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Review on the application of cloud computing in the sports industry

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Abstract

The transformative impact of cloud computing has permeated various industries, reshaping traditional business models and accelerating digital transformations. In the sports industry, the adoption of cloud computing is burgeoning, significantly enhancing efficiency and unlocking new potentials. This paper provides a comprehensive review of the applications of cloud computing in the sports industry, focusing on areas such as athlete performance tracking, fan engagement, operations management, sports marketing, and event hosting. Moreover, the challenges and potential future developments of cloud computing applications in this industry are also discussed. The purpose of this review is to provide a thorough understanding of the state-of-the-art applications of cloud computing in the sports industry and to inspire further research and development in this field.

Keywords Cloud computing, Sports industry, Digital transformation, Performance tracking, Operations management

Introduction

Background and importance of cloud computing

Cloud computing has risen to prominence in the last two decades as a result of significant advances in digital technology. It is a computing paradigm that allows on-demand access to shared pools of configurable computing resources, such as servers, storage, applications, and services, that can be rapidly provisioned with minimal management effort [1]. This flexibility, scalability, and cost-effectiveness have made cloud computing an integral part of businesses across various sectors. Today, more and more business domains have adopted cloud computing paradigm to provide more economic, convenient and lightweight service provisions.

In the context of sports, cloud computing has the potential to transform many aspects of the industry. The advent of cloud technology has ushered in new opportunities, allowing sports organizations to improve their operations, optimize performance, enhance fan engagement, and open up new revenue streams. For instance, cloud-based solutions can efficiently handle large volumes of data generated during games, providing insightful analysis for strategy formulation and performance enhancement [2]. Moreover, cloud computing is at the core of many innovative technologies that are changing the face of the sports industry. From wearable technology that tracks athlete's performance to virtual reality experiences that engage fans like never before, cloud computing is playing a pivotal role in driving these innovations [3]. It is also enabling sports organizations to transition from traditional operational methods to more efficient, scalable, and sustainable models, which are essential in today's rapidly evolving digital landscape [4].

To further clarify the importance and significance of introducing cloud computing technology into sports industry, we present a typical application framework of cloud computing in Fig. 1 where a three-layer architecture is provided. In concrete, in the 3rd layer, various

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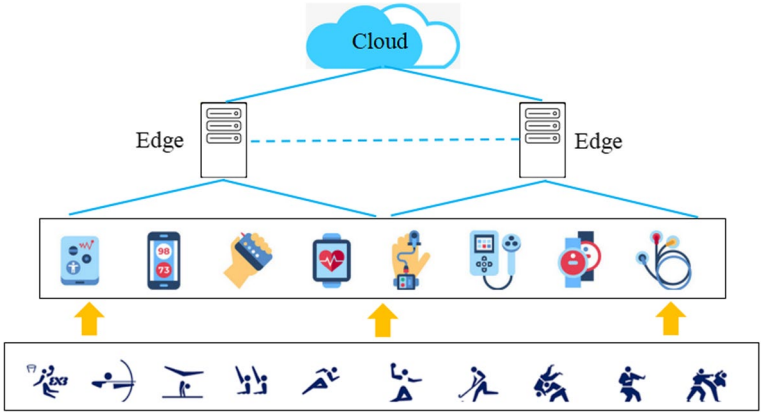

Fig. 1 Three-layer data processing structure in cloud-aided sport industry

sensors or embedded devices are used to monitor and collect the real-time health conditions or signals of players involved in different sport items; in the 2nd layer, the collected sensor data of players are transmitted to nearby edge servers for initial processing and computation; in the 1st layer, the core data processed by edge servers are integrated together by a central cloud platform for uniform data analysis, mining and decision-makings.

Overview of cloud computing in the sports industry

In recent years, the sports industry has increasingly adopted cloud computing, transforming multiple facets of the industry from athlete performance tracking to fan engagement, and operations management. Cloud computing technologies offer an effective solution for data storage and analytics in the sports industry. Large volumes of data can be generated from various sources, such as player tracking systems, ticket sales, and social media interactions. The cloud provides a platform where these vast amounts of data can be securely stored and effectively processed to derive actionable insights [5].

