling and acting - losing and also winning together
- Social skills (2), discipline, personal responsibility
- Making them better people and athletes
- Improve their current level of athleticism and become better athletes
- Motor and physical (strength) deficits
- Cognitive skills
- Understand German!
- “don’t know”, “complex answer – depends on personal preferences, but also on the environment and parenting”

All of the coaches/coaches implement a model of interplay (i.e., the use of elements of other sports in the training process) in the training process of children, youth and adolescents. 4 participants mentioned to use those interplay methods during warm up. The answers were grouped into following methods/sports:

- athletics (sprinting/running ABC; design SAQ) (3)
- various ball games – throwing catching (5)
- soccer (in case of basketball training)
- swimming
- weight training
- martial arts

## Policy

All but one participant stated that clubs/federations/associations have implemented a policy to safeguard/encourage minors in sports.



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## 5.2. Bulgarian football & basketball

The survey was conducted with football clubs, focusing on various aspects of coach training, methods, and tools used in training, the process of raising qualification levels, and other facets of sports training and management.

The majority of clubs, five out of ten, rely on formal or university-level training for their coaches. In contrast, four clubs prefer informal or internal training within their sports club or federation, and one club uses a different method.

In terms of the methods and tools used in coach training, a variety of digital and non-digital methods are employed. These include slides, online videos, meetings, and specific software. Some clubs also participate in seminars and lectures with foreign lecturers, indicating a commitment to continuous learning and development.

When it comes to raising the qualification level of their coaching staff, clubs employ different strategies. These include attending seminars and international courses, enrolling in coaching courses at national and international levels, and participating in internships abroad.

The number of coaches in the clubs varies, with figures ranging from as low as 2 to as high as 25. This variation likely reflects the size and resources of the different clubs.

All clubs have coaches working with specific age groups, ranging from children to adolescents and adults. This suggests a tailored approach to coaching, with different strategies and techniques employed depending on the age group.

Some clubs use digital tools like video analysis and GPS trackers in their teaching process, indicating a willingness to leverage technology in sports training.

In terms of soft skills development, some clubs focus on this area for personal development through sports during the training process. This suggests an understanding of the broader benefits of sports beyond physical fitness, including teamwork, leadership, and discipline.

Some clubs implement a multi-sport model in the training process of children, youth, and adolescents. This approach, which involves using elements from other sports in training, can help to develop a broader range of skills and abilities.

In terms of child protection, some clubs have a policy in place, reflecting a commitment to safeguarding the welfare of their young participants.





### 5.2.1 Basketball overview and survey

#### Interview and survey process

In accordance with the project requirements, eight basketball coaches completed the survey, and two face-to-face interviews were conducted with coaches who work with age categories U10, U12, and U14.

The interviews lasted between 20 and 30 minutes.

At the beginning of each interview, a brief presentation of the TEAM UP project goals and activities was given. The results of the questionnaire in Bulgaria were shared and discussed during the interviews, and the interviewees were also politely asked for their opinions on all questions.

Eleonora Rangelova organized and conducted both interviews.

#### Respondent's and interviewer's profile

The selection of the individuals interviewed was carefully made to achieve a variety of locations of the clubs across different regions of Bulgaria, as well as to represent different age groups.

However, the selection was primarily focused on the most active age category of coaches, 30-45, which had the largest representation.

The age of the 10 participants (respondents and interviewees) is as follows: 18-25 – 2, 30-45 – 6, 45+ - 2.

They are currently working for clubs in eight different regions of the country, including Sofia, Varna, Ruse, Plovdiv, Yambol, Botevgrad, Shumen, and Pleven.

Nine of them are male, and one is female.

#### Questions and answers

How is coaches' education conducted in your country:

The response indicates that the education is provided through:

a) formal/university level programs for 9 respondents.



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b) informally/internally by their sports club or umbrella organization such as Federation, Association, or Union - for 3 respondents.

c) other - One respondent believes that it is essential for every coach to make continuous efforts to seek out different sources of knowledge and find all possible ways to improve their education.

*What type of digital and /or non-digital methods and tools are used in coaches' education in your country? (Slide, video online, meeting online, jamboard ...)*

The summary of the answers:

a) At the club level, coaches can access educational resources such as slides, online videos, scouting software, and online resources for developing specific skills. However, some coaches mentioned that their clubs do not organize any education or training programs.

b) At the umbrella organization level, coaches can participate in online meetings and webinars to gain knowledge and share experiences with other coaches.

c) other sources of education for coaches include motivational video speeches from elite athletes and digital books. Additionally, online drills are available for coaches to develop specific skills for their players.

d) None of above – 0 respondents

*How do you raise the qualification level of your coaching staff ( including coaches' courses at national level, international level)?*

The participants provided insights into how coaching education is conducted at various levels in their country. Here is a summary of their responses:

At the club level, the most developed clubs have regular meetings where the main coach discusses all important aspects of preparation and games with the youth coaches. These meetings involve analyzing practice plans and scouting reports, as well as presenting new digital materials for raising the coaches' knowledge. Some clubs have a unified methodology for the preparation and concepts of offense and defense for all youth categories.

At the federation level, digital materials are posted on the coaching website, and coaching seminars with foreign guest lecturers are organized several times a year. The federation also sends a certain number of coaches to participate in international coaching clinics and other activities through FIBA Europe and Erasmus+ projects.







At the FIBA level, there is the FIBA Europe Coaching Certificate program, which is a three-year-long course. Each year, two Bulgarian coaches start the course.

At the European level, many international coaching seminars are organized in the most developed basketball countries.

*How many coaches do you have in your clubs (at volunteer's base, monthly salary, contract etc.)?*

According to the respondent, the number of coaches in their clubs varies between 2 and 8.

One club has two coaches, both of whom are volunteers. Another club has three volunteer coaches. The other clubs hire coaches on either a full or part-time basis, depending on their workload. Two clubs have four coaches, one has five, one has six, two have seven, and two have eight coaches.

*Do your coaches work with specific age groups of athletes – recreational/ professional (children, youth and adolescents)?*

All respondents stated that coaches in their clubs work with specific age groups of players. Two clubs work with only two age categories each - one has U8 and U10 and the other has U12 and U14.

The other clubs develop more age categories, ranging from four to eight youth age categories out of the total of nine official youth male age categories of BBF (U8, U10, U12, U13, U14, U15, U16, U17, and U19).

Two clubs also have female teams with four teams each out of the five official youth female age categories of BBF (U8, U10, U12, U14, and U19).

Typically, there are two teams per club coach, who leads teams of two consecutive age categories.

None of the respondents work with both gender teams; they work with either female or male teams.

*What type of digital tools you use in the training process of children, youth, and adolescents (aged 8-13)? If you use some of these, which area you need to improve your training methodology (cognitive, emotional, Proprioceptive sensory, motricity, etc).*



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While one respondent declared that their club does not use any digital tools, all the others stated that the most commonly used digital tools in their work are video analysis and teaching clips, depending on the specific skill or detail they are working on at the moment.

Regarding the areas in training methodology that need to be improved, the coaches predominantly stress on cognitive, emotional, and motricity.

However, one coach is convinced that all areas need improvement.

Another coach believes that conditioning training and psychological work are not developed in Bulgarian youth basketball.

