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Review Article

Emerging Technologies to Promote Fans Interaction in Football Events: A Systematic Review

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As the digital revolution continues to take hold in contemporary society, new technology and communications networks have provided football with new possibilities and prospects for expansion. This study provides an assessment of the published research regarding innovative digital tools designed to increase the interactivity of fans when watching a football match, regardless of whether they do it at home or at the stadium. A systematic review of the literature was performed, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline. The search was conducted in the PubMed, Web of Science, and Scopus databases. The final sample included eleven studies for analysis. Overall, the investigations that structure this review seem to be in the early stages of their development, with eight of them making tests with the target audience and the other three still in protocol development processes. Six studies concluded that fans had positive and exciting experiences using mobile applications or interactive systems. Two studies showed promising results in the area of football fans' health, and only one study showed some difficulties for fans using an ad hoc network in the stadium. Adding personal information, fan interaction systems, specific information about the players and the teams' tactical strategies, and interactive fan voting seem to be important elements for designing a successful interactive tool that contributes to increasing fans' enthusiasm during football matches.

1. Introduction

Football is a worldwide sport with billions of fans [1]. The globalization of this distinctive sport can be claimed by having a unique attendance of around 3.57 billion people watching 2018 FIFA World Cup in Russia [2] and over 3.4 million people as spectators in stadiums attending all 64 matches played in Qatar 2022 FIFA World Cup, with an average attendance of 96.3% of stadiums' capacity [3]. That said, it is clear that spectators become an essential component of each major sportive event, and their opinions are vital to the advancement of the sportive experience as a whole [1]. Football's popularity has made it appealing to a wider audience worldwide. Sports enthusiasts are still drawn to this since some watch major events like the World Cup every four years to witness its pleasure in person as well as on television or other smart technology [1]. In this sense, "fan" refers to any anyone who considers themselves to be a supporter of a specific team, as well as their idols or famous figures [4].

Unquestionably, sportive world is heading toward "digital stability," where nearly everything is managed digitally [5], and intelligent technology plays a major role in it [6]. Research on the digitalization of football events has grown significantly over the past 10 years, demonstrating the prevalence of multilateral digital communication among football networks [7]. Emerging technologies have provided new opportunities, especially in football, to develop a modernization process in its' entertainment and interaction processes [7]. In a broader sense, digital technology now actively shapes our sense of self and the development of our social and cultural networks [8]. As we are witnessing the era of hyperdigitalization, the type of interaction of fandom engagement have been changing [7, 9, 10]. For example, the Internet of Things is being used in some athletics, basketball, and football stadiums to better organize sportive events and improve the fans experience [6].

Also, the virtualization of sportive events was accelerated by the COVID-19 pandemic [11, 12]. The pressure for this drastic digital transition was huge during social isolation [13]. As the number of people watching sporting events on broadcast television started to drop, the number of people watching and interacting with sports on mobile applications started to rise [14]. Recent studies have reinforced the need for fans to return to stadiums safely due to the economic crises of clubs (especially in lower leagues) and the involvement and atmosphere that only the fans themselves can create in the stadium [15–17].

Over the last decade, different technological innovations have been developed to increase fan interaction and enthusiasm during football events, especially in the stadium itself [18–21]. With the aim of providing security so that fans would return to the stadiums on a regular basis, some innovative technologies have been developed, focusing on traffic mobility in and around football stadiums [22], early detection of acute disease outbreaks [23], and understanding the impact of innovative technology on the experience of football fans [24]. Even with so many research areas related to the digitization of football events, details on how this kind

of innovative technologies can promote fans' interaction and motivation to participate in football events, primarily in technological football stadiums [25]. Smart stadiums offer a platform that gives the possibility to test the newest innovations in sports technology, strengthening the bond between big data innovation and sports and enhancing the fan experience in and outside the stadium walls [6].

Considering and analyzing the extent to which digitalization has influenced football cultures is crucial to understanding its impact on fan interaction at football events [7]. Therefore, the purpose of this systematic review was to provide an assessment of the published research in the last 10 years regarding innovative digital tools designed to increase fans' interactivity and engagement during a football match, regardless of whether they do it at home or in the stadium.

