



State-of-the-art of sustainability in sports facilities: a systematic review

Cristian Gregori-Faus¹ · Josep Crespo¹ · Ferran Calabuig¹ ·
David Parra-Camacho¹

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Abstract

The importance of the sports context for sustainable development has been widely discussed in recent years. However, the contribution of sports facilities to sustainable development remains a topic rarely presented in academic literature. For this reason, this paper aims to synthesize the existing information in the literature related to sustainable development in the context of sports facilities, to this aim, a systematic review was carried out following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) 2020 methodology via the Scopus and Web of Science databases where a total of 28 studies have been identified. Among them, most of them focus on environmental sustainability, also most of the current literature are qualitative studies and mainly focus on the sustainable performance of sports facilities and organizations. Through these results, a total of 16 categories and 49 indicators are established to assess the contribution of sports facilities to sustainable development. In conclusion, this study not only analyzes the state-of-the-art related to sustainability and sports facilities but also provides the basis for analyzing the sustainable performance of sports facilities including the three dimensions of sustainability (environmental, social and economic) according to the triple-bottom-line framework, allowing future assessments of sport facilities contribution to the sustainable development.

Keywords Sport facilities · Sustainable development · Triple-bottom-line · Sustainable key indicators · Sport management

1 Introduction

Sustainability and sustainable development are increasingly relevant topics for society. Not only as a political perspective, but also from the viewpoint of the population and businesses, which are gradually becoming more aware of the importance of conducting their activities

✉ Josep Crespo
josep.crespo@uv.es

¹ Department of Physical Activity and Sports, University of Valencia, C/ Gascó Oliag, 3, Valencia 46010, Spain

from a more sustainable perspective, (Avesani, 2023). Similarly, in the academic context, a wide variety of investigations from different disciplines analyze environmental sustainability (Baek, 2021; Irfan et al., 2023; Li & Umair, 2023), social sustainability (Govindan et al., 2021; Mishra, 2021; Walker et al., 2021) or economic sustainability (Abad-Segura & González-Zamar, 2021; Khan et al., 2021) across a wide range of scenarios.

This growing interest in sustainability-related topics can be attributed, in part, to the clear effects that climate change generates, which includes the intensification of extreme weather events, rising temperatures or decreasing precipitation, as well as the effect that could have in society at social, economic and environmental levels (Sandoval-Díaz et al., 2024; Stanley, 2024). Additionally, this increased interest has been fueled to the shift to the global policy paradigm towards creating actions and policies to combat global inequalities, which has led to the establishment of the 2030 agenda and the creation of the Sustainable Development Goals (SDGs).

In this regard, the SDGs reflect an action plan comprised of a total of 17 objectives designed to enhance societal development through the interrelations between society, the economy and the environment (Herrero et al., 2023). Nevertheless, the implementation of such actions remains unclear, highlighting the necessity of enhancing their interpretation and measurement (Fonseca et al., 2020). Moreover, while existing literature often analyzes these dimensions separately, it is important to bear in mind that, in the context of sustainable development, these three dimensions constitute a construct that interrelates them and, therefore, must be analyzed and addressed collectively (García-Feijoo et al., 2020).

This growing interest in enhancing sustainability, coupled with the necessity to adopt a comprehensive approach that encompasses the three dimensions of sustainability, had resulted in the development of the Triple-Bottom-Line Framework (TBL). This framework has emerged as a vital tool for assessing the sustainability efforts of governments and businesses in relation to environmental, social and economic dimensions (Nogueira et al., 2023). The TBL, coined by Elkington (1997), advocates the creation of value towards sustainable development from the three dimensions of sustainability by all types of organizations (Nogueira et al., 2022). Although this concept may initially appear utopian to profit driven organizations, evidence suggest that such criteria can be adopted by organizations while still generating significant profits (Avesani, 2023) as well as providing a competitive advantage within the business context (Nogueira et al., 2023), establishing TBL as a very interesting tool for implementing and analyzing sustainable practices in businesses (Andersson et al., 2022).

However, the adoption of TBL by companies may present certain challenges, such as understanding which aspects to consider within each dimension, acquiring the necessary data, or generating suitable action plans. Nevertheless, the versatility of TBL also allows any type of organization to introduce this concept in order to enhance its sustainable development (Avesani, 2023) which, when supported by the academia, may increase the effectiveness of those efforts (Mio et al., 2020).

1.1 Sustainability and sport

On the other hand, as widely accepted, sport plays a very relevant role in sustainable development (Campillo-Sánchez et al., 2021; Hugaerts et al., 2022; McCullough et al., 2020). Not just in terms of improving health and well-being (Campillo-Sánchez et al., 2021) but

also at the organizational level through the actions carried out by sporting companies and events (Hugaerts et al., 2022; Trail & McCullough, 2020), as well as through sport's capacity to generate more sustainable behaviours among its spectators (Cayolla et al., 2023; Orr et al., 2020).

For these reasons, the studies related with the effects of the sport context on sustainable development have been increasing in recent years (Jensen, 2021) with the intention of enhancing the potential benefits and reducing the negative impacts. However, most of these studies focus on the actions carried out in sport events or the impacts that these can generate (Ito et al., 2022) leaving aside the role of sport facilities.

However, as highlighted by Cayolla et al. (2023) and Morán-Gámez et al. (2024), some of the main problems encountered in sport facilities, are expressed by managers as the lack of coherence, clarity, planning and/or objectives when implementing actions related to sustainability. Despite that, we can find different actions aimed at improving sustainable development by different sporting facilities.

For example, related to the environmental dimension, most of the actions that we can find in sports facilities are related to the analysis of the carbon footprint (Wicker, 2019) measuring the amount of greenhouse gases emissions generated by the activity of the users, actions related to the generation and use of renewable energies (Zhu et al., 2023) such as the installation of solar panels at the facilities, actions related to the reduction of water consumption (Burszta-Adamiak & Sychalski, 2021) such as the installation of water flow control devices or the reuse of grey water, as well as the inclusion of policies related to the reduction and recycling of waste from the facility (Thormann & Wicker, 2021).