*What is the main focus/ focuses during the training process of children, youth and adolescents?*

The coaches believe that the main focus during the training process depends heavily on the age of the player and the phase of the competition season. It is commonly understood that younger players require practices that include fun and entertaining elements to keep them interested and develop a love for the game. They primarily work on basic technical skills, motor skills, and musculoskeletal development. Players under 14 years old are not expected to work on tactics.

Older youth players should pay more attention to details and start working on tactics and different offensive and defensive systems. All coaches are convinced that developing certain soft skills is essential for success in this competitive environment. These skills will be explained in the next paragraph.

*Do you target the development of soft skills for personal development though sport during the training process of children, youth and adolescents?*

- a) Yes (please specify how exactly): 8
- b) No – 2

The coaches believe that they develop skills such as leadership, teamwork, trust, discipline, and concentration in their players through motivational speeches and training drills designed to enhance these soft skills. Creating a competitive environment during practices also helps in developing these skills.





*Do you apply an impact assessment methods ( to track the development of the athletes/ to measure the progress)?*

- a) Yes (please specify how exactly): 8
- b) No – 2

Only a few coaches have clarified that they track the physical progress of the players exclusively. The conditioning trainer periodically conducts testing to assess their conditioning.

What are the training needs of:

- a) Coaches (for additional qualification) and with what purpose?
- b) Children, youth, adolescents?

Most coaches have stated that they primarily need more national and international clinics, lectures, and practical demonstrations from elite experts in all areas. Some of them also suggest that more organized discussions and international tournaments would further enhance their knowledge. It has been suggested that unified and more innovative methods should be used by all coaches in Bulgaria.

Regarding the needs of young players, most coaches have highlighted the issue of inadequate facilities, particularly the lack of sports gyms. They emphasized the necessity for more preparation camps and friendly games. All coaches acknowledged that young players in Bulgaria do not practice enough hours per week compared to more developed basketball countries. When a young player has only one 90-minute practice per day, it becomes difficult to achieve proper conditioning and individual and team development. Some coaches believe that kids would benefit from more motivational personal meetings and conversations with the best Bulgarian National Team players, who serve as their role models.

Do you implement an interplay model in the training process of children, youth, and adolescents?

- Interplay refers to the use of elements from other sport/s in the training process

Seven respondents admit to using this model in the training process and consider it highly beneficial for the well-rounded development of youth players, especially up to the age of 13. A few coaches have mentioned that they would utilize it if they had more practice hours with their teams. Currently, they can only afford to use it during preparation camps.





*Does your club/federation/association have an implemented Child Safeguarding policy?*

Four coaches have stated that there is such a policy in their club/federation, while the others have admitted that they are not aware of its existence.

### **Summary**

#### *Assessment Needs of Coaches:*

- Coaches expressed the need for more national and international clinics, lectures, and practical demonstrations to enhance their knowledge and coaching skills in all areas.
- They emphasized the importance of organized discussions and participation in international tournaments to broaden their understanding of the game.
- Coaches highlighted the need for unified and innovative coaching methods to be implemented across all coaches in Bulgaria.
- Continuous professional development opportunities, such as attending coaching courses at the national and international levels, were identified as important for raising the qualification level of coaching staff.
- Coaches desired access to educational resources, including digital tools such as slides, online videos, scouting software, and online resources tailored for specific skill development.
- The implementation of an impact assessment method to track the development and progress of players was considered valuable.

#### *Assessment Needs of Players:*

- Coaches highlighted the lack of adequate facilities, particularly sports gyms, which hindered the training and development of young players.
- Players' training hours per week were deemed insufficient compared to more developed basketball countries, affecting their conditioning, individual practice, and overall development.
- Coaches emphasized the importance of providing more preparation camps and friendly games to enhance players' skills and competitive experience.
- Motivational personal meetings and conversations with successful Bulgarian National Team players were suggested as a way to inspire and motivate young players.
- Players' need for a well-rounded development approach that targets cognitive, emotional, and motoric skills was identified.
- The desire for improved training methodologies, including focus on specific areas such as conditioning, psychological work, and soft skills development, was expressed.





### 5.2.2 Football overview and survey

As part of the football survey 5 club representatives participated of whom 4 are men and 1 woman, with the majority being in the age group 30-45.

**Training of Coaches:** The training of coaches is carried out through formal/university level education, informal/internal training within their sports club or federation, and other methods. Some respondents mentioned the use of online platforms, slides, video materials, online meetings, and seminars. Some coaches also attend international courses and seminars.

**Methods and Tools Used in Coach Training:** The methods and tools used in coach training include slides, video online, online meetings, and seminars. Some coaches also use video analysis and scouting software.

**Raising Qualification Level of Coaching Staff:** The qualification level of coaching staff is raised through attending seminars at national and international levels, participating in additional seminars, and requirements to provide weekly training and discussions.

**Number of Coaches:** The number of coaches in the clubs varies, with some clubs having as few as 2 coaches and others having up to 25 coaches. Some coaches are volunteers, while others are on contract or receive a monthly salary.

**Coaches Working with Specific Age Groups:** Most coaches work with specific age groups of amateur/professional athletes, ranging from children to adolescents and adults.

**Digital Tools Used in Teaching:** Some clubs use video analysis, GPS trackers, and online platforms as digital tools in the teaching process.

**Areas of Improvement in Learning Methodology:** The areas of improvement in learning methodology include cognitive, emotional, motor, and proprioceptive areas.

**Main Focus During Training Process:** The main focus during the training process varies, with some focusing on technical improvement, developing a complex player, or creating interest and keeping it.

**Development of Soft Skills:** Some clubs target the development of soft skills for personal development through sports during the training process.

**Impact Assessment Methods:** Some clubs implement impact assessment methods to track athlete development/measure progress.





**Training Needs of Coaches:** The training needs of coaches for further qualification include pedagogical, psychological training, and faster access to innovative methods and technologies.

**Learning Needs of Children and Adolescents:** The learning needs of children and adolescents include personal development and developing their mental abilities.

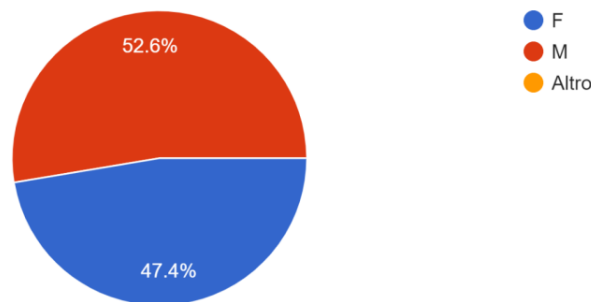
**Implementation of Multi-Sport Model:** Some clubs implement a multi-sport model in the training process of children, youth, and adolescents.