In the realm of athlete performance and health monitoring, the integration of cloud computing with wearable technology has been revolutionary. Wearable devices collect and transfer data to the cloud where sophisticated algorithms analyze the data and provide detailed performance reports and health assessments [6]. This empowers athletes and coaches to make data-driven decisions and develop personalized training regimens. Fan engagement has also been elevated by cloud computing, with platforms harnessing the cloud to deliver customized experiences. These range from interactive mobile applications providing real-time updates to virtual reality experiences immersing fans into the heart of the action [7]. Furthermore, cloud technology supports operational efficiency in sports organizations. It enables streamlined ticketing systems, better inventory management, and effective coordination of multi-faceted sporting events [8].

Despite these benefits, the adoption of cloud computing in sports is not without challenges. These range from data security concerns to the cost of technology implementation. This paper aims to offer a comprehensive review of these applications, highlighting both the opportunities and challenges that cloud computing presents to the sports industry.

Paper organization structure

This paper is organized as follows: "Applications of cloud computing in the sports industry" section provides a comprehensive examination of the applications of cloud computing in the sports industry, including athlete performance tracking, fan engagement, operations management, sports marketing, and event hosting. In "Challenges of cloud computing in the sports industry" section, we address the challenges associated with integrating cloud computing into the sports industry, such as data privacy, costs, and internet dependency. Following this, potential future developments and trends in the intersection of cloud computing and sports are discussed in "Future trends and potential developments" section, touching upon the integration with other technologies, customization, and sustainability. Finally, in "Conclusion" section, the paper concludes with a summary of key findings and suggestions for future research in this area.

Applications of cloud computing in the sports industry

Athlete performance tracking

One of the key applications of cloud computing in the sports industry is the tracking of athlete performance.

This involves capturing, storing, and analyzing vast amounts of data related to an athlete's physical and physiological performance. With the integration of cloud technology, this process has become significantly more streamlined, enabling detailed, real-time performance monitoring and creating a data-driven approach to performance enhancement. Cloud-based performance tracking often employs wearable technology to gather real-time data from athletes during training and matches. For example, wearable devices can track parameters such as heart rate, acceleration, and GPS location, among others [9]. This data, often substantial in volume, is then transferred to the cloud where it is securely stored and processed.

Through the application of machine learning and artificial intelligence techniques on the cloud, the raw data can be transformed into meaningful insights. These insights include patterns and trends in an athlete's performance, which can help to tailor training programs, identify areas for improvement, and anticipate potential injury risks [10]. Athletes wear devices (like smartwatches, fitness bands, or even smart clothing) can collect data on their heart rate, speed, acceleration, and more. This data is then uploaded to the cloud in real-time. Coaches and trainers can access this data from anywhere, analyze it using cloud-based software, and provide immediate feedback to the athlete. Over time, this data can be used to track performance trends, identify areas of improvement, and customize training regimens [11]. Furthermore, the remote and on-demand access to data and insights provided by the cloud allows coaches and sports scientists to monitor athlete performance and make timely interventions, irrespective of their physical location. This is particularly useful in the current era of global sports, where athletes and teams travel extensively [12].

Fan engagement

Cloud computing has a significant role in enhancing fan engagement in the sports industry, allowing fans to interact with their favorite sports and athletes in previously unimaginable ways. By providing fans with personalized and immersive experiences, cloud computing is transforming how fans consume sports. One of the primary areas where cloud computing impacts fan engagement is through the use of social media. Social media platforms provide a space where fans can engage with their favorite teams and athletes and share their experiences with others. Cloud computing enables these platforms to handle massive amounts of data and deliver personalized content to individual users. For example, the use of data analytics can help sports organizations understand fans' behavior, allowing them to provide fans with tailored content that meets their preferences and enhances their engagement [13].