In relation to the social dimension, sports facilities can not only improve aspects such as residents' health, social cohesion, understanding of culture, image of the city, etc. (Campillo-Sánchez et al., 2021; Mănescu, 2023) by serving as meeting points for society in addition to their dedicated use for the practice of physical activity and sport. Moreover, they can also harness potential of the sport context to affect the sustainable behaviours of their users, generating in them an interest in issues related to sustainability (Orr et al., 2020).

Among the most studied actions related with the social dimension in sports facilities we can find the inclusion of Corporate Social Responsibility plans (Guevara Pérez et al., 2023) to increase the positive impacts of the facilities on the local community, the inclusion of spaces dedicated to sustainable mobility, as is the case of bicycles (Stinnett & Gibson, 2016a; Trendafilova & McCullough, 2018) or electric vehicles. As well as having universal access design regulations in the different facilities so that they can be used by any person regardless of their condition, as is the case of the NIDE regulations (Spanish acronym for Sports and Leisure Facilities Regulations) in the case of Spanish sports facilities.

Regarding the economic dimension, most of the actions that we can find at the sport facilities are related to cost savings, whether they are energy costs savings produced by the use of new technologies (Fantozzi et al., 2016), costs for usage of different energy sources (Longarela-Ares, 2019) or long-term savings in maintenance costs due to the design and construction of sports facilities (Baek, 2021).

As stated, and despite the efforts made by sports facilities to implement several sustainable actions, there is currently no clear list of indicators that allow facility managers to know what kind of actions they should implement, no clear actions to improve the sustainable performance of their facilities, nor even a clear way to measure the usefulness of these actions despite the importance and the need to obtain these metrics as highlighted in studies

in recent years (Cayolla et al., 2021; McCullough et al., 2020; Trendafilova & McCullough, 2018).

This not only represents the first gap identified in the literature, but also establishes the need to create a framework that addresses the current approach to sustainable development in sport facilities. Furthermore, while there is a greater number of studies aimed at understanding and improving the sustainable performance of sporting events, we must understand that although both are part of the sporting context, the nature of sporting facilities is different from that of events and therefore, the actions to be carried out in each may vary.

In addition, studies focused on analysing the actions carried out in the three areas of sustainability in an interrelated way are still scarce (Cayolla et al., 2023; Hugaerts et al., 2021), representing the second gap which needs to be addressed due, as expressed before, sustainability is a interrelated concept which needs to be assessed from the three dimensions of sustainability point of view (Herrero et al., 2023). Hence, it is necessary to extract the most commonly studied indicators from the theoretical framework in order to establish a reference framework to allow future studies from the TBL point of view.

Therefore, the objective of this work is to extract and synthesize the literature related to sustainable development in the context of sports facilities, in order to identify the current state of this topic, allowing to nourish future research lines, as well as providing knowledge about the elements that make up the three dimensions of sustainable development in relation to sports facilities from the TBL point of view. To do so, a series of questions are formulated to guide this study. These questions are as follows:

RQ1: What characteristics are the most common among the analyzed works?

RQ2: What dimensions and categories are most often used to analyze sustainable development in sports facilities?

RQ3: What are the most common themes in the literature?

To answer all these questions and fulfill the objective of this study, a systematic review of the literature was carried out to provide a synthesis of the state of sustainability and sport following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) 2020 methodology, both in the description of the adopted method and study results, as well as in the writing of the work in its entirety.

2 Method

As mentioned in the previous section, to fulfill the objective of this study and answer the research questions, a systematic review of the literature was carried out using the PRISMA 2020 methodology based on the checklist published by Page et al. (2021).

First, the Web of Science and Scopus databases were selected to collect the information necessary for this review. The focal keywords were “Sports-facilit*”, “Sports-cent*”, and “Sustainab*” in the titles and abstracts of the articles. In addition, to maximize the number of results, the terms “environmental-sustainab*”, “social-sustainab*”, “economic-sustainab*” and “triple-bottom-line” were added to the search through different combinations thereof using the AND and OR connectors, as shown in Table 1.

Regarding the inclusion criteria for the articles in the present analysis, the following were adopted: (a) published between 2015 and 2023, (b) written in English or Spanish, and (c) an article or article review. These reduced the number of articles found via WoS to 122 and via

Table 1 Volume of articles found by search strategy

Search strategy	Number of articles
Search results in WoS	
TS=((Sports-facilit*)or(sports-cent*))and(sustainab*))	109
TS=((Sports-facilit*)or(sports-cent*))and(environmental-sustainab*))	7
TS=((Sports-facilit*)or(sports-cent*))and(social-sustainab*))	2
TS=((Sports-facilit*)or(sports-cent*))and(economic-sustainab*))	4
TS=((Sports-facilit*)or(sports-cent*))and(triple-bottom-line))	0
Search results in Scopus	
TITLE-ABS(((sports-facilit*)OR(sports-cent*))AND(sustainab*))	88
TITLE-ABS(((sports-facilit*)OR(sports-cent*))AND(environmental-sustainab*))	2
TITLE-ABS(((sports-facilit*)OR(sports-cent*))AND(social-sustainab*))	2
TITLE-ABS(((sports-facilit*)OR(sports-cent*))AND(economic-sustainab*))	2
TITLE-ABS(((sports-facilit*)OR(sports-cent*))AND(triple-bottom-line))	0

Scopus to 94, comprising a total of 216 articles found in the search and identification phase, carried out in September 2023.