2. Materials and Methods

2.1. Study Design. The current systematic review was undertaken following the Preferred Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist [26].

2.2. Eligibility Criteria. The search items used for this review were constructed using the population, intervention, comparison, outcome, and study design (PICOS) framework [27]: (1) population in general of both genders and any age, (2) studies based on digital technologies used in European football sportive events, (3) data from digital tools, independently of the comparisons made, (4) data reporting the use of digital tools (protocol studies will be considered, besides not having results), and (5) intervention studies with a pre- and post-test design, descriptive studies, and protocol proposals, and (6) articles written in English, Spanish, or Portuguese.

2.3. Information Source and Search Strategy. On November 16, 2023, three electronic databases (PubMed, Web of Science, and Scopus) were consulted to find articles that investigated emerging digital technologies focused on promoting and elevating fans interactions in European football sporting events. Primary source articles published in peer-reviewed scientific journals over the past 10 years and up to November 16, 2023, were eligible.

Table 1 summarizes the search terms used in the title and abstract level, combined with the Boolean operators "OR" and "AND."

2.4. Study Selection. All returning studies were aggregated and exported into a reference manager (EndNote X20, Clarivate Analytics, London, LON, UK). After deleting duplicate entries from the database search, two authors independently reviewed the title and abstract for eligibility (F.M. and C.F.). The same authors read all eligible records before determining what studies should be included. In case of doubts concerning the inclusion and exclusion decisions, a third and more experienced author was consulted (E.R.G.).

TABLE 1: Search terms and keywords used in the search strategy.

Key search terms	Related search terms
Fans	Fans OR supporters OR adherents OR crowd*
Football	Football OR soccer
Technology	Technology* OR application* OR app OR digital

2.5. Data Extraction and Harmonization. Data extraction and harmonization were carried out by the two authors (F.M. and C.F.) using a standardized approach with a consensus including ten items: (1) study, (2) year of publication, (3) aim, (4) participants, (5) football event, (6) study type, (7) tool, (8) methodology, (9) findings on fan interaction, and (10) research gaps.

2.6. Study Quality and Risk of Bias. The Crowe Critical Appraisal Tool (CCAT) was used to assess study quality [28]. The eight categories of this instrument that examine selection bias include preliminaries, introduction, design, sampling, data collection, ethical matters, results, and discussion. Those parameters are divided into 22 items and 98 item descriptors [29]. Each category was ranked from 0 (lowest score) to 5 (highest score). According to the instrument user guide [28], the score for each category was summed, giving a total score to each study. Then, the total score was divided by the maximum score of 40 and multiplied by 100 to provide an overall percentage value. Each of the eight categories contributed similarly to the overall score of each paper. The CCAT has been previously used to examine studies related to new technologies [30–32].

3. Results

3.1. Study Selection. Figure 1 shows the flowchart of the study selection procedure. A total of 502 articles were identified through the search in PubMed, Web of Science, and Scopus. Of those, 168 articles were duplicated, and 334 remained for analysis. Then, the documents were screened by title and abstract, and 276 were eliminated. Finally, 58 articles were assessed by full-text, and eleven remained as pertinent for inclusion. The exclusion process was based on the documents being about video assistant referee or goal line technologies (2), other events (2), social media (9), nontechnological studies (5), duplicated (1), global positioning system localization (2), video analysis (2), marketing and branding (14), nonaccessible (1), reviews (2), virtual reality (1), nonscientific article (1), collecting data from players (2), conference paper (1), and based on language (1). These inclusion and exclusion decisions can be found as a supplementary file (available here).

Following the selection phase, the resulting eleven articles went through a more detailed analysis and were presented next.

3.2. Study Quality and Risk of Bias. The data obtained from the study quality assessment is presented in Table 2. Concerning methodology quality, none of the articles included were classified with the total score. One of the papers was considered to have a very high reporting quality (90%) [20], five of them were classified as having a high reporting quality (range = 60–75%) [18, 22–24, 33], and five obtained a moderate reporting quality (range = 45–60%) [21, 34–37]. In summary, the authors believe that the quality of the articles included in the topic of this systematic review, depending on the quality assessment instrument used, is sufficiently satisfactory for further analysis and reflection.

