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Transforming the Peace and Friendship Stadium (S.E.F.) into a Sustainable Urban Ecosystem: A State-of-the-Art Review and Strategic Implications for Long Term Concessions

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Abstract

Large public sport venues are increasingly expected to operate as multifunctional urban infrastructures that deliver environmental performance, economic resilience, social inclusion, and cultural value. The Peace and Friendship Stadium (S.E.F.) in Piraeus, Greece, provides a timely case for examining how long-term governance arrangements can unlock deep sustainability retrofits and new models of public value creation. This state-of-the-art review synthesizes recent peer reviewed research and selected policy frameworks with an emphasis on the acceleration of four interlinked agendas after 2022: low carbon and energy positive operations, circular resource and waste management, social accessibility and health-oriented community programming, and the cultural reframing of stadia as heritage and learning ecosystems. Across these agendas, the literature converges on the importance of measurable Environmental, Social, and Governance (ESG) indicators, digital monitoring infrastructures, and transparent reporting as conditions for both accountability and sustainable finance. At the same time, current evidence highlights persistent tensions such as the tradeoffs between embodied and operational carbon, the risk of sustainability claims that outpace verified performance, and the possibility that green investments may increase inequalities if pricing and access are not designed inclusively. Building on the evidence reviewed, the paper proposes an integrated Sustainable Development Goals (SDGs) aligned Key Performance Indicator (KPI) dashboard for S.E.F. and outlines a forward research and implementation agenda for European public private sport venue partnerships. More specifically, the review makes three contributions: (1) it integrates the most recent evidence on environmental, economic, social, and cultural sustainability in large sport venues into a single analytical framework; (2) it translates that evidence into an SDG aligned and ESG oriented KPI dashboard tailored to the S.E.F. case; and (3) it identifies governance, data integrity, and stakeholder participation as the core implementation conditions for credible public value creation in long horizon sport venue concession arrangements. The review concludes that S.E.F. can function as a living laboratory for sustainable venue management, provided that governance, data integrity, and stakeholder participation are treated as core design variables rather than add ons.

Keywords: sustainable sport facilities; circular economy; ESG reporting; SDGs; climate resilience; accessibility; cultural heritage; Piraeus Greece.

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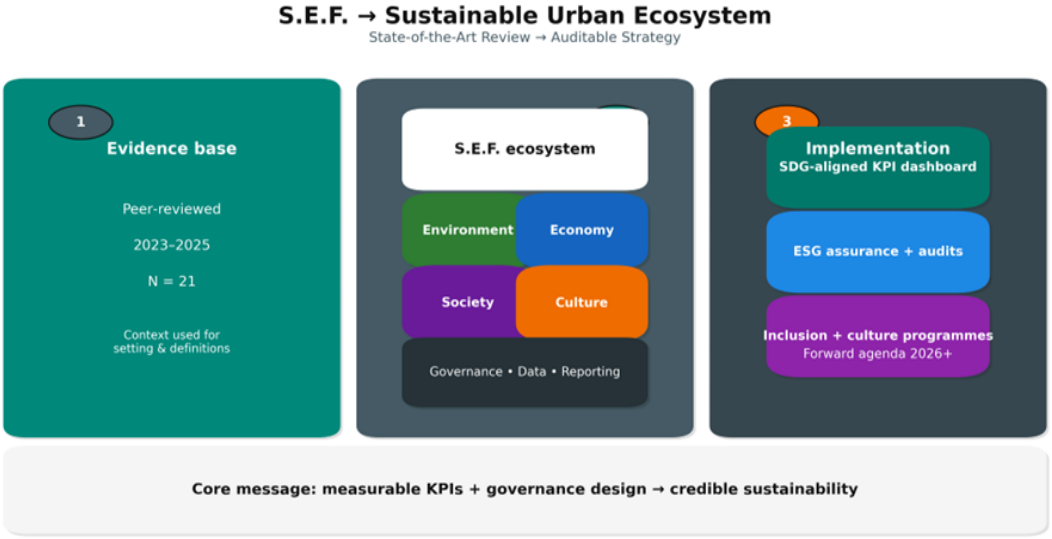
Graphical abstract