Once all duplicate articles were eliminated, the first phase of the study selection began. Specifically, with the intention of minimizing the risk of bias in the study, two of the authors independently analyzed both the titles and the abstracts of each of the above articles to decide which of them would be included in the study. Subsequently, the results of both authors were analyzed, where the inclusion or elimination of these articles was agreed upon, and any disagreements were resolved with debates. Finally, a total of 53 articles were thereby included in this phase of the study.

In the second phase of the study, another author carried out a complete reading of the articles, and a total of 25 articles were discarded because they were unrelated to sports facilities ($n=8$), lacked a direct relationship with the focal subject ($n=14$) or concerned the more limited concept of sustainability ($n=3$). Therefore, a total of 28 valid articles was finally obtained for the review, including three initial articles that were used in the phase prior to the search for information but that fit all the selection criteria. Figure 1 shows the flow chart, illustrating the search and selection process following the PRISMA 2020 protocol.

In addition, during this second phase of article review, amid the reading of these documents, all the salient information was transferred into a record sheet where all the categories analyzed were organized: (a) author, (b) year of publication, (c) title, (d) name of the journal, (e) publisher, (f) type of work, (g) type of study, (h) scope of sustainability, (i) keywords, (j) objectives, (k) main results, (l) categories analyzed, and (m) indicators or actions analyzed.

Finally, Microsoft Excel was used for the categorization of the responses, the descriptive analyses, and for the analysis of the frequencies of the results presented in the following section.

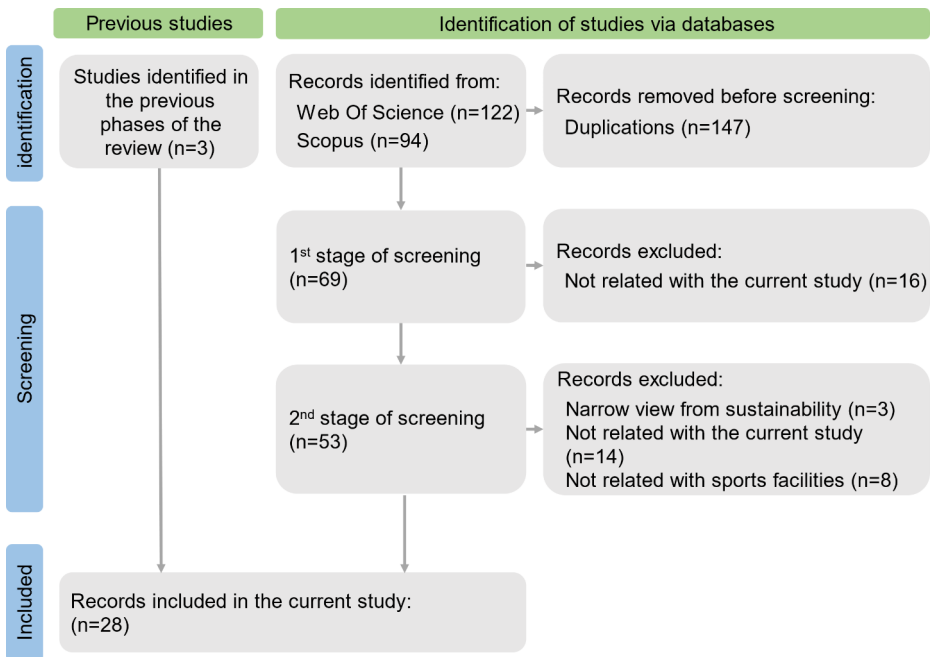


Fig. 1 Flowchart of the bibliographic selection process

3 Results

To clearly present the results of this study, we divide this section into three subsections. The first subsection, where we detail the characteristics of the studies obtained, is followed by a second subsection in which we will present all the information extracted from these articles, and lastly one last subsection to compare previous literature reviews with the results on this analysis. However, first, we must highlight the articles included in this review (see Table 2).

3.1 Characteristics of the studies included in the review

3.1.1 Publications by journal

The 28 articles analyzed in this study have been published in a total of 19 journals; the four journals shown in Fig. 2 are the only ones with two or more published articles on the focal subject. Among these journals are a total of nine publishers, with Routledge ($n=8$), MDPI ($n=6$), Emerald Publishing Limited ($n=5$) and Elsevier ($n=2$) the four most prevalent.

3.1.2 Study type

Regarding the type of papers found in this review, the majority are original articles ($n=27$; 96.43%); there is a single review article (3.57%) but a total of 15 papers with a qualitative approach (53.57%) and nine with a quantitative approach (32.14%). A total of 14.29% of the papers ($n=4$) present a mixed approach (see Fig. 3).