In addition, cloud computing is enabling the creation of advanced mobile applications that provide fans with real-time updates, video content, and opportunities for interaction. Sports organizations can use these applications to engage fans during live events, providing them with real-time statistics, instant replays, and interactive features such as voting systems or quizzes [14]. Beyond mobile applications, the intersection of cloud computing and virtual reality (VR) technology is providing fans with immersive experiences. For example, fans can use VR headsets to experience a live game from the best seats in the stadium, or even from the perspective of a player on the field, all from the comfort of their own homes [15]. Cloud computing underpins these experiences by providing the necessary processing power and data storage capacity. Furthermore, the ability of cloud platforms to integrate various types of data has opened up new possibilities for fan engagement. For example, by combining data from different sources, such as ticket sales, social media interactions, and online merchandise purchases, sports organizations can gain a more comprehensive understanding of their fans' behavior. This can inform marketing strategies and create personalized fan experiences [16].

Fans can use VR headsets or AR-enabled smartphones to access cloud-hosted virtual stadiums, watch games from unique angles, or even walk on the field with their favorite players. The cloud ensures that these experiences are smooth and high-quality by handling the heavy computational load and delivering content seamlessly to users worldwide.However, while cloud computing offers tremendous opportunities to enhance fan engagement, it also raises concerns related to data privacy and security. Sports organizations must ensure they adhere to data protection regulations and take appropriate steps to protect their fans' data. In summary, cloud computing is significantly enhancing fan engagement in the sports industry by enabling personalized, interactive, and immersive fan experiences. As technologies continue to evolve, it is anticipated that the role of cloud computing in fan engagement will become increasingly integral.

Operations management

The application of cloud computing in operations management is shaping the sports industry by introducing efficient, scalable, and flexible solutions that transform traditional operational processes. From inventory management to ticketing systems, cloud computing's robust capabilities are driving operational efficiency and improving overall performance. In terms of inventory and facility management, sports organizations

often grapple with managing vast inventories of equipment, merchandise, and food and beverage supplies. The adoption of cloud-based inventory management systems allows these organizations to accurately track inventory in real-time, streamline procurement processes, and minimize waste, resulting in significant cost savings [17]. Similarly, for facility management, cloud-based solutions can assist in scheduling, maintaining, and managing sports facilities more efficiently, resulting in improved utilization and cost effectiveness [18].

Ticketing and registration systems have also benefited from cloud technology. Traditional ticketing systems often involve labor-intensive processes and are prone to inefficiencies and inaccuracies. However, cloud-based ticketing solutions offer a more efficient approach, allowing fans to purchase and validate tickets digitally, reducing the likelihood of counterfeit tickets and enhancing the fan experience [19]. Moreover, these systems can handle large volumes of transactions simultaneously, a critical feature during high-demand periods. The coordination and management of sports events, particularly large-scale events like the Olympics or the FIFA World Cup, can be exceedingly complex. Cloud computing provides a platform for effective coordination of all aspects of these events, from logistics and security to volunteer management and media coverage. For example, during the 2020 Tokyo Olympics, cloud technology was used to integrate and manage data from various sources, enabling efficient operations and real-time decision-making [20]. Cloud-based systems can handle ticket sales, reservations, and access control for large-scale sports events. Fans can purchase tickets online, receive digital tickets, and use their smartphones or QR codes for entry. The cloud system can handle peak loads (like during a major game's ticket release) and ensure that operations run smoothly.

Cloud computing is also facilitating collaborative work environments in the sports industry. Cloud-based platforms allow staff to access necessary documents and applications from any device, promoting productivity and flexibility in workflows [21]. Despite these advantages, transitioning to cloud-based operations management can be challenging, involving significant costs and requiring a change in organizational culture and workflows. Also, the reliance on internet connectivity and concerns about data security need to be addressed. Cloud computing is transforming operations management in the sports industry, providing efficient, scalable, and flexible solutions that enhance organizational performance. As the industry continues to adapt to digital transformation, the use of cloud technology in operations management is expected to become more prevalent.

Sports marketing

Cloud computing has introduced a transformative shift in sports marketing, enabling strategies to become more targeted, personalized, and data-driven [22]. The unprecedented levels of connectivity and data accessibility provided by cloud computing are paving the way for more effective marketing strategies and more lucrative sponsorship opportunities.