3.3. Intervention Characteristics. Table 3 provides a summary of the characteristics of each research project that was included in our review. Three included documents were descriptive protocols of conceived mobile applications [34, 36, 38]. Six studies [18, 20, 21, 23, 33, 35], considered a total of 18,081 participants, from both genders (67% male and 33% women), aged between 12 and 77 years. The remaining 2 studies did not reveal the demographic data associated to their sample [22, 39].

There was a variation in the duration of each intervention, depending on the type of study. Four of them were conducted during four different international football competitions (2014 FIFA World Cup, 2018 FIFA World Cup, 2021 FIFA Arab Cup, and 2022 FIFA World Cup) [20, 22, 23, 39]. Two other studies presented interventions and data collection of about one session per participant of 10–12 minutes in a controlled environment [18, 33]. The last two had the intervention and data collection process in the stadium during three to five games [21, 35].

Overall, most interventions were performed through mobile applications or interaction systems accessed through smartphones and smartwatches [18, 20, 23, 33, 35]. Four studies presented an experimental prototype that did not require the participants' use of any type of technology since it would be incorporated into the stadium environment [20–22, 39]. Several studies considered the users' acceptance and satisfaction, using pre- and post-intervention semi-structured interviews, questionaries, and surveys [18, 20–22, 33, 35, 39]. Direct and indirect observation evaluations were applied to verify the interactions and emotional reactions to the innovative apps or systems of fans interaction [18, 20, 21, 33, 35]. Only one study conducted a quantitative analysis of the data collected through participatory surveillance and did not present the qualitative analysis instruments mentioned above [23].

3.4. Main Results. Most of the studies included in this review are directed towards affective analysis, exciting experiences, and emotional reactions of fans at football events [18, 20–22, 33, 34, 39]. Other investigated topics ranged from the level of fans' satisfaction [35] to tackling health
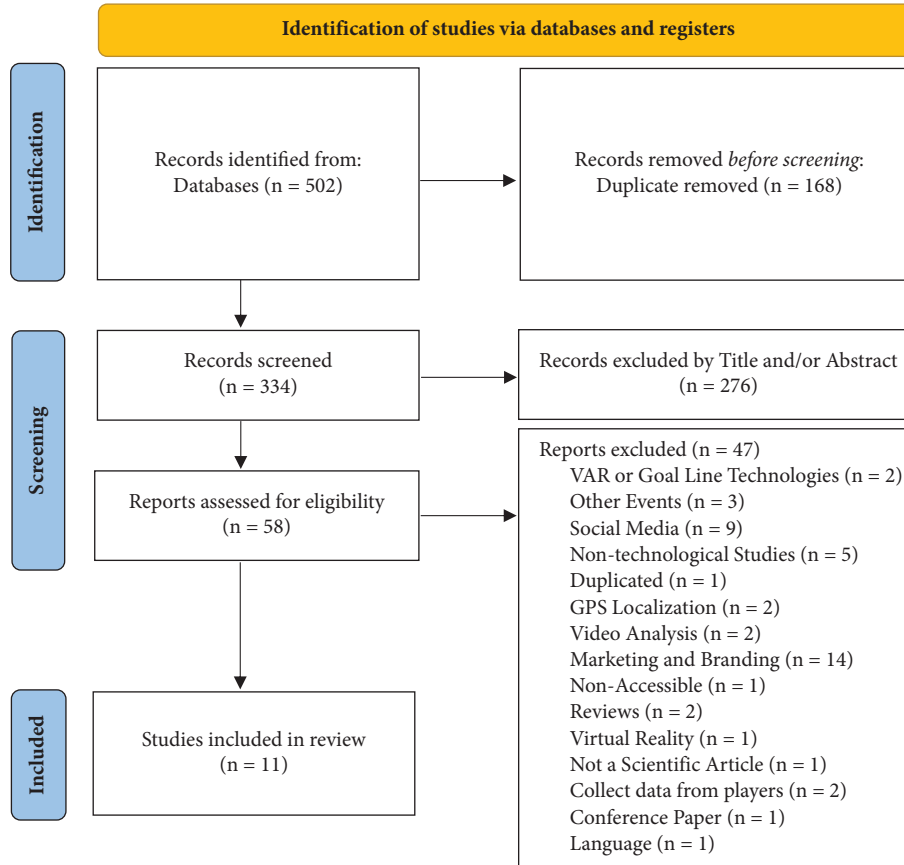
FIGURE 1: Flowchart of the study selection process.