Table 2 List of articles included in this study

Authors	Year	Title
De Mare et al.	2015	Weak and Strong Compensation for the Prioritization of Public Investments: Multidimensional Analysis for Pools
Kellison & Hong	2015	The adoption and diffusion of pro-environmental stadium design
Davies	2016	A wider role for sport: community sports hubs and urban regeneration
Demirel et al.	2016	Environmental Sustainability for Future Generations (A Comparison of 2020's Candidate Cities)
Fantozzi et al.	2016	LED Lighting for Indoor Sports Facilities: Can Its Use Be Considered as Sustainable Solution from a Techno-Economic Standpoint?
Gholami et al.	2016	State-of-the-art Green HRM System: sustainability in the sports center in Malaysia using a multi-methods approach and opportunities for future research
Musso et al.	2016	Making small sports clubs manageable and economically sustainable – a study on clay target shooting in Italy
Stinnett & Gibson (a)	2016	Sustainability and Recreational Sports Facilities: An Exploratory Study Regarding Levels of Institutional Adoption
Stinnett & Gibson (b)	2016	Sustainable facility development: perceived benefits and challenges
Dingle & Stewart	2018	Playing the climate game: climate change impacts, resilience and adaptation in the climate dependent sport sector
Kamahina	2019	Green certification to achieve sustainable development goals
Longarela-Ares	2019	Financial viability and environmental aspects in the selection of energy sources for sanitary hot water (SHW) and heated swimming pools
Azzali	2020	Challenges and key factors in planning legacies of mega sporting events
Rahmani et al.	2020	Identifying factors affecting sustainable development in sports facilities of Razavi Khorasan Province
Zhu et al.	2020	Construction of the Evaluation System of Sustainable, Utilization of Large Stadiums Based on the AHP Method
Baek	2021	Plan for the Sustainability of Public Buildings through the Energy Efficiency Certification System: Case Study of Public Sports Facilities, Korea
Cayolla et al.	2021	Sustainable Initiatives in Sports Organizations—Analysis of a Group of Stakeholders in Pandemic Times
Lee	2021	A thin line between a sport mega-event and a mega-construction project: the 2018 Winter Olympic Games in PyeongChang and its event-led development
Yüce et al.	2021	Examination of sustainable features of stadiums as an integral part of sustainable urban development: the case of Turkey
Zhang et al.	2021	The influence of Community Sports Parks on residents' subjective well-being: A case study of Zhuhai City, China
Abu-Omar et al.	2022	A proposed checklist for climate-friendly sport and exercise programmes
Daddi et al.	2022	Environmental management of sport events: a focus on European professional football
Hou et al.	2022	Research on sustainable design of sports centre based on algorithm verification
Hugaerts et al.	2022	Are sport organisations environmentally sustainable? – A website analysis of sport federations in Belgium
Lim	2022	The Impact of Attracting a Mega-Sport Facility on the Development of a Small Town: A Case Study on Taekwondowon in Muju, South Korea
Cayolla et al.	2023	Fans' perceptions of pro-environmental sustainability initiatives in sport and triple bottom line benefits
McCullough et al.	2023	Environmental perspectives of external stakeholders in sport
Zheng et al.	2023	Sustainable Coupling Coordination and Influencing Factors of Sports Facilities Construction and Social Economy Development in China

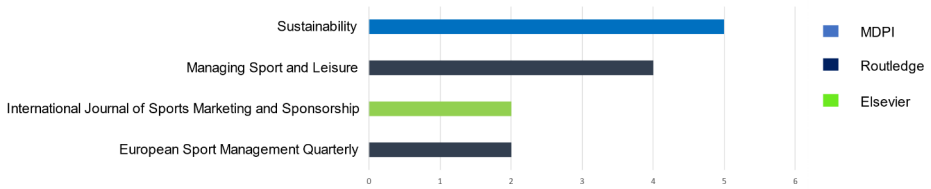


Fig. 2 Summary of the frequencies of publications on sustainability and sports facilities

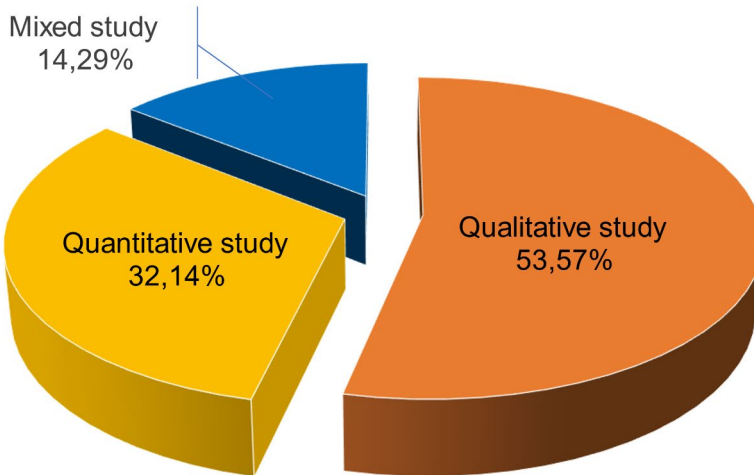


Fig. 3 Typologies of studies analyzed

3.1.3 Areas of sustainability

As seen in Table 3, among the studies analyzed, a number refer to sustainable development in a general way ($n=11$; 39.29%), and others place greater attention on the environmental field of sustainable development ($n=9$, 32.14%). In addition, a few studies focus on the social or economic areas of sustainable development, with one study dedicated to each of these areas.

Table 3 Frequency of areas in the analyzed jobs

Type of areas	Total	
	<i>N</i>	%
Sustainable development (general)	11	39.29
Environmental development	9	32.14
Social development	1	3.57
Economic development	1	3.57
Combination between areas	6	21.43
Total	28	100.00

3.2 Extraction of information from articles

3.2.1 Most analyzed topics regarding sustainability and sports facilities

Concerning the topics that are most discussed within the articles that make up this study, the information in Table 4 details the conceptualization of each of the objectives and the main results of each of the studies.

Specifically, most of the articles ($n=16$; 57.14%) analyze the sustainable performance of sports organizations, meaning that the majority of the articles are topic related with how to improve or how to test how sport organization manage their activities in order to become more sustainable, as for example implementing a checklist to assess the sustainability of sport activities or sport facilities, or highlighting the best sustainable practices found on sport stadiums as well as those article aimed to show how the construction of sport facilities affects to the wellbeing perception of residents.

the second most discussed topic will be the awareness and environmental education ($n=6$; 21.43%) of both managers and users of sports centers and programs, related with how the perception of stakeholders is being affected through these sustainable actions and how managers perceive these actions as well as their levels of consciousness regarding sustainability.

Finally, the energy consumption ($n=3$; 10.71%), as for example topic related with the energy certification or usage new technologies affect to the facility consumption. And impact of sports facilities on the development of the society that surrounds them ($n=3$; 10.71%) explaining how sports facilities support the development of their surroundings through city image improvement, infrastructures improvements, environmental improvement etc., are the least present topics in this analysis.

3.2.2 Dimensions and indicators

After analyzing and categorizing all the dimensions and indicators in each of the articles analyzed, the categories and indicators that are the most common and the sport facilities context are highlighted below (see Fig. 4).