1. Introduction

The conversation about sustainability in sport management has changed from voluntary environmental initiatives to integrated strategies that combine climate action with social and cultural responsibilities. The most recent literature has sped up this change by framing sports venues as urban infrastructures whose legitimacy depends on clear environmental performance and public value. This change is clear in large arenas and stadiums by the increasing focus on renewable energy systems, circular procurement and waste streams, inclusion by design, and the reuse of venues as community assets all year round (Breitbarth *et al.*, 2023; Mallen & Chard, 2011). Peace and Friendship Stadium (S.E.F.) in Piraeus, Greece, is an adequate example because its size, symbolic importance, and public role make sustainability results very clear and important to politicians. This review considers S.E.F. not merely as a facility for enhancement, but as a governance test case for reconciling environmental objectives with social accessibility and cultural obligations under quantifiable accountability standards.

The Peace and Friendship Stadium (S.E.F.) is a large multi-purpose indoor arena located in Neo Faliro, within the Municipality of Piraeus on the coastal zone of the Athens metropolitan area (Attica), Greece. The venue was inaugurated on 16 February 1985 and has since hosted major international indoor sport events, cultural programming, and large-scale conferences. Its central arena is reported at approximately 4,000 m², while seating capacity varies by configuration and event type, with basketball configurations commonly reported at around 11,600 spectators, and higher capacities reported depending on seating set up. The stadium is served by dense public transport connections, including tram and rail access in the immediate area, and it is positioned near the port of Piraeus, which amplifies its metropolitan reach and event mobility significance. This locational and functional profile supports treating S.E.F. as a governance test case where sustainability ambitions can be evaluated through auditable indicators and public value commitments, rather than through narrative claims alone.

This review situates S.E.F. within a wider European trend in which long-term concession and partnership models serve as governance mechanisms to establish timeframes conducive to capital-intensive decarbonization and circularity initiatives. The Greek government announced a 49-year concession framework for S.E.F. in July 2025. This decision shows that the policy assumption is that sustainability retrofits need planning, financing, and accountability cycles that last for decades (AMNA, 2025; Kathimerini, 2025). The main question is not whether long-term concessions make it possible to invest, but how they can be set up to protect the public interest through measurable performance, clear reporting, and enforceable social access commitments. The review looks at how these types of concession agreements can turn sustainability goals into measurable indicators and governance protections that lower the risk of making empty promises and make sure that environmental improvements don't make things less affordable or less inclusive. Recent empirical evidence beyond the sport venue field also suggests that collaborative institutional arrangements can improve ESG performance directly and can strengthen adjacent implementation conditions, such as information quality, enforcement capacity, and investment efficiency, that are critical for long horizon sustainability implementation (Yan *et al.*, 2024; Li *et al.*, 2026). Although these studies examine corporate and public governance settings rather than sport venue concessions directly, they reinforce the present argument that long horizon concession performance depends on the quality of the coordinating institutional architecture, not only on the duration of the concession itself.

The need for this review arises from recurring implementation failures documented in the recent literature on legacy sport venues (Francis *et al.*, 2023; Gregori Faus *et al.*, 2025; Xuan *et al.*, 2025; Zafari *et al.*, 2025). Evidence indicates that facility sustainability claims often outpace verified performance because life cycle boundaries are unclear, operational monitoring is incomplete, and ESG disclosure lacks consistent, auditable indicators, conditions that can undermine both accountability and access if costs are transferred without explicit equity safeguards (Gregori Faus *et al.*, 2025; Zafari *et al.*, 2025; Gerke *et al.*, 2024). In parallel, circularity and waste interventions frequently fail at the level of system design, procurement enforcement, and partner incentives, while climate and event day resource peaks introduce operational risks that require structured governance and preparedness rather than ad hoc responses (Han *et al.*, 2023; Liu & Wu, 2023; Safarpour *et al.*, 2025). For S.E.F., these generic vulnerabilities become strategically consequential under a long horizon concession, because multi-dependent investment depends on credible measurement, stable reporting cycles, and governance protections that keep social access commitments enforceable. By synthesizing the most recent evidence and tracing its implications for long horizon venue management, the paper attempts to clarify what currently constitutes "best available knowledge" for sustainable stadium transformation and further identifies the most consequential tensions that future implementation should resolve. Accordingly, this paper makes three distinct contributions. First, it synthesizes the most recent peer reviewed evidence on sustainable sport venues across four interlinked domains, namely environmental transformation, economic resilience, social sustainability, and cultural sustainability. Second, it translates that synthesis into an implementable strategy for S.E.F. through auditable, SDG aligned, and ESG oriented indicators connected to venue management and reporting. Third, it advances a governance argument by showing that data integrity, stakeholder participation, and public value safeguards are not secondary operational considerations, but core conditions for credible sustainability implementation under long horizon concession arrangements. The novelty of the present review lies not only in synthesizing the most recent literature on sustainable sport venues, but also in translating that evidence into a policy relevant and operationally auditable framework for a specific long horizon public venue context. In this respect, the paper moves beyond descriptive sustainability mapping by connecting four sustainability pillars to concession governance, SDG aligned strategy, ESG oriented reporting, and implementable KPI design for S.E.F.