**Child Protection Policy:** Some clubs have a child protection policy in place.

### 5.3. Italian football & basketball

SEX:

Genere:  
19 responses



AGE:



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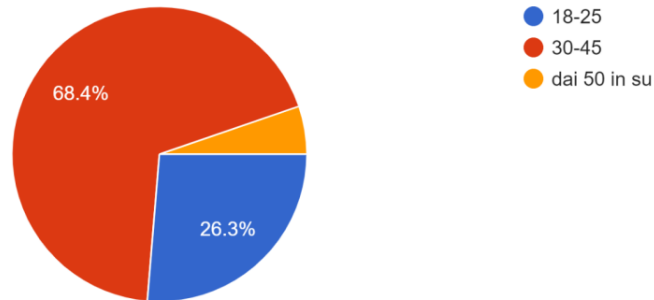
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Età:

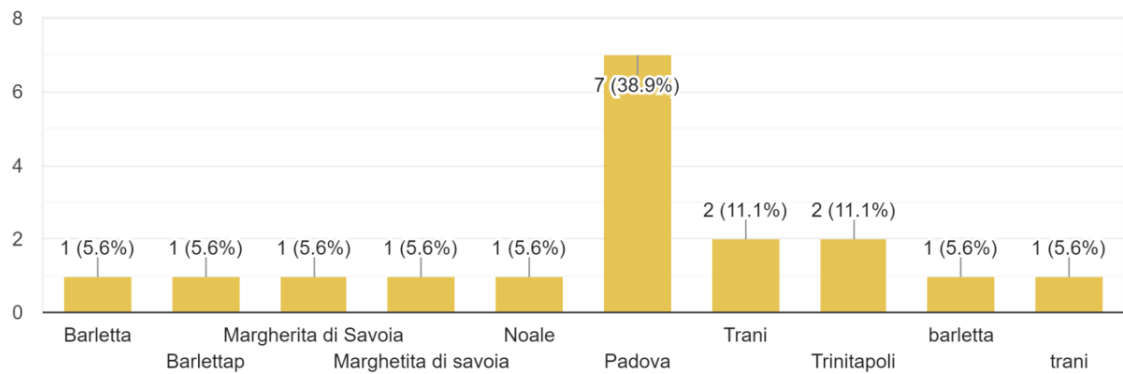
19 responses



COUNTRY (ITALY) CITY:

Città in cui risiedi:

18 responses



Bari, Barletta, Margherita di Savoia, Noale, Trani - sud italy

Padova

SPORT:



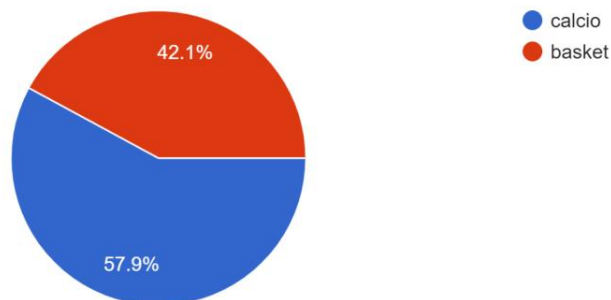
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Sport:

19 responses



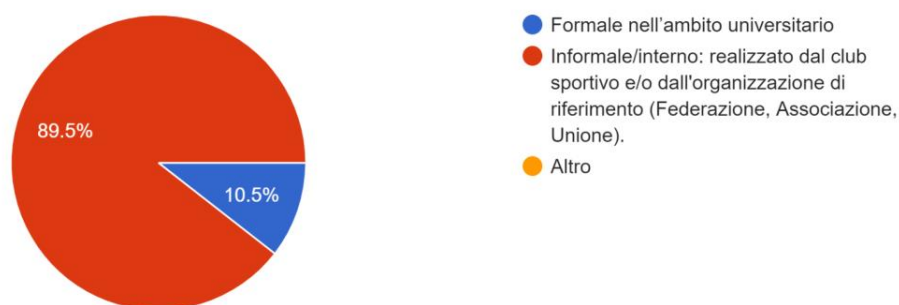
BLU - FOOTBALL

RED -BASKET

TRAINER (INFORMAL OR FORMAL)

Come viene condotta la formazione dei coach nel vostro Paese:

19 responses



BLU FORMAL TRAINER

RED INFORMAL TRAINER (inside your club or organization)

DIGITAL TOOL:



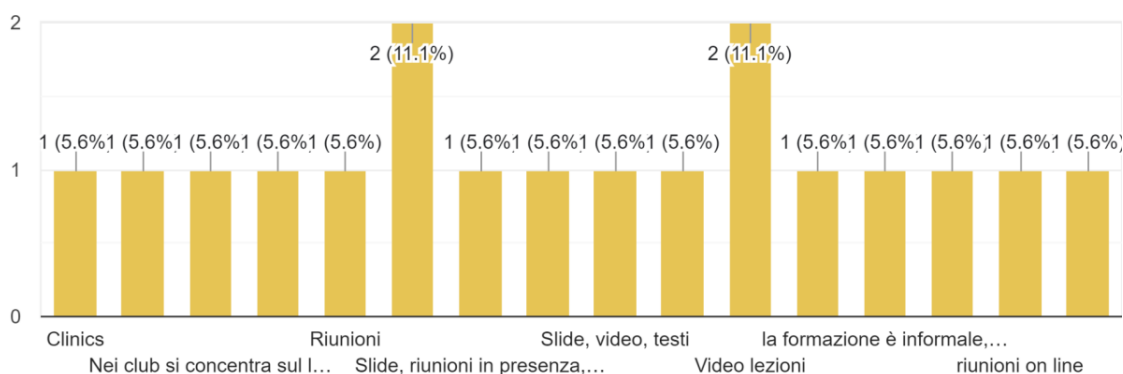
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Che tipo di metodi e strumenti digitali e/o non digitali vengono utilizzati nella formazione dei coach nel vostro Paese? (slide, video online, riunioni online ... al livello del tuo club, sia a livello di Federazioni.

18 responses



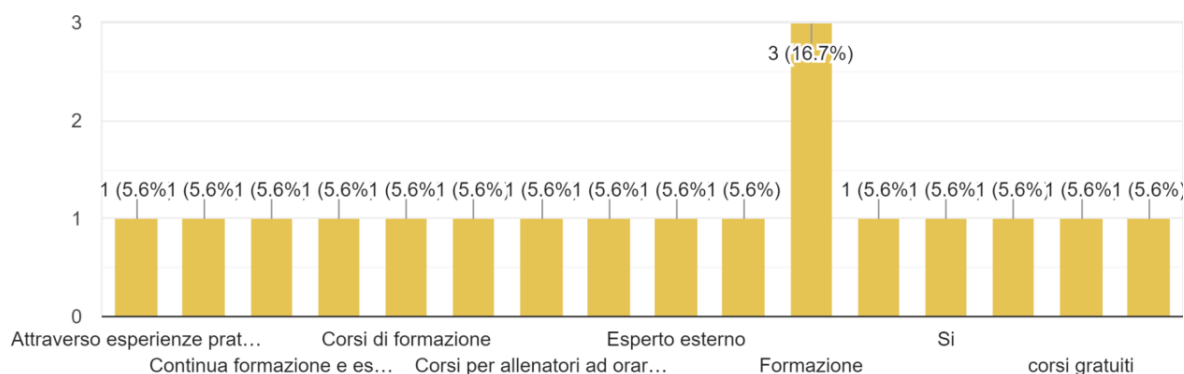
Presentation, slide for the meeting (11.1%)

Video for lessons (11.1%)

#### IMPROVE COACH SKILLS WITH:

Come secondo te si aumenta il livello di qualificazione del proprio staff di allenatori/allenatrici (compresi i corsi per allenatori a livello nazionale e internazionale)?