These results are presented with the 49 main indicators present on the literature divided into a total of 16 categories and 3 dimensions. We can thereby define the most common categories and indicators in the literature related to sports facilities and sustainable development.

Table 4 Objectives and results of the analyzed works

Authors	Main objectives	Main results
De Mare et al. (2015)	Build socio-environmental convenience indices and integrated sustainability indices for the provision of sports facilities	The multidimensional analysis of sustainability in pools is complex, emphasizing that economic aspects alone should not be the sole consideration in decision-making.
Kellison and Hong (2015)	Expand existing studies on sports and the environment, identifying underlying issues influencing decisions to incorporate sustainable design in arenas, stadiums, and new or renovated stadiums	Building more sustainable facilities is facilitated by technological advancements, emphasizing the importance of decision-makers' pro-environmental attitudes in the construction of sustainable facilities.
Davies (2016)	Identify gaps in the literature regarding the contribution of community sports centers to societal regeneration	While various stakeholder groups perceive a positive social and economic impact, empirical measurement is challenging. There is a call to find quantitative methods to demonstrate the "real impact" of sports facilities on urban regeneration.
Demirel et al. (2016)	Examine and compare the environmental perspective of bids for the 2020 Olympic Games	Highlights key sustainability proposals by the three candidate cities for the 2020 Olympic Games.
Fantozzi et al. (2016)	Identify general criteria for evaluating the techno-economic sustainability of using LED lighting in indoor sports facilities	LED technology helps reduce energy consumption, requires fewer installations, and has lower maintenance needs. However, it comes with higher installation costs.
Gholami et al. (2016)	Specify a "Green Human Resources Management" system in a large public intensive sports center in southern Malaysia	Identifies factors facilitating the focus of organizational human resources on sustainability, contributing to social, environmental, and economic development.
Musso et al. (2016)	Provide an in-depth analysis of the management of small non-profit sports clubs	Proposes characteristics to improve the sustainability of facilities from an economic perspective.
Stinnett and Gibson (2016a)	Evaluate institutional adoption levels related to sustainable initiatives in university recreational sports facilities	Extracts common sustainability initiatives and characteristics of centers that tend to adopt more sustainable initiatives, along with regions where sustainable actions are more prevalent.
Stinnett and Gibson (2016b)	Describe the perceived benefits and challenges by department directors associated with implementing sustainable initiatives in campus recreational sports facilities	Identifies the benefits and challenges of implementing sustainable initiatives in sports facilities.
Dingle and Stewart (2018)	Advance understanding of the intersection of climate change and climate-dependent sports	Concludes that managers often evaluate facility performance regarding climate change, advocating for integrating such actions into strategic planning. Managers often lack resources and capabilities for these strategies.
Kamahina (2019)	Create and implement an environmental certification project for sports facilities to assess compliance with environmental requirements and assign a distinctive mark	Proposes an evaluation protocol for the environmental performance of sports facilities.
Longarela-Ares (2019)	Compare four alternatives for hot water and pool facilities to select the most suitable for a sports center, considering financial evaluation and commenting on their environmental impacts	Having a biomass installation is the best option economically and environmentally.

Table 4 (continued)

Authors	Main objectives	Main results
Azzali (2020)	Identify replicable best practices and successful examples used in mega events to transform event sites into livable open public spaces	Raises factors related to facility use and its post-event impact, highlighting underutilization of temporary facilities, high economic expenditure, excessive use of public funds, and insufficient attention to citizens' needs.
Rahmani et al. (2020)	Identify factors affecting sustainable development in sports facilities in the Razavi Khorasan province	Presents 10 categories of factors that can affect the sustainable development of sports facilities.
Zhu et al. (2020)	Establish an evaluation index system exploring the use of large stadiums and gyms in the context of sustainable development, providing an important reference for the construction and use of stadiums and gyms in the future	Proposes indicators and categories to analyze the sustainable use of facilities.
Baek (2021)	Identify the energy efficiency certification system for the sustainability of sports centers and analyze the status of energy efficiency planning, suggesting institutional-level measures to activate the certification plan	Analyzes energy certification and its implementation in Korean sports centers.
Cayolla et al. (2021)	Contribute to the emerging field of sports ecology by quantitatively analyzing the knowledge of relevant stakeholders of a professional football club and its positioning as a form of sustainability	Highlights low awareness of sustainable initiatives by different analyzed stakeholder groups.
Lee (2021)	Identify the economic and ecological impact of the 2018 Winter Olympics in PyeongChang	Concludes that the 2018 Winter Olympics in PyeongChang mostly generated negative impacts.
Yüce et al. (2021)	Examine stadiums in Turkey in terms of social, environmental, and economic sustainability and assess their impact on urban development	Validates a tool for analyzing the sustainability of football stadiums.
Zhang et al. (2021)	Analyze the impact of community sports parks on the well-being of nearby residents	Community sports parks enhance residents' well-being perception, diversity, and highlight important aspects these spaces should fulfill.
Abu-Omar et al. (2022)	Present a brief and easy-to-implement checklist for eco-friendly exercise programs	Introduces a checklist with 16 items to assess and support the environmental performance of sports programs and organizations.
Daddi et al. (2022)	Investigate how sports facility managers address environmental issues for national football events at the operational and governance levels, outlining cutting-edge environmental management in sports events	Asserts a lack of clear coherence among managers in applying such practices and suggests sharing experiences and actions among organizations to enhance environmental sustainability in the sports context.
Hou et al. (2022)	Analyze the algorithm of sports facilities with sustainable development characteristics	Sports facilities can have both positive and negative impacts on the sustainable development of populations.
Hugaerts et al. (2022)	Examine the institutionalized behavior of sports federations by analyzing their environmental initiatives, environmental strategy, and detect and discuss opportunities for further development	Shows the limited commitment to environmental sustainability by sports federations in Belgium through their websites.
Lim (2022)	Explore the impact and importance of Taekwondowon, a large-scale sports facility	Sports facilities can enhance sustainable development through economic revitalization, improved infrastructure, and the city's image.