2. Approach to State-of-the-Art Synthesis

State of the art reviews aim to provide an interpretive synthesis that explains where a field stands now, how it arrived there, and what future directions appear most plausible and most consequential. Accordingly, this section clarifies how recency, scope, and interpretive depth were balanced so that the synthesis captures both the current frontier and the pathways that produced it. In contrast to strictly systematic reviews, a state-of-the-art approach is explicitly chronological and argument driven, and it is often used when a topic spans multiple disciplines and evidence types (Barry *et al.*, 2022). Chronology is treated here as an analytic device that assists the identification of inflection points, emerging consensus, and contested claims, rather than as a descriptive timeline. This paper utilizes cutting-edge lenses to analyze sustainable sports facilities and the conversion of evidence into a practical venue strategy. The focus on translation is important for places like S.E.F., where claims about sustainability should be put into action through measurable indicators, governance arrangements, and limits on implementation.

The evidence base was assembled through targeted searches and backward citation tracing, prioritizing peer reviewed sources published from 2023 onward, while retaining foundational works that established core concepts in sport facility sustainability, community legacies, and sport governance. Targeted research focused on indexing services and bibliographic databases commonly used in sport management and built environment research(e.g., Scopus, Web of Science, SPORTDiscus, INSPEC, IEEE Xplore) and employed keyword combinations that reflected the review's four pillar logic and cross cutting enablers, including, but not limited to, sustainable stadium, sport facility sustainability operations, arena operations, circular economy, waste diversion, Environmental, Social, Governance (ESG) reporting, Sustainable Development Goals (SDG) aligned indicators, accessibility, inclusion, cultural heritage, and immersive technologies. Methodological guidance for evidence synthesis was informed by contemporary evidence synthesis standards, including the 2024 edition of the JBI Manual for Evidence Synthesis (JBI, 2024). Screening prioritized relevance to large venue settings and the presence of implementable implications, including measurable metrics, governance mechanisms, finance linkages, and evidence on adoption barriers, because these elements determine whether synthesis can be translated into an actionable venue strategy. To improve transparency, **Tables 1 to 5** map the reviewed themes with evidence types, implementation levels, and research gaps. **Table 1** functions as an evidence landscape map, while the subsequent tables are designed to move from synthesis to application by connecting themes to implementation levels and by making research gaps explicit and actionable. As is typical in state-of-the-art synthesis, the intent is not exhaustive coverage, but a transparent and reasoned selection that represents the leading edge of debates and practice while keeping the synthesis coherent and decision relevant.

2.1. *Review aim and questions*

The aim of this state-of-the-art review is to synthesize the most recent evidence on sustainable sport facilities and to translate that evidence into an implementable strategy for a large public venue context. The review is guided by three questions: (a) which developments after 2023 have most shaped environmental performance, circular operations,

social inclusion, and cultural sustainability in large venues; (b) which cross cutting enablers and recurring tensions determine whether these developments can be implemented with credibility; and (c) which Key Performance Indicators (KPIs) and governance implications follow for long horizon concession and partnership arrangements in the S.E.F. case.