18 responses



TRAINING (16.7%)



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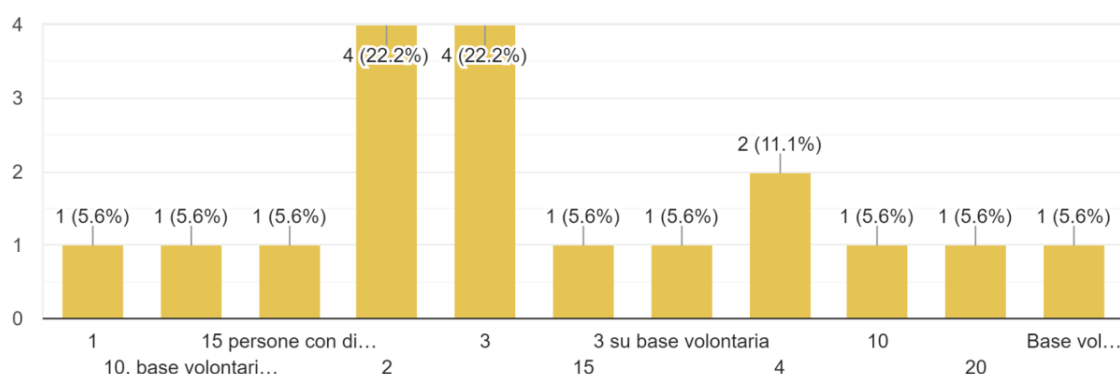
TRAVELS (5.6%)

FREE TRAINING (5.6%)

### NUMBERS OF COACH FOR CLUB:

Quanti allenatori/allenatrici avete nel vostro club (con base volontaria, stipendio mensile, contratto, ecc.)?

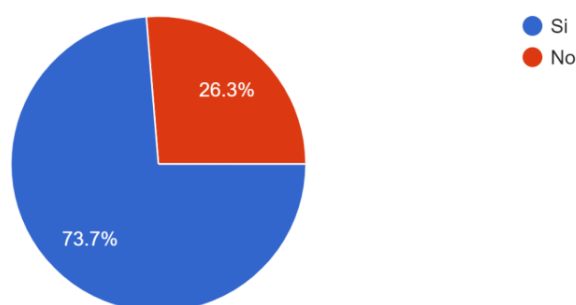
18 responses



### COACHES AND SPECIFIC AGE GROUPS OF ATHLETES:

I vostri allenatori/allenatrici lavorano con specifiche fasce d'età di atleti - ricreativi e professionisti (bambini, giovani e adolescenti)?

19 responses



BLU - YES

RED - NO



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### IF IT IS YES SPECIFY THE AGE OF THE TARGET:

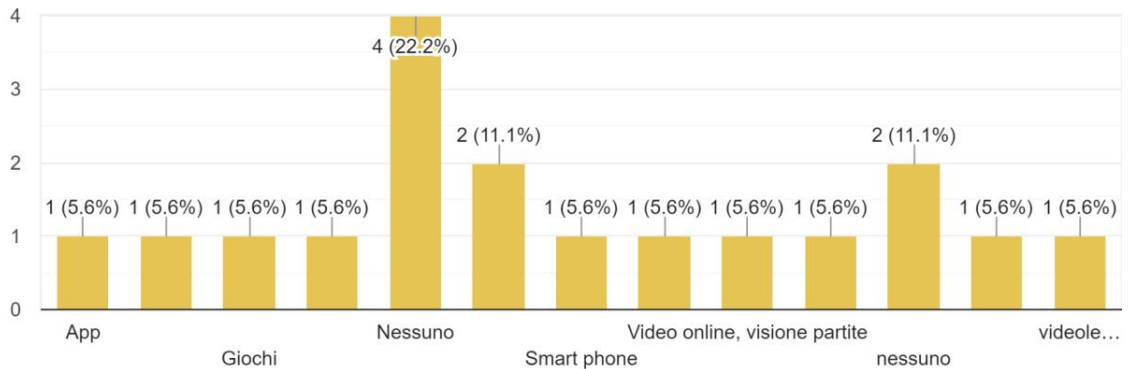
Se hai risposto sì, specifica il target con cui lavori  
14 responses

under12
11-12 anni
Da 5 anni ai 30
under 16
25
bambini e adolescenti
Bambini
8-13
8-13
Senior non professionale
Ragazzi e ragazze dai 9 ai 14 anni
6/18 anni
Ragazzi dai 10 ai 14 anni

### DIGITAL TOOLS FOR TRAINING FOR YOUTH:

Che tipo di strumenti digitali utilizzate nel processo di formazione di bambini, ragazzi e adolescenti (8-13 anni)?

18 responses



NOTHING 22.2%

APP 5.6%



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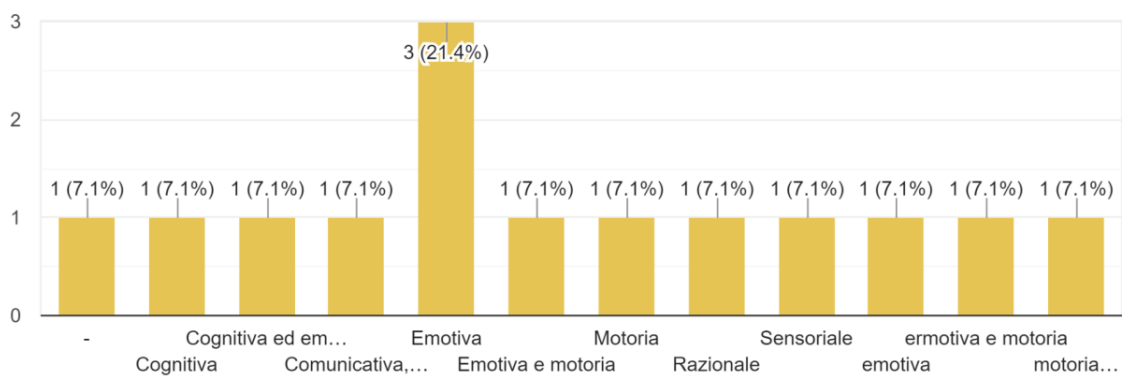
VIDEO 5.6%

GAMES 5.6%

### IN WHICH AREA YOU WANT TO IMPROVE YOUR TRAINING (PER COACH):

Se ne utilizzate alcuni, in quale area volete migliorare la vostra formazione (cognitiva, emotiva, sensoriale, motoria, ecc.) scegli uno/due campi:

14 responses



Emotional area 21.4%

Cognitive area 7.1%

Rational area 7.1%

Physical area 7.1 %

### OBJECTIVE OF YOUR TRAINING :



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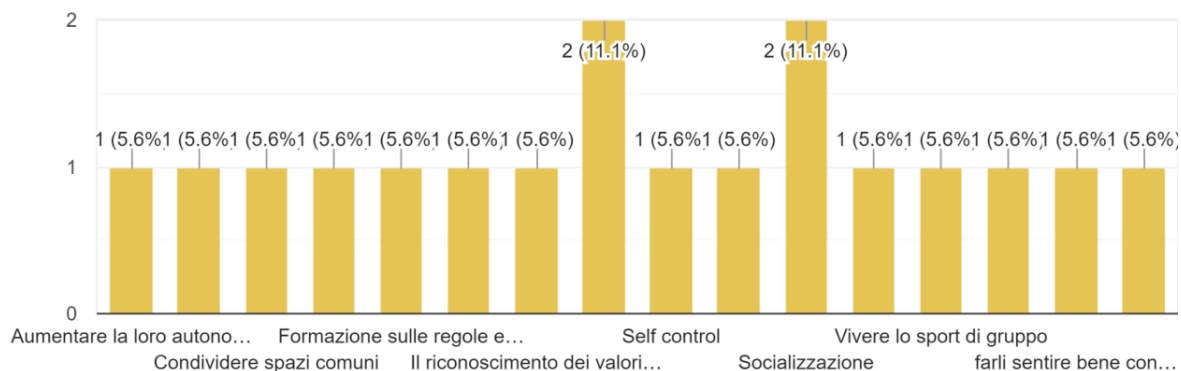
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Qual è l'obiettivo principale durante il processo di formazione di bambini, giovani e adolescenti?

18 responses



Social values 11.1%

Socialization 11.1%

Self control 5.6%

Autonomy 5.6%

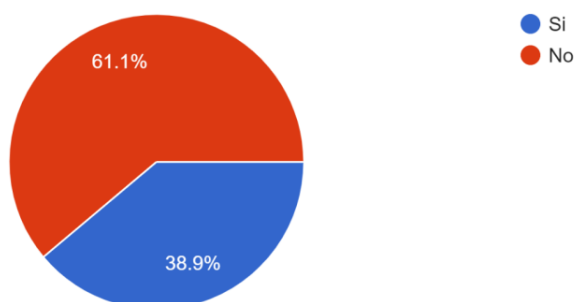
Respect for the rules 5.6%

Respect for common space 5.6%

USE SOFT SKILLS IN YOUR TRAINING:

Durante il processo di formazione dei bambini, dei giovani e degli adolescenti, puntate sullo sviluppo delle soft skills per la crescita personale attraverso lo sport?

18 responses



RED - NO



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BLUE - YES

IF YES, WHICH SOFT SKILLS:

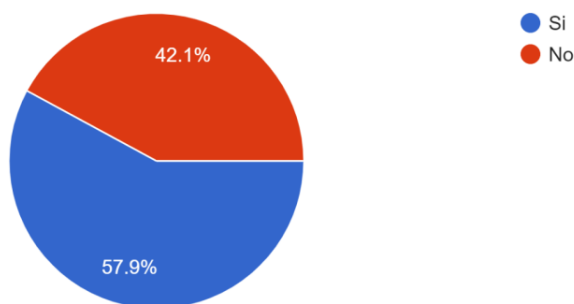
soprattutto comunicazione e rispetto nello stare con gli altri
Socializzazione
Emotività
Coinvolgendo i giovani nel processo di apprendimento, autovalutazione e comunicazione tra pari.
Sensibilizzazione del concetto di squadra
Attraverso la creatività motoria, il prendere buone decisioni, risolvere problemi, essere empatici, avere motivazione e consapevolezza di se
Incentiviamo momenti di incontro e socializzazione che trascendono il mero ambito sportivo

- Communication ability and respect
- Socialisation ability
- Self-evaluation and communication
- Problem solving, decision making;
- Empaty

IMPACT ASSESMENT:

Applicate un metodo di valutazione dell'impatto (per seguire lo sviluppo degli atleti/per misurare i progressi)?

19 responses



BLUE- YES

RED- NO



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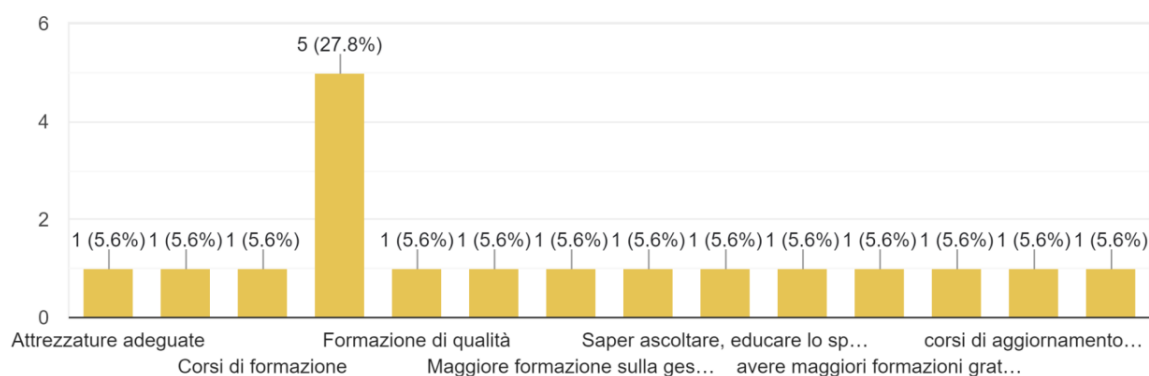
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## COACHES' NEEDS

Quali sono i bisogni formativi degli allenatori e allenatrici (per una migliore qualifica nel proprio lavoro) e perché?

18 responses



- High quality training 27.8%
- Better sport equipment 5.6%
- conflict management training 5.6%
- listening training 5.6%

### NEEDS FOR YOUNG ATHLETES:

- Easier access to sport, which must be free and open to all\*.
- Competent coaches
- Understand the rules for respecting teammates and teamwork
- Growing both technically but also learning not to separate sport from everything else uniting other areas of life with sport
- Free outdoor spaces
- Training
- Free outdoor spaces
- Experiences from different realities
- Experiences abroad



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- Outdoor spaces
- Playing team sports
- Serenity for better living
- Serenity and well-being
- Greater motor commitment, fun and autonomy
- Motor progress, application of sports skills is consequent Mental growth and social relations Mental maturation and understanding reward system based on effort.

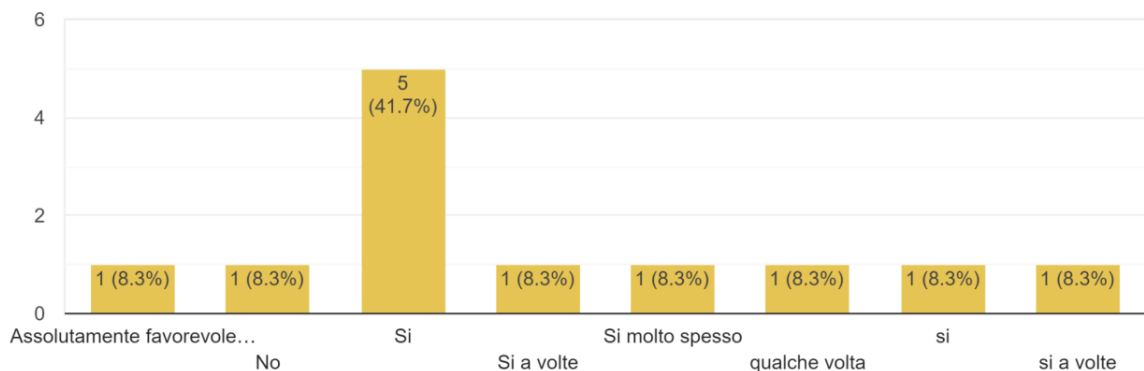
The training needs are not only those of a sporting nature but also those of fair play, respect for rules, companions and the environment. Needs that can be transferred to all contexts of life, especially sports.