Table 4 (continued)

Authors	Main objectives	Main results
Cayolla et al. (2023)	Examine fans' perceptions of pro-environmental sustainability initiatives promoted by a professional sports club and their effects on a triple-bottom-line (TBL) approach	Finds a positive relationship between club sustainability initiatives and fans' perception and the dimensions of the "Triple-Bottom-Line."
Mc-Cullough et al. (2023)	Obtain a greater understanding of the environmental attitudes of external stakeholders in a sports organization	The perception of fans regarding environmental sustainability is detailed, emphasizing the importance they place on sports managers taking more sustainable actions
Zheng et al. (2023)	Measure the synergy between the construction of sports facilities and the development of social economy in the municipalities of Fujian	The development of sports facilities is linked to the development of the society hosting them, suggesting the need to improve infrastructure, urbanization, and environmental development in the future

3.3 Comparison with previous studies

Finally, with the intention of highlighting the main contributions of the present analysis, we compare the main differences of the current study with respect to similar studies carried out in the sports context (see Table 5).

As can be seen in Table 5, among the reviews carried out on sustainability and sport, we can find that most of them deal with the sporting context in general or in reference to sporting events but no focus on the sport facilities, which just happen in one location. However, when the searches are related to sporting facilities, the number of articles found in the literature decreases drastically compared to the ones related to the sporting events.

Furthermore, in most of the reviews, a greater presence of the environmental part is highlighted as well as the importance of the analysis of the three areas of the sustainability, but with fewer contributions analyzing this three dimensions as a whole. In addition, of all the reviews consulted, only one of the cases presents indicators, although only referring to the environmental part of sustainability.

4 Discussion

The results presented in this study, as well as the comparison with similar analyses carried out in recent years, show that there is still a scarcity of work related to sports facilities and how they implement sustainable practices which, once again underlines the need to deepen our knowledge of the sports field and its relation to sustainable development (Casper et al., 2021; Wicker & Thormann, 2022).

However, through this systematic review we have been able to analyze a total of 28 articles found in the literature related to sports facilities, on which we highlight the main characteristics among the works analyzed, answering the first of the research questions (RQ1).

Firstly, qualitative studies remain the most common type of work in the literature. Among them, most of the works focus on identifying and understanding the main relationships between sports facilities and sustainable development, as well as establishing the criteria for a sports facility to increase its sustainable performance. On the other hand, most of the

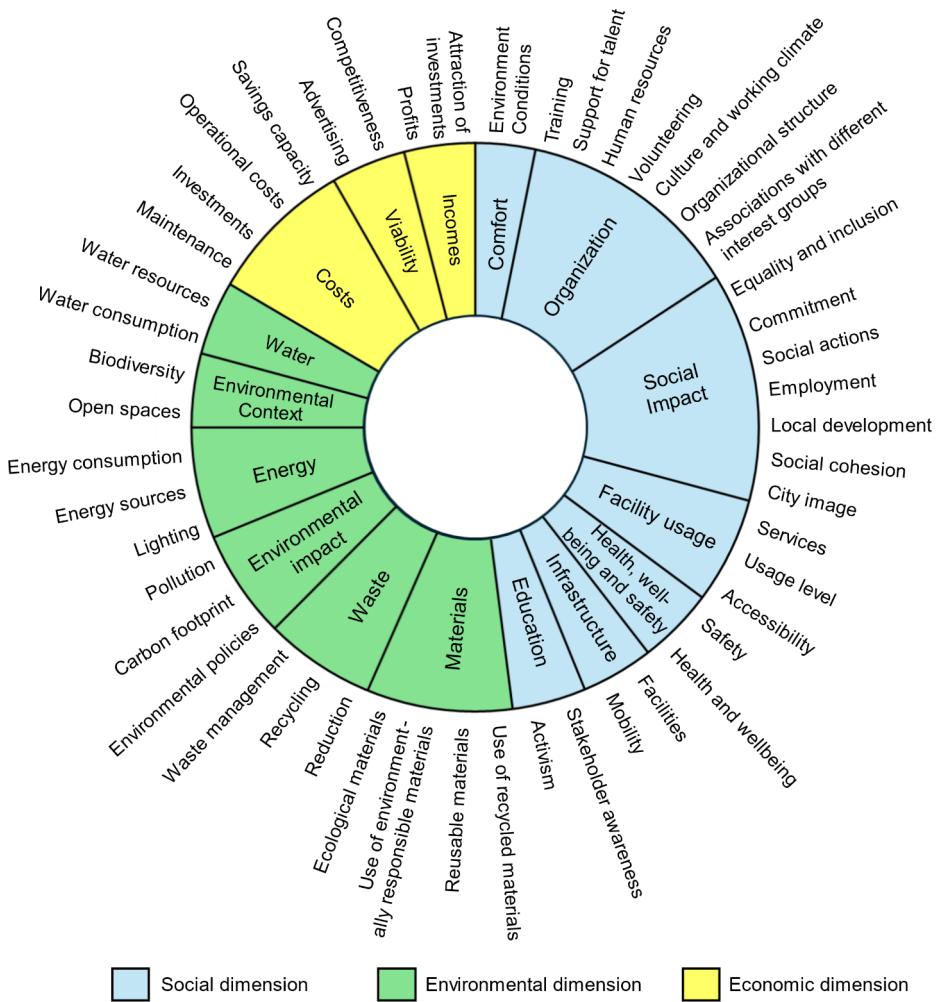


Fig. 4 Most common sustainability indicators divided by categories and dimensions

quantitative studies found through this work focus on analyzing the impacts generated by a sports facility or improving the efficiency of sports facilities.