2.2. *Eligibility criteria*

Included sources in the core evidence base were peer reviewed journal articles published between 2023 and 2025 that addressed sustainability in large sport venues, arenas, or stadia and contributed to at least one of the four pillars or cross-cutting enablers. Books, institutional reports and manuals, media items, and preprints were not included in the core evidence base. These sources were used only to document the contextual setting of the S.E.F. concession and to support methodological framing and definitions, and they are cited as contextual or foundational sources rather than counted in the included evidence base.

Table 1. Evidence Landscape and Thematic Emphases in Sustainable Sport Venue Research

Illustrative recent sources	Common methods	Theme	Typical focus
Francis *et al.* (2023); Wergeland and Hognestad (2021); Xuan *et al.* (2025)	Systematic reviews, life cycle perspectives, case analysis	Environmental design and construction	Energy demand, material choices, embodied and operational emissions, retrofit pathways
Gregori Faus *et al.* (2025); International Olympic Committee (2020); Salimi *et al.* (2023)	Case studies, modelling, operational benchmarking, digital systems design	Operations and energy management	Renewables, smart energy management, IoT monitoring, ESG dashboards and reporting
Wergeland & Hognestad (2021); Zafari *et al.* (2025);	Systematic reviews, policy analysis, program evaluation	Circularity and waste	Zero waste strategies, reuse and deposit return schemes, composting, circular procurement
Chappelet (2019); Mason *et al.* (2024)	Risk assessment, event studies, applied public health analysis	Climate risk and resilience	Extreme heat and weather preparedness, crowd safety, public health and emergency planning
Gerke *et al.* (2024); Han *et al.* (2023); Liu & Wu (2023)	Conceptual typologies, empirical assessment, sector modelling	Finance and circular business models	Mixed use revenue streams, circular sport business models, green finance and disclosure
Campos *et al.* (2024); Charway *et al.* (2025); Koželj *et al.* (2025); Oldörp *et al.* (2025)	Stakeholder studies, scoping reviews, mixed methods	Social inclusion and accessibility	Universal design, disability inclusion, communication and service design, policy implementation
Brennan *et al.* (2025); Chalip (2006); Misener & Mason (2006)	Case studies, impact evaluation, longitudinal monitoring	Social legacy, participation, and well being	Social capital, community programming, youth development, social impact accountability
Consoli *et al.* (2023); Wang *et al.* (2025); Geçikli *et al.* (2024); UNESCO (2015)	Bibliometric analysis, design research, human computer interaction studies	Cultural sustainability and experience	Heritage interpretation, linked open data, immersive technologies, cultural tourism linkages
Myung (2024); Hognestad *et al.* (2022); Safarpour *et al.* (2025)	Conceptual frameworks, scale development, governance analysis	Governance, reporting, and measurement	ESG governance, indicator design, reporting integrity, sustainability management values

Note. The table summarizes the evidence landscape across the thematic clusters used in the present state of the art synthesis and provides illustrative sources drawn from the manuscript's reference set.

2.3. *Information sources and search strategy*

An iterative, targeted search strategy was used, consistent with a state-of-the-art approach and with JBI guidance on transparent evidence identification and documentation in evidence syntheses (JBI, 2024). Search terms were structured into three concept blocks: venue type, sustainability domain, and governance or finance. An example string is provided to support replication: (stadium OR arena OR sport venue OR sport facility) AND (sustainab* OR ESG OR circular economy OR decarbon* OR net zero OR renewable energy OR waste management OR accessibility OR inclusion OR cultural heritage OR immersive technolog*) AND (governance OR concession OR public private partnership OR PPP OR financing OR green bonds). Backward citation tracing was then used to capture

influential works referenced by recent reviews and high impact articles, and forward tracing was used selectively to identify newer studies building on key sources.