(1) Targeted marketing strategies

In the realm of sports marketing, cloud computing's capacity to handle large volumes of data and conduct sophisticated data analytics has enabled highly targeted marketing strategies. These strategies are underpinned by the analysis of a myriad of data sources, from social media interactions and online merchandise purchases to ticketing information and fan app usage [23]. By analyzing this data, sports organizations can gain valuable insights into fans' behavior and preferences, enabling them to create highly targeted and personalized marketing campaigns. For instance, clubs can use these insights to tailor email marketing content to individual fans, promoting merchandise or tickets based on their past behavior and preferences [24]. Moreover, cloud-based platforms can enable real-time marketing, allowing organizations to react instantly to events on and off the field. For example, a memorable moment in a game can be instantly converted into a marketing opportunity, with relevant content quickly created and distributed across digital platforms [25].

(2) Data-driven sponsorship opportunities

In terms of sponsorship opportunities, the adoption of cloud computing allows sports organizations to provide potential sponsors with detailed, data-driven insights into their fan base. This ability to quantitatively demonstrate fan engagement levels and demographic breakdowns makes sports organizations more appealing to sponsors, as they can better assess the potential return on investment and align their marketing efforts with the right audience [26]. Furthermore, during live events, cloud technology can facilitate dynamic sponsorship opportunities. By analyzing real-time data, digital advertising hoardings can display personalized advertisements tailored to the audience watching at home, opening up a new dimension to sports sponsorships [26].

Sports teams and organizations can collect data on fan preferences, online interactions, merchandise purchases, and more. This data, stored and analyzed in the cloud, can be used to create personalized marketing campaigns. For example, a fan who frequently watches a particular

player's highlights might receive special merchandise offers related to that player. Nevertheless, with these new opportunities come challenges related to data privacy and security [27–29]. Organizations must balance their marketing strategies and sponsorship opportunities with the ethical and legal requirements of data protection, underlining the importance of robust data governance policies. Cloud computing is driving a transformative shift in sports marketing, enabling more targeted, personalized, and data-driven strategies. As cloud technology continues to evolve, it is expected to play an increasingly integral role in sports marketing and sponsorship.

Event hosting

Cloud computing has significantly revolutionized the process of hosting sports events. From the planning phase through execution to the post-event analysis, cloud computing provides robust, scalable, and cost-effective solutions that enhance efficiency, engagement, and experience [30, 31]. Cloud-based event management tools simplify the planning process by providing a central platform where all aspects of event planning can be coordinated. Tasks such as scheduling, resource allocation, volunteer management, and participant registration can all be managed effectively on these platforms. By using the cloud, these processes can be automated, tracked, and updated in real-time, enhancing efficiency and communication among the event management team [32].

The actual execution of the event can also benefit from cloud technology. The integration of ticketing systems, access control, real-time information updates, and security management into a unified cloud platform can improve event operations, resulting in a smoother and more enjoyable experience for attendees [33]. Moreover, cloud-based systems can handle the surge in internet traffic during the event, ensuring seamless access to information for attendees, staff, and online viewers. One of the most transformative applications of cloud computing in event hosting is the provision of live streaming services. Through cloud platforms, sports events can be broadcast live to viewers worldwide, dramatically expanding the reach of the event. The scalability of the cloud ensures that the streaming service can handle large viewer numbers, providing a smooth viewing experience [34].

Furthermore, cloud computing enables the real-time analysis of event data. Data gathered from ticket sales, social media interactions, and audience engagement can be analyzed to provide valuable insights during the event. This allows event organizers to make data-driven decisions to enhance the ongoing event experience [35]. Post-event, the cloud facilitates efficient wrap-up procedures, including financial reconciliation, feedback collection, and performance analysis. The data gathered before and during the event can be further analyzed to evaluate the event's success and inform the planning of future events [36].