TABLE 2: Studies methodological quality assessment using Crowe Critical Appraisal Tool.

Authors	[18]	[33]	[34]	[20]	[21]	[35]	[36]	[23]	[22]	[24]	[37]
Preliminaries	4	4	3	5	4	4	4	5	4	5	3
Introduction	5	4	4	5	4	3	3	4	5	4	3
Design	4	3	2	4	2	3	3	3	4	4	4
Sampling	2	2	NA	5	2	1	NA	4	3	2	NA
Data collection	2	3	1	5	1	2	2	2	3	3	1
Ethical matters	2	2	2	4	1	2	2	2	2	1	1
Results	3	4	3	3	3	3	4	3	3	4	3
Discussion	3	4	3	4	3	3	4	4	4	4	3
Total score	25	26	18	36	20	21	22	27	28	27	18
Percentage value (%)	63	65	45	90	50	53	55	68	70	68	45

NA (not applicable).

conditions [23] and promoting interaction and social integration [36, 38].

Six interventions pointed out positive outcomes, evaluating them through usability and users' experience questionnaires and semistructured interviews, regarding fans' experiences, emotional reactions, and interactivity at football events [18, 20–22, 33, 39]. Studies that examined mobile applications or systems that can be accessed through smartphones and smartwatches had participants report them as easy to use. Some mobile application features, such as vibration and sound, were praised due to the increased interactivity and engagement that connected the fan to the sportive event. Consequently, participants' reactions were positive [18, 33]. Regarding the studies that deployed interactive systems implemented in stadiums such as Banner Battle, they concluded that there was a positive and frequent collective interaction between fans and the interactive system, with fans singing and dancing throughout the live game tests (e.g., beta tests) [21]. Another study reported that fans were effectively linked to the results of the team they supported, showing affective fluctuations regardless of fan identity [20]. Indeed, fans' reactions were shown to be more intense when the team they were supporting showed a negative result. Also, a study that aimed to understand the impact of semiautomated offside technology on the fans experience concluded that there is a need to have a clearer

TABLE 3: Summary of the studies' description and variables considered.

Study	Year	Aim	Participants	Football event	Study type	Tool	Methodology	Findings on fan interaction	Research gaps
[22]	2023	Analysis of traffic mobility in and around football stadium	Football fans with no demographic data associated	2021 FIFA Arab Cup	User mobility study	WaveTraf road sensors	32 matches across six locations. The sensors detect and track Bluetooth and Wi-Fi-enabled user devices. Analysis of user mobility (origin of spectators, time to stadium, time inside, and time to return to home)	Understanding user mobility patterns during the event, which is valuable information for event organizers, city planners, and transportation providers to optimize services and enhance the overall user experience	Challenging to overcome filtering data anomalies and validating and preparing the data for analysis
[37]	2023	Generating the acoustic environment with high-quality speech and with the data labeling using Arabic speech recognition	N/A	N/A	Product development study	FOOCTTS	The app, equipped with Arabic automatic speech recognition and fine-tuned speech, efficiently generates speech within 15 minutes of soccer announcer recording. Its adaptable prototype easily extends to diverse domains and languages	N/A	Further exploration of the system's scalability and performance across diverse linguistic and domain contexts
[18]	2013	Assess an interaction mechanism conveys on users' engagement during a match live broadcast	16 participants aged between 12 and 43 years	2012 international football matches	Usability study	WeBet	Testing sessions at the University campus. 10 minutes highlight videos of 2 football matches were used. While testing, researchers were observing and taking notes on users' behavior	Participants liked and said it was easy to use and made football experience more interesting. Users affirmed that vibration and sound helped to understand the app state. Users considered it enthusiastic, fun, pleasant, and attractive	No real-time experiment. No comparison user tests between other kind of interaction gestures

TABLE 3: Continued.