2.4. *Selection process and evidence charting*

Screening was conducted in two stages. Initially, titles and abstracts were assessed for relevance to large venue sustainability and to the review's pillar framework. Then, full texts were assessed against the eligibility criteria, with borderline cases retained when they contributed to conceptual clarity or to implementable implications. In line with the inclusion criteria, the final included evidence base comprises N = 21 peer reviewed journal articles published from 2023 to 2025. Foundational and contextual sources were consulted to frame concepts and to document the S.E.F. concession setting, but they were not counted as included evidence. Evidence was charted using a structured template capturing publication year, evidence type, venue context, relevant sustainability pillar, key constructs, reported outcomes or claims, and implementable implications for operations, governance, and reporting. The evidence charting matrix for the included evidence base is provided in Appendix A to support transparency and traceability. Charted elements were used to populate the evidence landscape table and to support the translation of synthesis themes into auditable indicators and strategic recommendations.

2.5. *Critical appraisal and confidence considerations*

Given the heterogeneity of evidence types and the interpretive aims of a state-of-the-art review, a single critical appraisal instrument was not applied across all sources. In line with the inclusion criteria, the core included evidence base was restricted to peer reviewed journal articles published from 2023 to 2025; non peer reviewed documents and preprints were not counted as included evidence and were used only for contextual or methodological framing where relevant. Instead, credibility was assessed through pragmatic checks that included publication status, transparency of methods, coherence with adjacent evidence, and the presence of measurable or verifiable claims. Where feasible, greater confidence was assigned to peer reviewed synthesis studies and to papers that reported explicit methods, transparent metrics, and clearly transferable implications for large venue operations. Preprints and non-peer reviewed documents were treated as emerging evidence and were interpreted cautiously, with emphasis placed on peer reviewed synthesis where available. Accordingly, claims supported by convergent findings across multiple peer reviewed sources were treated as higher confidence, whereas claims relying on single studies or emerging documents were treated as provisional.

2.6. *Synthesis approach and methodological limitations*

Synthesis combined chronological and thematic analysis. Chronology was used to identify post 2023 inflection points and emerging consensus within the 2023 to 2025 included evidence base, rather than to provide a descriptive historical timeline. The included evidence base was concentrated in the most recent literature, comprising 6 sources published in 2023, 5 in 2024, and 10 in 2025, which supports interpreting chronology as a lens on emerging developments rather than as a retrospective history. For every pillar, themes were identified in the post 2023 literature and then interpreted in relation to foundational constructions and to recurring implementation tensions. Foundational sources were used to clarify core constructs and interpretive lenses; however, they were not counted within the included evidence base. Cross cutting enablers were derived through pattern matching across pillars, focusing on measurement, reporting, data integrity, stakeholder participation, and governance design. To support traceability, the charting template fields are operationalized in the evidence charting matrix provided in Appendix A. The resulting interpretive synthesis was translated into a venue level strategy through the development of a KPI dashboard and an implementation agenda. Translation prioritized auditable indicators and governance implications suited to long horizon concession arrangements. Methodological limitations include the purposive nature of targeted searching, the likelihood of publication bias toward successful interventions, and the absence of exhaustive enumeration of all screened records, which is common in state-of-the-art approaches but reduces strict replicability (**Table 1**). Additional limitations include the restriction to peer reviewed sources, which may underrepresent practice based grey literature and local technical documentation, and the heterogeneity of study designs, which limits direct comparability of effect magnitudes across interventions. In response to peer review, a limited number of newly published cross sector studies were also consulted at the revision stage in order to sharpen the discussion on governance coordination, ESG measurement divergence, and greenwashing related verification risks. These studies were used as targeted contextual updates and interpretive reinforcement, rather than being counted in the core included evidence base, which remains defined by the original eligibility window and charting procedure. Taken together, these methodological choices reflect the logic of a state-of-the-art review that privileges interpretive synthesis, recency, and decision relevance, while still maintaining explicit boundaries, traceability of included evidence, and transparency about confidence and limitations.