During large sports events, organizers can use cloud-connected cameras and sensors to monitor crowd movements, identify potential congestion points, and ensure safety protocols are followed. The cloud processes this data in real-time, allowing event managers to make quick decisions, like redirecting foot traffic or dispatching security to specific locations. However, the integration of cloud computing into event hosting presents challenges. These include concerns over data security, reliability of internet connectivity, and the requirement for significant upfront investment in cloud technology.

Challenges of cloud computing in the sports industry

Data privacy and security

While cloud computing offers significant benefits to the sports industry, it also presents certain challenges, with data privacy and security being paramount among them [37]. With the vast amounts of data generated and stored in the cloud, including sensitive personal data, health information, and performance metrics, it is crucial that these are securely managed and protected. Data privacy represents a significant concern, as information stored in the cloud can potentially be accessed from anywhere, by anyone with the correct credentials. This increases the risk of unauthorized access and privacy breaches. The situation is compounded by the fact that the data involved often includes sensitive personal information, such as names, addresses, health data, and credit card information [38]. Especially in the big data context, the traditional centralized data processing paradigm with cloud is not efficient enough. Therefore, to alleviate the heavy burden of cloud platform, many edge servers are often used to make initial data preprocessing before the massive data are directly sent to the cloud platform. In this situation, private user data are probably disclosed to other parties during the data transmission among cloud, edge and users.

Security is another major challenge in cloud computing. Despite robust security measures, no system is completely immune to security threats. These threats can include hacking attempts, data breaches, and other cyber-attacks. Such incidents not only compromise the privacy of individuals but can also significantly damage the reputation of sports organizations [39]. The use of third-party cloud service providers further complicates matters. Organizations often have limited control over their data security when using third-party services, which can result in potential vulnerabilities [40]. Sports

organizations are also faced with the complex task of navigating global data protection regulations. Laws such as the General Data Protection Regulation (GDPR) in Europe impose stringent requirements on how personal data is handled, including how it is collected, stored, and shared. Non-compliance can lead to significant penalties [41].

To address these challenges, sports organizations need to ensure they have robust data governance policies in place and that they are using secure and reliable cloud services. This includes ensuring appropriate encryption, access controls, and intrusion detection systems are in place. They must also ensure they are transparent with their stakeholders about their data handling practices and that they are in compliance with all relevant regulations [42]. In conclusion, while cloud computing offers vast potential for the sports industry, it is not without its challenges. Data privacy and security issues need to be thoroughly addressed to ensure the benefits of cloud computing can be realized without compromising the privacy and security of stakeholders.

Cost and complexity of implementation

Implementing cloud computing in the sports industry can be both costly and complex. While cloud computing promises cost savings over time due to reduced need for hardware and physical infrastructure, the upfront costs can be significant. These costs can include the implementation of the cloud solution itself, staff training, and ongoing maintenance and support [43]. The cost can be particularly challenging for smaller sports organizations, which may not have the necessary budget to invest in advanced cloud solutions. Although cloud services are generally billed on a usage basis, which allows for scaling according to need, the initial investment can still be a barrier for these organizations [44].

Moreover, migrating to a cloud-based system can be a complex process, requiring specialized knowledge and expertise. Depending on the size of the organization and the extent of its data, the migration process can be time-consuming and potentially disruptive to operations. This process often requires the support of external IT specialists, which adds to the overall cost of implementation [45]. The complexity of implementation also extends to the integration of the cloud solution with existing systems. This can be particularly challenging if the organization's existing IT infrastructure is outdated or incompatible with the cloud solution. In such cases, a complete overhaul of the IT infrastructure may be required, adding further to the cost and complexity [43].

There's also the issue of vendor lock-in. When sports organizations commit to a particular cloud provider's platform, they may find it difficult to migrate their services to another provider later on. This can limit the organization's flexibility and could lead to increased costs over time [46]. While cloud computing offers many potential benefits to the sports industry, the cost and complexity of implementation are significant challenges that need to be carefully managed. To successfully implement cloud solutions, sports organizations need to carefully plan their cloud adoption strategies, taking into account their specific needs, budget constraints, and IT capabilities.