Study	Year	Aim	Participants	Football event	Study type	Tool	Methodology	Findings on fan interaction	Research gaps
[33]	2018	To engage fans and promote social interaction between them, during broadcasts live football events	31 participants aged between 17 and 45 years	FIFA World Cup 2014	Usability study	ReactIt	Testing sessions with two and three participants using the system simultaneously. Investigators took notes on participants' behavior and provided assistance when needed. Important moments of a match of the 2014 FIFA World Cup was compiled in a 12-min video	Users considered the system easy to learn and liked to use it in both devices. They found it an interesting concept and were very enthusiastic about using it while watching football on TV. The levels of user satisfaction were evident in both smartphone and smartwatch	Not testing the app during a real-time football match with users interacting with the app at the same time in different locations (evaluate experience in a real-time)
[20]	2020	Determine the affective intensity and emotional responses of spectators	251 participants with a mean age of 29 years	FIFA World Cup 2018	Experience sampling study	Science-app	30 days and 22 games tracking 251 German supporters, assessing high-resolution changes in core affect to address their dynamic emotional trajectories	Fans exhibited strong changes on both affective dimensions and slightly more intense affect than nonfans, particularly during losses. Small effect in comparison to the magnitude of the affective fluctuations that occurred independent of fan identity	Not considered any effects of the changed competition mode in the knock-out stage or the affective dynamics of potential extra time and penalty shootouts
[34]	2018	Create, distribute and share live video streaming of football matches	N/A	N/A	System developing study	Mobile crowdsourcing system app	Two types of user sessions: Broadcaster who can stream and sound from a camera and microphone of their mobile, and the viewer who can watch live video on their mobile in the app	N/A	Generalization of the results to other regions or levels of competition may be limited

TABLE 3: Continued.

Study	Year	Aim	Participants	Football event	Study type	Tool	Methodology	Findings on fan interaction	Research gaps
[23]	2017	Describe the early detection of acute disease outbreaks	7155 participants aged between 13 and 77 years	FIFA World Cup 2014	Participatory intervention study	Healthy Cup	Users were able to record their health condition for 2 months. For very ill or ill users, a screen with a list of 10 symptoms was displayed. Participatory surveillance allows real-time identification of aggregates of symptoms that indicate infectious disease cases	Participatory surveillance through community engagement was an innovative way to conduct epidemiological surveillance. Lower costs of data acquisition, timeliness of information collected and shared, platform scalability, and capacity for integration of the population	The criteria used to classify the syndromes may have underestimated the number of users with any of the syndromes (respiratory, diarrheal or exanthematous)
[36]	2019	Analyze the development and update protocol of global football glossary app	N/A	N/A	Product development study	Global football glossary mobile app	Create a terminographic product, to define the terms that would form the app corpus. After, the purpose was to develop the global football glossary mobile app	N/A	Limited information about app downloads
[21]	2014	Develop a perspective on crowd experience, through a trial prototype	9000 participants	Danish Premier League	Exploratory interaction study	Banner Battle	Test sessions in three matches. Eight-meter-long digital displays, video cameras, microphones, and computers to generate the data. One banner faced the home crowd and other the away with the same displays' interfaces content	The spectator's crowd was engaged with interacting with the banner, collectively singing, chanting, and dancing	More research needed to validate the effectiveness in different contexts

TABLE 3: Continued.