Creating a healthy and virtuous dimension of sociality and competition

#### INTERPLAY MODEL:

Implementate un modello di interplay (Interplay ovvero l'utilizzo di elementi di altri sport nel processo di allenamento) nel processo di allenamento di bambini, ragazzi e adolescenti?

12 responses



41.7% YES

SOMETIMES 8.3%

#### CLUB POLICIES FOR CHILD PROTECTION:



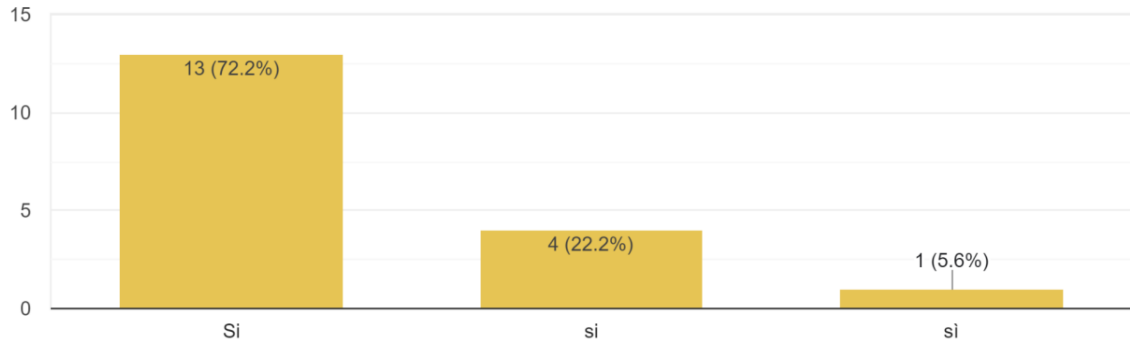
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Il vostro club/federazione/associazione ha implementato una politica di salvaguardia/incoraggiamento dei minori nello sport?

18 responses



## 6. Conclusions

In conclusion, this comprehensive research study has provided an in-depth exploration of the use of digital training tools in European football and basketball grassroots clubs. The study has traversed a wide range of topics, each of which contributes to a holistic understanding of the current landscape of digital training tools in sports coaching.

The research has underscored the growing importance of digital technologies in coaching practices. The integration of these technologies into coaching methodologies has been shown to enhance the effectiveness of training programs. Digital technologies offer a wealth of data that can be harnessed to monitor athletes' performance in real-time, providing coaches with the insights needed to adjust training regimens and strategies accordingly. This data-driven approach to coaching has the potential to revolutionize the way coaches design and implement training programs, leading to more personalized and effective training strategies.

The use of wearable technologies in coaching has been a particular focus of this study. These devices provide valuable data on athletes' physical performance, enabling coaches to track progress and adjust training regimens accordingly. The study has highlighted the various types of wearable technologies currently in use, from GPS trackers to heart rate monitors, and





discussed their advantages and disadvantages. The potential of these technologies to enhance coaching practices is immense, but their use also raises important questions about data privacy and security, which must be addressed.

The study has also delved into the potential of artificial intelligence (AI) and virtual reality (VR) in transforming coaching practices. AI and VR offer promising avenues for creating immersive and interactive training environments. These technologies can enhance athletes' engagement, facilitate the acquisition of complex skills, and provide a platform for simulating real-world game scenarios. However, the integration of AI and VR into coaching practices is still in its early stages, and further research is needed to fully understand their potential and limitations.

The research has also examined the use of performance analysis software and online training platforms in coaching. These tools provide a platform for analyzing performance data, designing training programs, and facilitating communication between coaches and athletes. The study has highlighted the various types of software and platforms currently available, discussed their features and benefits, and explored their potential to enhance coaching practices.

However, the research has also identified several challenges associated with the use of digital training tools. These include issues related to data privacy and security, the need for technical expertise to effectively use these tools, and the potential for over-reliance on technology at the expense of traditional coaching methods. Addressing these challenges is crucial to ensuring the ethical and responsible use of digital training tools.

Looking ahead, it is clear that digital training tools will continue to play a pivotal role in the evolution of coaching practices in football and basketball grassroots clubs. As such, there is a pressing need for ongoing research to keep pace with technological advancements and to explore innovative ways of integrating these tools into coaching practices.

Furthermore, it is crucial to address the identified challenges to maximize the benefits of digital training tools. This includes developing robust data privacy and security measures, providing adequate training for coaches to effectively use these tools, and promoting a balanced approach that combines the strengths of both digital technologies and traditional coaching methods.

Finally, the findings of this study underscore the importance of collaboration among various stakeholders, including sports organizations, educational institutions, technology developers, and policymakers. Such collaboration is key to harnessing the full potential of digital training tools, ensuring their ethical and responsible use, and ultimately enhancing the quality of coaching in European football and basketball grassroots clubs.





In sum, the use of digital training tools in coaching is a dynamic and rapidly evolving field. As we continue to navigate this exciting landscape, it is our hope that the findings of this study will serve as a valuable resource for all stakeholders involved in the promotion of education in and through sports. This research is a stepping stone towards a future where digital training tools are seamlessly integrated into coaching practices, enhancing the quality of training and contributing to the overall development of athletes.

## 7. Recommendations

In recent years, technological advancements in team sports have altered the sport sciences' daily operations. The tracking system's information reduces uncertainty in the decision-making process. In this way, tracking systems facilitate the application of the PDCA cycle (Plan, Do, Check, Act) to optimize player performance and prevent injuries. Following the principles of this model, the tracking system should allow one to identify and analyze the main problems related to the external load, locomotor demands, and technical–tactical performance of any session or match (Plan), develop and implement a holistic solution to the identified situation with the rest of the staff (Do), evaluate the results and the achieved goals based on the performance and injuries of the players (Check), and set standards (Standardize). In conclusion, tracking systems can be recognised as a valid and trustworthy instrument for implementing a problem-solving model in the context of elite team sports.

Technology has become established in elite sport in recent years and is used on a regular basis, especially in team sports. Nowadays many grassroots club use technological tools in their coaching practices. Thereby, monitoring movement patterns reveals important results regarding sport performance. In the area of semi-professional or elite football, the best system to quantify these results and the kinematic profile of the players are Global Positioning Systems (GPS). With the ability to record real-time data about time, speed, distance, position, altitude, and direction, these devices are widely used in the analysis of team sports, as they have been deemed a reliable method for assessing the external load in intermittent sports.

Furthermore, the technology of a multiple-camera match analysis system, implemented in nearly all European professional leagues and international competitions, has been demonstrated to be as reliable as GPS; it can obtain quantification results with less than 5% error and has been validated for investigational purposes. Thus, these types of systems have been utilized in various elite and grassroots competitions for physical and tactical performance research. Utilizing numerous elite competitions in professional sports for physical and tactical performance research enables a more comprehensive understanding of player movements and game







strategies. This innovation has transformed how coaches and players approach training and game preparation.