Dependence on internet connectivity

The sports industry's reliance on cloud computing also means a dependency on consistent and robust internet connectivity. This dependence on internet connectivity is one of the fundamental challenges associated with the adoption of cloud computing. For sports organizations, the reliance on internet connectivity means that any disruption in their internet service could potentially bring their operations to a halt. This is a particular concern for live events, where a disruption in internet service could affect everything from ticketing to live streaming, potentially damaging the reputation of the event and the organization [47].

Similarly, for athletes and coaches who rely on cloud-based systems for performance tracking and analytics, a lack of internet connectivity could mean lost data or an inability to access crucial information. For example, a coach might be unable to access real-time data about an athlete's performance during a training session or a game if there is a disruption in internet service [48]. In areas with weak or inconsistent internet coverage, the adoption of cloud-based solutions can be particularly challenging. This is especially true in developing countries or rural areas where internet infrastructure may not be robust. The digital divide can limit the reach and effectiveness of cloud-based solutions in these areas [49]. Additionally, the reliance on internet connectivity also has implications for data security. An insecure internet connection can expose data to potential security threats, underlining the importance of secure and reliable internet connectivity [50]. Mitigating these challenges requires investment in robust, reliable, and secure internet infrastructure. Where possible, organizations might also consider hybrid cloud solutions, which combine private and public cloud services. These solutions can offer offline capabilities, reducing the dependence on constant internet connectivity [51].

Future trends and potential developments

Integration with other technologies (AI, IoT, etc.)

The convergence of cloud computing with other advanced technologies such as Artificial Intelligence (AI), Internet

of Things (IoT), and Blockchain presents significant opportunities for the sports industry [52, 53]. This integration can amplify the benefits of each technology, driving innovation and creating new ways to enhance athletic performance, fan engagement, and operational efficiency. AI and cloud computing are increasingly becoming interdependent. AI applications, ranging from predictive analytics to automated decision-making systems, rely on the vast computational resources offered by the cloud. On the other hand, the cloud benefits from AI's ability to process and analyze large datasets, optimize system performance, and improve data security [54]. In sports, AI can enhance cloud-based athlete performance tracking systems, allowing for real-time analysis and feedback. It can also enhance fan experience by enabling personalized content delivery and predictive services, such as predicting game outcomes or player performance [55].

IoT, which refers to the network of physical devices connected to the internet, can benefit significantly from integration with cloud computing [56]. Cloud platforms can store and analyze the large amounts of data generated by IoT devices, allowing for real-time decision-making and enhancing the value of IoT applications in sports [57, 58]. IoT devices, such as wearable technology and smart equipment, can provide detailed data about athletes' performance, health, and safety. When combined with cloud-based analytics, these insights can inform training strategies, injury prevention measures, and even tactics during competitions [59]. Blockchain technology, known for its security and transparency features, can also complement cloud computing. In sports, blockchain can enhance cloud-based ticketing systems by preventing fraud and ensuring transparency. It can also create new possibilities for fan engagement, such as token-based reward systems or secure voting platforms for fan decisions [60].

While these integrations offer promising potential, they also introduce additional complexities and challenges, particularly in terms of data privacy, system integration, and technology management [61]. Future research and innovation should focus on addressing these challenges to fully realize the potential of these integrated technologies in the sports industry.

Customization and personalization

The future of cloud computing in the sports industry points towards a greater focus on customization and personalization [62–65]. As the volume of available data continues to increase, there is a growing opportunity for sports organizations to create personalized experiences and offerings for their stakeholders [66], including athletes, fans, and sponsors. For athletes, cloud-based tools can provide personalized training plans, nutritional advice, and injury prevention strategies. These customized solutions can be developed based on a variety of data, including historical performance data, real-time tracking data, health data, and even genetic information. Such personalization can optimize athlete performance and promote long-term athlete health and wellbeing [67].