This results, therefore highlights the interest of the scientific community in understanding and measuring the impact of sports facilities on sustainable development, which strongly suggests that there is a need to deepen quantitative perspectives on sustainable development in the context of sports facilities, facilitating the measurement of this impact on sustainable development by sports facilities as highlighted by authors such as Trendafilova and McCullough (2018) which to date remain unavailable.

In addition, another noteworthy fact is the predominance of works related to the development of sustainability in general, (without focusing on any of the dimensions), followed by the presence of works focusing on environmental sustainability and leaving aside the social or economic dimensions.

Table 5 Comparison with previous literature reviews regarding sustainability in sport

Authors	Main results	Main differences
(Annesi et al., 2023)	• The search with the most results is through the words “Sport” and “sustainab*”. • Most of the analyzed studies are related to environmental impact • Results are based on different sport disciplines. • Only 13% of the studies discuss all three dimensions of sustainability.	• The authors get a total of 321 articles on the study • It's focused on different sporting contexts (events, education, health, etc.) • No information is provided on what type of indicators are used in each study.
(Cury et al., 2023)	• demonstrates the growing interest in environmental sustainability. • Most of the studies are conducted in the United States”.	• The authors get a total of 89 articles on the study • It's focused on different sporting contexts (events, education, health, etc.) • Systematic review through SQLR and meta-synthesis methodology • Only analyze the environmental dimension • It presents the theories analyzed within the environmental dimension but does not provide any indicators to measure these theories.
(Francis et al., 2023)	• synthesizes state-of-the-art stadium design and construction methods and initiatives that can be applied for improved environmental sustainability outcomes. • Provides a checklist to analyze whether the stadium is environmentally sustainable.	• The authors get a total of 18 articles on the study • focused on sports stadiums • Only analyze the environmental dimension • It presents environmental indicators
(Ulloa-Hernández et al., 2023)	• A greater number of qualitative studies related to the analysis of sustainability in the sports context are found • It shows the growing evolution of publications related to sustainability • Results are based on different sport disciplines. • Only 9.4% of the studies discuss the three dimensions of sustainability	• The authors get a total of 224 articles on the study • focused on sports events • It does not provide information on what type of actions or actions are dealt with in each dimension • It does not analyze in depth the information that appears in the articles

However, as stated in the introductory part, the sustainability of a business, in this case a sports center, relies on the balance between the three dimensions of sustainability (Andersson et al., 2022), and as can be clearly observed through the results of this work, the lack of information in academia on two of the three dimensions of sustainability related to sports facilities is recognized.

Therefore, these results not only highlight the need to increase the presence of academic work focused on improving the measurement of the impact of sports facilities on sustainable development, but we also need this work to be carried out from the perspective of TBL, which could allow both academia and policy makers to improve the sustainable performance and analysis of facilities from the three areas of sustainability (environmental, social and economic).

In this sense, with the intention of bringing to light which are the most frequent dimensions and categories to analyze sustainable development in sports facilities (RQ2). The results of this work allow us to extract a total of 49 indicators, divided into 16 categories, distributed among the three areas of sustainability (see Fig. 4), as follows: environmental (6 categories; 17 indicators), social (7 categories, 24 indicators) and economic (3 categories; 8 indicators).

To carry out this classification, both the scope and the nomenclature found in the different articles analyzed, scales applied in other contexts have been taken into account such as the scale created by Gibberd (2003), to analyze the level of contribution of buildings to sustainable development (the Sustainable Building Tool [SBAT]), or Saraiva et al. (2019), where the development of the Sustainability Assessment of Secondary School Buildings in Portugal (SAHSBPT) methodology.

The results presented in this analysis not only facilitate the identification of the most common indicators in the literature but can also provide guidance to help identify the actions needed to improve the sustainable performance of facilities in line with works such as Davies (2016), Yüce et al. (2021) and Zhu et al. (2020), broadening the categories and providing information for the literature related to sports facilities.

Finally, in relation to the last research question of this paper (RQ3). The results show that the main theme present in the analyzed articles is constituted by the sustainable performance of sport organizations. That is, most of the papers that can be found in the literature focus on how to analyze or improve the different actions that sport organizations implement to further improve their sustainable development, which confirms the statements of authors such as Daddi et al. (2022), Hugaerts et al. (2021), and Thormann and Wicker (2021) that point to a growing concern of sport organizations with the implementation of sustainable practices in their operations.

On the other hand, the second most relevant issue within the literature analyzed is related to the environmental awareness and knowledge of the different stakeholders in sports facilities, more specifically how the perception of this type of actions by sports facilities affects not only their knowledge but also the predisposition of these stakeholders to carry out more sustainable actions.

In relation to this issue, the levels of environmental awareness and knowledge of the population have been a subject under the spotlight of academia, because, as authors such as Hugaerts et al. (2022) state, despite the years in which sustainability is present in almost all areas of our lives, there is still a lack of understanding and knowledge on issues related to

sustainable development. This is a problem because the predisposition to take more sustainable actions is preceded by the individual's knowledge of sustainability issues.

In this sense, the sport context could be a key element to improve this situation due to its potential to influence its followers to behave more sustainably, while creating a higher level of knowledge and interest among its different stakeholders (Orr et al., 2020).

Therefore, the results presented in this study can not only improve the analysis of the performance of the facilities through the implementation of the proposed indicators to measure the different dimensions, but can also be a starting point for the different stakeholders to increase their knowledge of what aspects should be taken into account in relation to sustainable development, highlighting the importance of this type of information for individuals who are no longer in school.

In addition, highlight the most common indicators, could be used to enable future research to design action plans to improve the sustainable performance of sports facilities. Thus eliminating the most prominent problems in the relationship between sports facilities and sustainable development, such as the lack of knowledge about what kind of actions to implement and the lack of clear plans and/or objectives within the organisations themselves (Cayolla et al., 2023; Morán-Gómez et al., 2024), as well as facilitating a way to measure sustainable performance by sports facilities from a TBL perspective, without focusing only on the carbon footprint as is currently being done (Thormann & Wicker, 2021).