While the processes underlying elite football tactics have evolved over time, scientific approaches have not progressed at the same rate. Big data technologies offer a potential solution to this issue. Typically, big data is defined by the so-called three Vs: volume, variety, and velocity. Big data aims to standardize access to complex processing algorithms for researchers and enable non-expert users to apply cutting-edge analysis technologies to their data. The development of computing has enabled the collection of player-movement position data. Positioning tracking systems establish the player and ball positions in the x coordinates (parallel to lateral lines) and y coordinates at a rate of 25 frames per second, which corresponds to approximately 135,000 positions per subject and game and a total of approximately 3,100,000 positions between all players and the ball. This data compilation and subsequent analysis will facilitate the simplification of sports theory and practice. In this way, while physical parameters such as distance covered and speed have been analyzed in recent years, there is a lack of scientific evidence evaluating tactical parameters in team sports.

Utilizing these data in predictive models is one of the most urgent research topics in Sport Sciences. Specifically, according our review the previous research has included variables of physical performance (maximum speed ( $V_{max}$ ) and medium speed ( $V_{medium}$ ) in 15 minute intervals; distances covered at different speeds; medium distance covered, maximum speed in sprints; peak acceleration; and the number of accelerations of players in different ranges) and technical performance (number of passes, ball control, tackles, headed shots, shots on goal, corners, and free kicks by areas: defensive area (third of the field), offensive area (third of the field of play closest to the opponent's goal); number of short distance passes (10 m), average(>10 m), and minimum distance (2 m); number of shots on goal; percentage of ball possession; number of tackles and interceptions at 15-minute intervals).

To determine the tactical behavior of players or teams, it is necessary to demonstrate the behavioral dynamics of these agents through a series of variables.

Previous research has focused on variables of physical performance and technical performance. To determine the tactical behavior of players or teams, it is necessary to demonstrate the behavioral dynamics of these agents through a series of variables. The team's centroids, depth and width, and stretch rates provide a solid foundation for analyzing collective behavior in attack and defense team dynamics. Variables can be obtained via the multiple-camera match analysis system and other technologies. Utilizing these data in predictive models is one of the most urgent research topics in Sport Sciences.





The applicability of the information obtained by this technology can be oriented in different areas of execution, such as injury prevention, orientation of training tasks, and technical-tactical development. It allows for the identification of critical competition scenes, the identification of tactical limitations and strengths, and the establishment of interaction networks with the aim of knowing the tactical behavior of the team.



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## 9. Annexes

### 9.1. Questionnaires in three languages



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# EU-Projektforschung - TEAMUP. Bestehende und notwendige Tools für das Training in Breitensportvereinen (Basketball und Fußball)

Die Forschung wird im Rahmen des Erasmus TeamUp-Projekts durchgeführt und hat drei Hauptziele:

- Verbesserung der Strategien zur Integration digitaler Tools in das Training von Fußball- und Basketballklubs an der Basis;
- Untersuchung der bewährten Praktiken von Breitensportvereinen bei der Verwendung digitaler und effektiver Tools für Sporttraining und -erziehung, um die Fähigkeiten von Trainer\*innen sowie das Interesse und die Leistung junger Sportler\*innen zu steigern;
- Analysieren der Bedürfnisse der Zielgruppen (Trainer\*innen, Vereine, Sportler\*innen)

Wir bitten Sie als Sportvereine, Manager\*innen und Trainer\*innen um Ihre Mithilfe beim Ausfüllen des Fragebogens! Vielen Dank für Ihre Mitarbeit!

\* Indicates required question

1. \*

Geschlecht

Mark only one oval.

- Männlich
- Weiblich
- Andere



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2. Alter \*

Mark only one oval.

18-29

30-45

46+

3. Stadt, in der Sie wohnen: \*

---

4. Sport: \*

Mark only one oval.

Fußball

Basketball



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5. Wie wird die Trainer\*innenausbildung in Ihrem Land durchgeführt? \*

Mark only one oval.

- Formal/auf Universitätsebene
- Informell/intern - durchgeführt von Ihrem Sportverein und/oder Ihrer Dachorganisation - Verband, Vereinigung, Union
- Andere

6. Wenn Sie mit „Andere“ geantwortet haben, geben Sie bitte an, wie:

---

7. Welche Art von digitalen und/oder nicht-digitalen Methoden und Tools werden in Ihrem Land in der Trainer\*innenausbildung eingesetzt? ( Präsentation, Online-Video, Online-Sitzung, interaktives Whitboard ...)  
Geben Sie sowohl auf Vereinsebene als auch auf Verbandsebene an.

---

8. Wie erhöhen Sie das Qualifikationsniveau Ihres Trainer\*innenstabs (einschließlich Trainer\*innenlehrgänge auf nationaler und internationaler Ebene)? \*

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9. Wie viele Trainer\*innen sind in Ihrem Vereinen (auf Basis von Freiwilligen, Monatsgehalt, Vertrag usw.)? \*

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10. Arbeiten Ihre Trainer\*innen mit bestimmten Altersgruppen von Sportler\*innen - \*  
Freizeit-/Profisportler\*innen (Kinder und Jugendliche)?

Mark only one oval.

 Ja

 Nein

11. Wenn Sie mit Ja geantwortet haben, geben Sie bitte die Altersgruppen an, mit denen Sie arbeiten

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12. Welche Art von digitalen Hilfsmitteln verwenden Sie im Trainingsprozess von Kindern und Jugendlichen (8-13 Jahre)?

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13. Wenn Sie einige davon verwenden, in welchem Bereich sehen Sie Verbesserungsbedarf bei Ihrer Trainingsmethodik (kognitiv, emotional, propriozeptiv-sensorisch, motorisch, etc.).

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14. Was ist der Hauptfokus im Trainingsprozess von Kindern und Jugendlichen? \*

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15. Wird im Trainingsprozess von Kindern und Jugendlichen die Entwicklung von Sozialkompetenzen für die persönliche Entwicklung durch Sport angestrebt? \*

*Mark only one oval.*

Ja

Nein

16. Wenn Sie mit Ja geantwortet haben, geben Sie bitte an, wie:

---

17. Wenden Sie Methoden zur Erfolgskontrolle an (um die Entwicklung der Athlet\*innen zu verfolgen/den Fortschritt zu messen)? \*

*Mark only one oval.*

Ja

Nein



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18. Worin liegt der Ausbildungsbedarf bei Trainern\*innen (für zusätzliche Qualifikationen) und mit welchem Ziel: \*

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19. Worin liegt der Ausbildungsbedarf bei Kinder und Jugendliche: \*

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20. Setzen Sie ein Interplay-Modell im Trainingsprozess von Kindern und Jugendlichen ein? \*

- Interplay bezieht sich auf die Verwendung von Elementen aus anderen Sportarten im Trainingsprozess

Mark only one oval.

Ja

Nein



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21. Wenn Sie mit Ja geantwortet haben, geben Sie bitte ein Beispiel an:

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22. Verfügt Ihr Verein/Verband/Vereinigung über eine Richtlinie zum Schutz von Kindern? \*

Mark only one oval.