Fans also stand to benefit from more personalized experiences [68, 69]. Using data collected from various sources, such as ticketing systems, social media, merchandise sales, and digital platform interactions, sports organizations can create highly targeted content and marketing campaigns. For instance, fans could receive personalized match updates, tailored merchandise recommendations, and bespoke content featuring their favorite players. This level of personalization can improve fan engagement, deepen fan loyalty, and increase revenue from fan-related activities [25]. For sponsors and partners, personalization can lead to more effective collaboration and improved return on investment. By leveraging the data stored and analyzed in the cloud, sports organizations can provide sponsors with detailed insights into their fan base, enabling the creation of highly targeted marketing strategies. This data-driven approach can enhance the value of sponsorships and partnerships, leading to mutually beneficial relationships [14].

Looking forward, advancements in AI and machine learning are expected to further enhance the customization and personalization possibilities in sports [70]. These technologies can help to analyze and interpret the vast amounts of data generated in the sports industry, leading to more accurate insights and more effective personalization strategies [55]. The future of cloud computing in the sports industry is likely to be characterized by a greater focus on customization and personalization. As technology continues to advance, the possibilities for creating personalized experiences for athletes, fans, and sponsors are expected to grow.

Sustainability and green IT

The role of cloud computing in promoting sustainability and green IT practices within the sports industry is another emerging trend [71–73]. As the societal focus on environmental sustainability continues to grow, so does the pressure on sports organizations to reduce their environmental impact. Here, cloud computing can be an essential tool. Cloud computing can contribute to sustainability in several ways. Firstly, it reduces the need for physical IT infrastructure, which in turn reduces the energy consumption associated with running and cooling these systems. Cloud data centers benefit from economies of scale and can operate more efficiently than smaller, organization-specific data centers, leading to a smaller carbon footprint [74–76].

Secondly, the scalability of cloud computing means that resources are only used when needed, preventing the waste associated with underutilized infrastructure. As a result, cloud computing can contribute to more sustainable IT practices within sports organizations [77]. Moreover, cloud computing can also support sustainability in the sports industry beyond IT practices. The data processing and analysis capabilities of the cloud can support the implementation of other environmentally friendly practices. For example, it can help optimize travel schedules for teams and fans, reducing carbon emissions associated with transportation. It can also enable smarter management of facilities, such as predictive maintenance and energy management, contributing to greener operations [78]. Looking forward, we can expect further advancements in green cloud computing technologies. For instance, improvements in energy-efficient data center design, renewable energy use, and energy-aware scheduling algorithms will continue to enhance the environmental sustainability of cloud computing [75].

As environmental sustainability becomes an increasingly important concern for society and for the sports industry, the role of cloud computing in promoting green IT practices and broader sustainability efforts is set to grow. Embracing this trend will not only contribute to environmental protection efforts but also build a positive reputation for sports organizations among increasingly eco-conscious stakeholders.

Conclusion

This study was motivated by the rising prominence of cloud computing and its profound influence on the sports industry. The purpose of this review was to provide a comprehensive overview of the applications of cloud computing in sports, discuss the challenges faced, and identify future trends and potential developments. The research highlights several key applications of cloud computing in sports, including athlete performance tracking, fan engagement, operations management, sports marketing, and event hosting. These applications illustrate how cloud computing has transformed traditional sports practices by facilitating data collection and analysis, enhancing communication, and optimizing operations.

Cloud computing often works well in business systems involving big data processing due to the high computational capability of cloud platforms. Inspired by this observation, cloud computing technology is introduced in sport industries in this paper to deal with big sport data and has achieved good performances in sport industries. However, not all sport items can produce big volume of data that need to be processed by powerful cloud platforms; in such cases, cloud computing platforms are not a necessity since small sport data can be processed by local clients such as computer or laptops.

Alongside the benefits of cloud computing, the research also illuminated several challenges associated with the adoption of cloud computing in the sports industry, including issues of data privacy and security, cost and complexity of implementation, and dependence on internet connectivity. In addition, how to extend the traditional cloud-based sport data processing systems to more flexible and cost-effective edge-based systems to adapt time-efficient and cost-efficient business applications is still a challenging task in future study. These challenges underscore the need for careful planning, robust security measures, and continuous monitoring and adjustment of cloud solutions.

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Authors' contributions
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