Study	Year	Aim	Participants	Football event	Study type	Tool	Methodology	Findings on fan interaction	Research gaps
[24]	2023	Understand the impact of semiautomated offside technology on the experience of football fans	Football fans with no demographic data associated	2022 FIFA World Cup	Content analysis study	Semiautomated offside technology	366 distinct articles were explored about SAOT and football fans. 20% were before, 75% during and 5% post World Cup	Positive introduction of the technology before and controversial reception of it during the World Cup. Gaps in communication causing confusions between the organizers, commentators, journalists, and fans. Need for clear and consistent communication for the technology to be accepted by fans	Limited time frame of the study may limit the long-term interpretation of SAOT acceptability
[35]	2014	Deploy an android app build as an ad hoc network amongst the attendees at matches	1628 participants	English Premier League	Pilot study	Android app	Trialed sessions in five games. Each game was used to provide new services and to refine the app protocol implementation. In the last two games, the software was stable, and the users' DTN worked	95% of the fans report connectivity issues with the system and some problems with battery consumption when using the app frequently. Issues connecting Android Gingerbread devices, mostly down to bootstrapping the app details	Variability in the results make it difficult to accurately estimate the sample size needed for the final study

and more consistent communication for the technology to be accepted by football fans [39]. To combat the impact of COVID-19 and guarantee security to the fans, a recent study developed a innovate technology to analyze the traffic mobility in and around football stadiums [22]. The authors concluded that understanding user mobility during football events can optimize services and enhance the overall fan experience. An intervention focused on fan satisfaction pertinent to integrating an Internet network in the stadium showed mixed results [35]. Most participants reported connectivity issues with the system and also some problems with battery consumption when using the application frequently [35]. The intervention related to health verified a great integration and participation by the target population, enunciating several advantages of performing epidemiological surveillance through a mobile application compared to traditional epidemiological surveillance [23]. Three studies described protocols for the development of a mobile application to share live videos of football matches [34], to enhance social integration of football fans [36] and to generate acoustic environment with high-quality speech [38], without reporting results.

4. Discussion

This study aimed to provide an assessment of the published literature regarding innovative digital tools designed to enhance fan interaction and engagement at football events. Those range from mobile applications, live video streaming, hoc networking, to interaction systems, and physical implementation in stadiums. Overall, the investigations that structure this review seem to be in the early stages of their development. Some carried out initial tests, exploratory studies, and assessed receptivity of football fans through usability and users' experience tests and semistructured interviews [18, 20–23, 33, 35, 39], while others were still in protocol decision-making, creating first versions of the mobile applications and preparing to test market acceptance and receptiveness to its interactive system [34, 36, 38]. In summary, six studies presented promising results in affective analysis, describing the fans' exciting experience while testing mobile applications or interactive systems [18, 20–22, 33, 39]. One study showed interesting outcomes in using a mobile application for health surveillance [23], two studies showed positive outcomes in fan experience and sports social inclusion through mobile applications [34, 36], another two studies showed encouraging results in integrating new technological systems to the sports stadiums [22, 39], and only one study did not show promising results for participants' satisfaction using an ad hoc network in stadiums [35].

Most interventions focused on the fans' experience by analyzing their emotional reactions and affectivity with the football matches and the team they support [18, 20–22, 33, 39]. The interventions were conducted using mobile applications [18, 33] or interactive systems placed in the stadiums [20–22, 39]. Optimistic outcomes were reported regarding supporters' affection for their teams [20], interaction with the interactive systems [33, 39], excitement

of users' experiences [18, 21], and traffic mobility patterns during football events [22]. Regardless of their presence in the stadiums, fans often meet to share their emotions and feelings about their team's games and performance [40]. The impact of new technologies on fandom interaction is visible, regardless of whether it takes place offline (e.g., stadiums) or online (e.g., technology apps) [41–43]. Indeed, the long abstention of fans from the stadiums due to the COVID-19 pandemic has changed the interactions between teams, athletes, and their supporters [44, 45]. This is potentially a direct consequence of the lack of social interactions during virtual events and was characterized by lower levels of engagement [46].