5 Conclusions

The main objective of this study is to analyze and synthesize the information available in the literature related to sustainable development and facilities, to this end a systematic review has been presentend following the PRISMA 2020 Methodology in order to create a valuable, complete, transparent and updated review helping to increase the knowledge about the state-of-the art of the sustainability and sports facilities relationship.

This review contributes to establishing a framework for understanding the role of sports facilities in sustainable development by shifting the attention that events and sports tourism have received in recent years and focusing it on this type of centers, that, unlike events or tourism, develop their activity continuously throughout the year and, therefore, could be a key tool to maximize the potential of the sports context in terms of sustainable development.

The findings of this study not only confirm previously noted trends in the literature, such as the predominance of the environmental dimension in studies related to sustainability, or the need for more quantitative research in this area. But they also highlight the growing interest within the academic community in understanding the environmental/sustainable performance of sports facilities.

However, many studies focus on how to analyze this performance by focusing their attention on the environmental dimension, neglecting the importance of integrating the three dimensions of sustainability (environmental, social, and economic dimensions) to comprehensively analyze the sustainable performance of an organization.

Furthermore, these results are based on a thorough review of prior research on the sustainability of sports facilities, providing valuable insights to improve our knowledge in this

regard and laying the groundwork for further analysis while drawing comparisons with previous work conducted in different contexts.

For those reasons, this work contributes to both the academic and professional fields by proposing a framework for optimizing the actions carried out by sports facilities by establishing a comprehensive review of the current state of the art regarding the relationship between sports facilities and sustainable development, using the TBL framework.

More specifically, through the present analysis, we can highlight several theoretical and practical implications that can help to improve the knowledge and performance of sustainable actions in sports facilities.

5.1 Theoretical implications

The main theoretical contributions of this work are the following: First, through the present work an exhaustive analysis has been made on the state of the art of the phenomenon of sustainability in sports facilities using the PRISMA methodology, through which it has been possible to establish what are the gaps regarding a topic that is in full development, thus helping the academy to study and remedy these gaps through studies to improve the understanding of the phenomena of sustainability in the sports context.

Secondly, this work provides relevant information on the three dimensions within sports facilities and, at the same time, sheds light on the need to deepen the impact of these actions in sports centers based on the TBL framework and contributing to alleviate one of the gaps previously detected in the literature such as the scarcity of works related to the three dimensions of sustainability.

In addition, through the results of this study, it contributes to guide future research related to sustainable development and the sports field, more specifically on the impact, both positive and negative, that sports facilities have, not only at an environmental level, but also at a social and economic level on the society that surrounds them. It can serve as a starting point for the analysis of such facilities worldwide.

And finally, through the results of this analysis, and after evidencing the lack of quantitative analysis, as well as the statements of other authors of the need to develop tools that help us to analyze the sustainable performance of sports facilities from a quantitative perspective, this work contributes to lay the foundations through which future research can use the results of this work to create tools that help to increase analyze with a quantitative methodology the efforts that are made from sports facilities, taking as a reference the proposed indicators.

5.2 Practical implications

On the other hand, in relation to the practical implications of this work and as discussed in the first section of this paper, the need for indicators to generate actions and measurement tools related to the sustainable performance of sports facilities was raised.

Not only because these indicators can help us develop tools to measure the impact that sports facilities have on the society around them, but also because sports managers or public policy makers need a clear pathway on what actions or strategies to take to improve the sustainable performance of these types of facilities.

Therefore, through the results presented in this work we provide information on the areas in which these actions should be carried out, thus eliminating the problem of the lack of knowledge on the phenomenon of sustainability and also eliminating the problem of the lack of time of these managers or policy makers to update their knowledge on sustainable development, thus facilitating the implementation of concrete actions and strategies aimed at improving their activity from a more sustainable perspective by comprehensively contemplating the three dimensions of sustainability: environmental, social and economic. While providing them with information to generate tools that allow them to know quantitatively how these actions are developed over time.

6 Limitations and future lines of investigations

Although this work was carried out following the PRISMA methodology, it may have some limitations that must be taken into account. First, there are limitations in the data analyzed because, both in the search criteria and the selection of the analyzed works, important contributions have been avoided in the field of sustainable development and sports facilities. Hence, future lines of research should broaden their selection criteria of the works to be analyzed.

Also, to obtain the results, each of the articles was analyzed individually. All the information presented in them was categorized according to the distribution found in the analyzed literature. However, this categorization may not be appropriate for the reality of sports facilities. For this reason, future lines of research should analyze the level of adaptation of these categories to the real context of sports facilities to expand, reduce or adapt the table of categories and indicators to ensure that they can be applied in a more suitable way.

On the other hand, this work has focused on analyzing the most used indicators in academic works without considering what specific actions related to sustainability were carried out in the different centers. However, this topic could be very interesting for future research and observe not only what actions are carried out by the sports centers but also what new technologies could be applied to improve the sustainable performance of the facilities, such as the use of new methods for the improvement of water use (Mahdavi et al., 2022; Zinatloo-Ajabshir et al., 2019, 2020, 2024) or the use of alternative clean energy resources (Ghodrati et al., 2020).

Finally, the studies analyzed in this review cover a wide variety of contexts. In this sense, the level of development of the society in which a sports facility is located, the environment, and the cultural or climatic context of its sport could affect the categories acquired in this review. Therefore, future lines of research should not only analyze these categories in more specific sports contexts or environments but also compare different contexts or environments to a better understanding of the sustainable performance of sports facilities.

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Data availability All the data used for this article can be found on the above information.

Declarations

Competing interests The authors have no competing interests to declare that are relevant to the content of this article.

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