3. Environmental Transformation: From Energy Upgrades to Circular and Climate Resilient Infrastructure

Environmental sustainability has evolved from an aspirational narrative to a strategic necessity in the management of large sport venues. In the current state of the art, environmental performance is increasingly treated as a condition for institutional legitimacy and finance readiness, because venues are expected to demonstrate measurable progress rather than isolated green initiatives. Recent reviews emphasize that stadium impacts are produced across the full life cycle, spanning design and construction choices, operational energy consumption, and the temporary intensity of event day resource peaks (Francis *et al.*, 2023; Xuan *et al.*, 2025). This life cycle framing implies that S.E.F. oriented interventions should

distinguish clearly between embodied and operational impacts, define reporting boundaries, and specify what is included in annual accounting in order to avoid inflated or incomparable claims. For S.E.F., the environmental pillar is closely aligned with SDG 7 (Affordable and Clean Energy), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action) and forms a prerequisite for the credibility of broader ESG performance claims (Breitbarth *et al.*, 2023; Hautbois & Desbordes, 2023). Within the conceptual framework of this review, the environmental pillar also interacts directly with cross cutting enablers such as data governance and transparent reporting, because measurement quality determines whether ESG disclosure functions as accountability or as branding. Recent empirical ESG research also suggests that sustainability related performance outcomes are shaped by interacting technological, organizational, and environmental conditions rather than by isolated variables in linear sequence (Li *et al.*, 2025). Although this evidence addresses firm level ESG performance rather than venue specific carbon accounting, it reinforces the present review's multi factor analytical logic, according to which retrofit choices, operating systems, data infrastructures, and governance arrangements should be interpreted as interdependent determinants of sustainability performance.

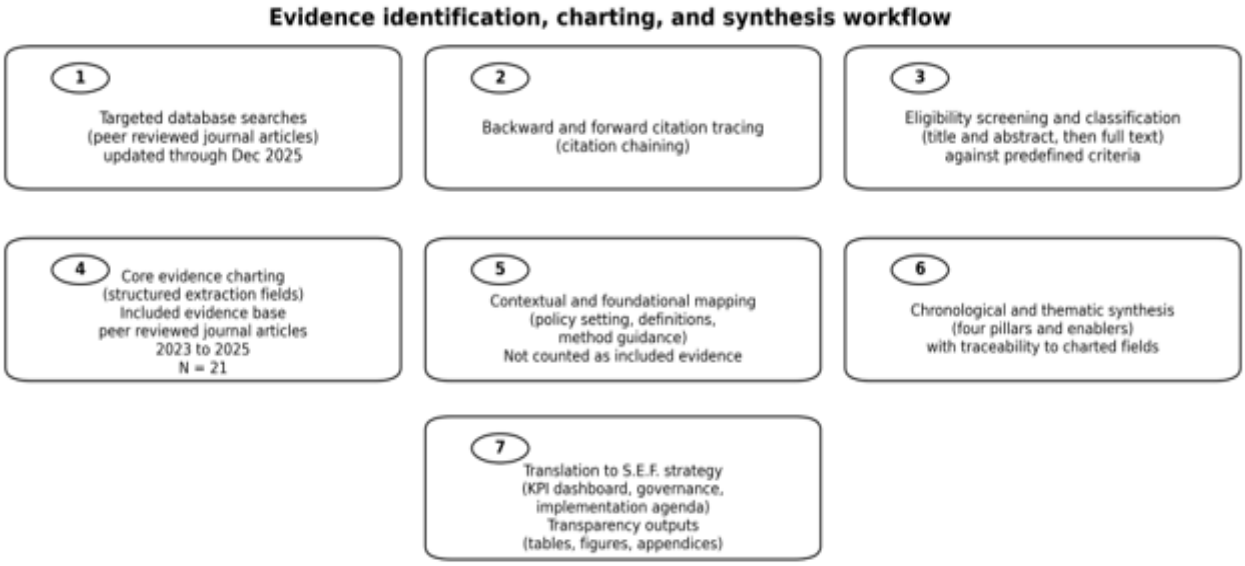


Figure 1. Evidence identification, charting, and synthesis workflow. *Note.* Stage numbers indicate the sequence of evidence identification, classification, charting, synthesis, and translation steps. The included evidence base comprises peer reviewed journal articles published from 2023 to 2025 (N = 21). Contextual and foundational sources were used to frame concepts and document the concession setting but were not counted as included evidence.