It becomes not only important to investigate the impact of new technologies on the interaction of fans with sport events, but also to gain a better understanding of the affective relationships that fans show towards the performances of the clubs and nations they support. In a 30-day study with an average population of 29 years, participants exhibited strong affective attachment and significant changes in this domain depending on the sports results of the German football team in the 2018 FIFA World Cup [20]. In addition, participants who identified themselves as fans had more intense variations in their emotional responses than nonfans, particularly in losses [20]. In another study conducted among 31 participants aged between 17 and 45 years, a system was tested on smartphones and smartwatches to share emotional reactions after watching 12 minutes of highlights from European football matches at the 2014 FIFA World Cup [33]. Users reported having a simple and easy experience using the system and were enthusiastic about using it while watching football matches on TV [33]. In another intervention based on testing sessions aiming to assess enjoyment while using an interactive mechanism during live broadcast football matches [18], participants described the system as simple, attractive, fun, exciting, and entertaining [18]. Also, an experimental prototype study was made across three football matches with an audience of 9,000 fans [21]. This interactive system puts the fan groups in competition with the opposite fans during live matches. More noise and movement make the groups more visible on the advertising displays [21]. The spectators demonstrated collective interaction, singing and dancing as a group so that their supporters would have more screen time, proving to be a system capable of increasing social interaction with the football game itself [21]. Lastly, a study conducted in 2022 FIFA World Cup about the impact of semiautomated offside technology determined that fans need the system and the communication between the professionals who interact with it and those who verbalize the decision to be more clear and consistent [39]. In conclusion, the results of these studies reiterate that it is increasingly critical to ensure that fans need to feel physically and emotionally involved with the sports spectacle so that they feel drive to go the stadiums.

Sports provide live group experiences, which individuals appear to crave more than ever after months of constraints [13]. Research among European football fans has frequently been used to examine the social aspects of the sport [47]. Technology improvements have helped information,

materials, and pictures flow more quickly worldwide [48]. As a result, fans now have new instruments to communicate, gather, and express themselves, thanks to mobile applications, Internet, and their potent combination [49].

The authors of the study revealed novel epidemiological surveillance through community management in relation to the development of a mobile application targeted at the health and safety of 7,155 football spectators attending stadiums [23]. Furthermore, they reported several advantages compared to traditional epidemiological surveillance, such as the platform ability to scale, the timely collection and sharing of information, decreased data collection costs, and the ability to integrate innovative services for the assisted population. In fact, it is essential that sport organizations focus on monitoring and regulating the health and well-being of fans at sporting events, such as football, so that more and more people view stadiums as a means of safety and well-being. Some recent studies addressed the issue of COVID-19 and the acceleration of digital technologies in public events [46–48]. Another study that was part of this systematic review developed exactly one sensor system to analyze traffic mobility in and around soccer stadiums, with the aim of understanding how such a mechanism can improve the overall fan experience and increase their safety [22].

From a practical point of view, it is crucial to consider whether live spectatorship is still desirable for technical organizations. Indeed, streaming and pay-per-view services improved significantly and relatively quickly during the pandemic, representing a viable option for global lockdowns [1, 49]. Consequently, European football clubs should investigate innovative strategies to lure fans back to stadiums and generate revenue while minimizing the impact of such health problems on the sporting world [48]. Thus, the combination of health, represented by epidemiological surveillance, and mass sports movement, represented by fans going to stadiums, is essential if we are to have full stadiums again. This study strengthens the hypotheses of complementation between health and sports through a mobile application, demonstrating the novelty of this approach.

Meanwhile, a study conducted in the final five home games of a professional football Premier League team with the participation of 1,628 enthusiasts revealed some fan issues with the connectivity of their smartphones to the ad hoc network installed in the stadium [35]. In addition, battery consumption was high when using the network frequently and not all devices could be connected [35]. Consequently, the satisfaction of most participants was rather low when using the ad hoc network in the stadium. Even so, it can be seen that even traditional spaces like stadiums have started to include digital elements, such as Wi-Fi capability and integrated smart functions in the whole arena [50, 51]. It seems critical to us that professional teams first understand the needs and motivations that drive their fans to stadiums. Building upon this, the next step should include multidisciplinary work to learn what kind of technological innovations they can implement in their physical structures that respond to such motivations of the fans. Testing with focus groups becomes fundamental for the club to present a final version of a quality service to its mass of associative mass, captivating them to use the stadiums.