Ja

Nein

23. Sind Sie an weiteren Informationen über das Projekt und Materialien interessiert? Wenn ja, hinterlassen Sie Ihre E-Mail:

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# Ricerca progetto EU - TEAMUP. Strumenti esistenti e necessari per la formazione nei club sportivi di base (basket e calcio)

La ricerca è condotta all'interno del Progetto Erasmus TeamUp e si pone 3 obiettivi principali:

- Migliorare le strategie per integrare gli strumenti digitali nella formazione dei club di base di calcio e basket;
- Studiare le buone pratiche dei club sportivi di base nell'utilizzo di strumenti digitali ed efficaci per la formazione e l'educazione sportiva, al fine di aumentare le capacità degli allenatori e l'interesse e le prestazioni dei giovani atleti;
- Analizzare i bisogni dei gruppi target (allenatori, club, atleti)

Chiediamo il Vostro aiuto, come club sportivi, dirigenti e coach, nella compilazione del questionario! Grazie della collaborazione!

1. **Genere:**

*Mark only one oval.*

F

M

Altro



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2. **Età:**

*Mark only one oval.*

18-25

30-45

3. **Città in cui risiedi:**

4. **Sport:**

*Mark only one oval.*

calcio

basket



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5. Come viene condotta la formazione dei coach nel vostro Paese:

*Mark only one oval.*

- Formale nell'ambito universitario
- Informale/interno: realizzato dal club sportivo e/o dall'organizzazione di riferimento (Federazione, Associazione, Unione).
- Altro

6. Se hai risposto altro specifica in basso in che modalità:

---

7. Che tipo di metodi e strumenti digitali e/o non digitali vengono utilizzati nella formazione dei coach nel vostro Paese? (slide, video online, riunioni online e offline, jamboard...). Specifica sia al livello del tuo club, sia a livello di Federazioni.

---

8. Come secondo te si aumenta il livello di qualificazione del proprio staff di allenatori/allenatrici (compresi i corsi per allenatori a livello nazionale e internazionale)?

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9. Quanti allenatori/allenatrici avete nel vostro club (con base volontaria, stipendio mensile, contratto, ecc.)?

---

10. I vostri allenatori/allenatrici lavorano con specifiche fasce d'età di atleti - ricreativi e professionisti (bambini, giovani e adolescenti)?

Mark only one oval.

Sì

No

11. Se hai risposto sì, specifica il target con cui lavori

---

12. Che tipo di strumenti digitali utilizzate nel processo di formazione di bambini, ragazzi e adolescenti (8-13 anni)?

---

13. Se ne utilizzate alcuni, in quale area volete migliorare la vostra formazione (cognitiva, emotiva, sensoriale, motoria, ecc.) scegli uno/due campi:

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14. Qual è l'obiettivo principale durante il processo di formazione di bambini, giovani e adolescenti?

---

15. Durante il processo di formazione dei bambini, dei giovani e degli adolescenti, puntate sullo sviluppo delle soft skills per la crescita personale attraverso lo sport?

*Mark only one oval.*

Si

No

16. Se hai risposto sì specifica in che modo:

---

17. Applicate un metodo di valutazione dell'impatto (per seguire lo sviluppo degli atleti/per misurare i progressi)?

*Mark only one oval.*

Si

No



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18. Quali sono i bisogni formativi degli allenatori e allenatrici (per una migliore qualifica nel proprio lavoro) e perché?
- 
19. Quali sono i bisogni formativi dei bambini e dei giovani per una crescita sportiva e perché?
- 
20. Implementate un modello di interplay (Interplay ovvero l'utilizzo di elementi di altri sport nel processo di allenamento) nel processo di allenamento di bambini, ragazzi e adolescenti?
- 
21. Il vostro club/federazione/associazione ha implementato una politica di salvaguardia/incoraggiamento dei minori nello sport?
- 
22. Saresti interessato/interessata ad avere maggiori informazioni sul progetto e eventuali materiali? Se sì lascia la tua mail:
- 



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# Проучване по проект на ЕС - TEAMUP. Съществуващи и необходими инструменти за обучение в масови спортни клубове (баскетбол и футбол)

Изследването се провежда в рамките на проекта Erasmus TeamUp и има 3 основни цели:

- Подобряване на стратегиите за интегриране на дигитални инструменти в тренировките на масов футболен и баскетболен клуб;
- Да проучи добрите практики на масовите спортни клубове в използването на дигитални и ефективни инструменти за спортно обучение и образование, с цел повишаване на уменията на треньорите и интереса и представянето на младите спортисти;
- Анализ на нуждите на целевите групи (треньори, клубове, спортисти)

Молим за Вашето съдействие като спортни клубове, ръководители и треньори при попълването на анкетата!

Благодаря за съдействието!

1. Пол

Mark only one oval.

М

Ж

Друг



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2. Възраст

*Mark only one oval.*

18-25

30-45

45+

3. Град

4. Спорт

*Mark only one oval.*

футбол

баскетбол



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5. По какъв начин се извършва обучението на треньори

*Mark only one oval.*

- Формално/университетско ниво
- Неформално/вътрешно – вашия спортен клуб и/или вашата обща организация – федерация, асоциация, съюз /
- Друго

6. Ако сте посочили друго, моля обяснете

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7. Какъв тип дигитални и/или недигитални методи и инструменти се използват в обучението на треньори във вашата страна? (слайд, видео онлайн, среща онлайн, jamboard ...). Моля опишете както на клубно, така и на ниво федерация/асоциация

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8. Как повишавате нивото на квалификация на вашия треньорски персонал (включително курсове за треньори на национално ниво, международно ниво)

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9. Колко треньори имате във вашият клуб (доброволци, месечна заплата, договор и т.н.)?

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10. Вашите тренъори работят ли със специфични възрастови групи спортисти – любители/професионалисти (деца, младежи и юноши)?

Mark only one oval.

Да

Не

11. Ако сте посочили ДА, моля посочете, с кои възрастови групи работят

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12. Какъв тип дигитални инструменти използвате в процеса на обучение на деца, младежи и юноши (8-13 години)?

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13. Ако използвате някои от тях, в коя област трябва да подобрите методологията си на обучение (конгнитивна, емоционална, проприоцептивна сетивност, моторика и т.н.).

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14. Какъв е основният фокус/фокуси по време на тренировъчния процес на деца, младежи и юноши?

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15. Насочват ли се към развитието на меки умения за лично развитие чрез спорт по време на тренировъчния процес на деца, младежи и юноши?

*Mark only one oval.*

Да

Не

16. Ако отговорът е ДА, моля посочете как точно?

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17. Прилагате ли методи за оценка на въздействието (за проследяване на развитието на спортистите/за измерване на прогреса)?

*Mark only one oval.*

Да

Не

18. Какви са нуждите от обучение на треньори с цел допълнителна квалификация?

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19. Какви са нуждите от обучение на деца и юноши?

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20. Прилагате ли многоспортов модел в тренировъчния процес на деца, младежи и юноши?

- Многоспортов модел се отнася до използването на елементи от други спортове в тренировъчния процес

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21. Вашият клуб/федерация/асоциация има ли въведена политика за защита на децата?

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22. Бихте ли се интересували от повече информация за проекта и всякакви материали? Ако да, оставете вашия имейл:

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