This review also considers protocol studies on innovative applications that aim to increase fan interaction at football events. Thus, we integrated a study that seeks to develop a mobile application for sharing live videos of European football matches [34]. Another protocol study developed a global football glossary that would facilitate the processes of social inclusion and interaction in football stadiums with people who speak different languages [36]. Also, an integrated study aimed to generate an acoustic environment with high-quality speech and with data labeling using Arabic speech recognition [38]. These studies, although in their initial stages, seem vital to us since the globalization of European football ought to be seen as an empowering process of social inclusion and antidiscrimination. Accordingly, several studies have been conducted to reinforce the importance of sports, particularly football, in social inclusion and combating social discrimination of gender, age, sexuality, and ethnicity, among many others [15, 52–57].

Although the number of studies in this review is restricted, it underlines an essential gap in the literature concerning the availability of innovative digital tools focused on enhancing fans' interaction and engagement in football events. Considering the positive outcomes attained in most of the interventions evaluated, it seems important to provide more opportunities focused on fans' interaction with the sports event. Given the speed at which technology is developing, experts anticipate a growing demand for technological solutions focused on specific football events [58]. Since fans have a major role in football events, using technology can be a privileged way to make their interaction, enthusiasm, and commitment to go to stadiums even greater [16, 59]. Although there are increasingly fewer cases of this sort, it is crucial that club organizations also adopt alternatives for fans who go to the stadiums but do not have smartphones so that social inclusion processes are safeguarded. In light of the epidemiological certainty that pandemics will continue to affect humanity in the future [60], the development of new technologies and new forms of communication and interaction certainly have future practical ramifications and elevate risk management to a critical concern to all types of organizations and public events.

5. Conclusions

The results of this systematic review suggest that mobile applications and interaction systems were generally praised and well accepted by European football fans, given the goal of increasing their interactions at football events. Applications and interaction systems geared toward increased fan enthusiastic engagement and the uses of a mobile application geared toward health were the two aspects that were best reported by fans. Still, connection problems and hardware deficiencies were the negative aspects exhibited them. Given the scarce literature on this emergent topic, the development

of mobile applications and systems for fans interaction and socialization with the game seem to make sense to respond to the population's return to live sportive events. According to the results, the development of an app that addresses health issues and promote the emotional involvement of fans showed a strong possibility of success in football context. Even so, it is important to emphasize that the number of studies included in this systematic literature review is limited and that the practical implications drawn from its analysis should be reflected upon with some sensitivity. Furthermore, we suggest that future mobile applications dedicated to increasing fan interaction at football events should consider adding personal information, fan interaction systems, specific information about players and team tactical systems, and interactive voting (i.e., best goal of the game or man of the match). It would also be essential for future studies to include more reports of collective interaction between fans and the game, mediated by the technologies used. Thus, it would be possible to link the two most positive and compelling aspects reported by fans in the studies that make up this systematic review with aspects related to players and teams' performance.

Ethical Approval

Ethical review and approval were waived for this study since this study comprises a systematic review of emerging technologies to promote fans interaction in football events.

Disclosure

The study protocol was registered with INPLASY (INPLASY202320015) [61].

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

F.M., C.F., P.P., P.C., B.G., H.L., E.M., and E.R.G. conceptualized the study. F.M., C.F., and D.V.M. proposed the methodology. P.P., B.G., A.I., E.M., and E.R.G. performed validation. F.M., C.F., and D.V.M. performed formal analysis. F.M., C.F., P.P., D.V.M., and E.R.G. investigated the study. P.P., P.C., H.L., A.I., and E.R.G. provide resources. F.M., C.F., D.V.M., and E.R.G. wrote the original draft. P.P., P.C., B.G., H.L., A.I., and E.M. wrote, reviewed, and edited the article. P.C., B.G., A.I., and E.R.G. visualized the study. B.G., H.L., E.M., and E.R.G. performed project administration. P.P., P.C., B.G., H.L., and A.I. contributed to funding acquisition. All authors have read and agreed to the published version of the manuscript.

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Supplementary Materials

Inclusion and exclusion criteria of the scientific articles in full-text. (*Supplementary Materials*)

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