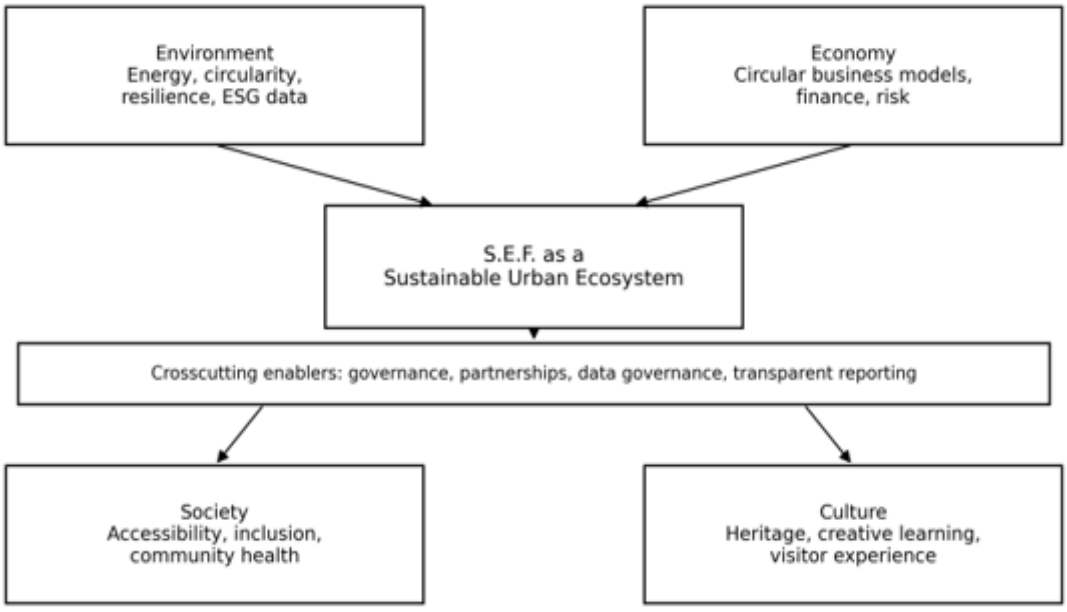


Figure 2. Conceptual synthesis framework for S.E.F. as a sustainable urban ecosystem. Note. Figure 2 visualizes the four sustainability pillars and the cross-cutting enablers identified in the reviewed literature. Arrows indicate the conceptual flow from pillar specific evidence to an integrated venue logic, with cross cutting enablers operating as the governance and measurement layer that enables implementation and accountability. The framework is a synthesis of themes discussed across the reviewed evidence base.

Energy demand in arenas is structurally high because of large, enclosed volumes, fluctuating occupancy, lighting and audiovisual loads, and the need for thermal comfort under diverse event conditions. A state-of-the-art implication is that decarbonization strategies should combine supply side upgrades with demand side management, because peak loads and event driven variability can undermine annual efficiency gains if not actively controlled. A plausible decarbonization pathway begins with rooftop photovoltaics, thermal upgrades, and efficient HVAC systems such as heat pumps, combined with operational monitoring and smart energy management to reduce waste and stabilize performance (Francis *et al.*, 2023; Gregori Faus *et al.*, 2025). Recent facility focused evidence also supports the integration of metered baselines, energy intensity indicators, and continuous commissioning practices, because performance drift over time is a common reason why retrofits underdeliver relative to design expectations. LED lighting retrofits and the digitalization of energy flows can support transparent reporting and operational optimization, enabling ESG oriented dashboards and external verification (International Olympic Committee, 2020). In practical terms, this means that the measurement chain should start with submetering and end with annual disclosure that can be checked by outsiders. This is important if S.E.F. wants to use ESG performance to assist with financing decisions and build trust with stakeholders.

Recycling bins are just one part of circularity in venue operations. It necessitates procurement policies that minimise single-use materials, the implementation of reuse initiatives like deposit return cups, and contracts that motivate vendors and partners to achieve specified diversion rates and material standards (Wergeland & Hognestad, 2021; Zafari *et al.*, 2025). Modern literature increasingly regards procurement clauses, vendor incentives, and monitoring protocols as the operational essence of circularity, as waste diversion rates often stabilize when circular practices are communicated to stakeholders but lack enforcement throughout supply chains and service providers. When used as a participatory system, circularity can also be a way to educate the public by changing their daily habits through the venue experience (Gregori-Faus *et al.*, 2024). A further state of the art implication is that circular outcomes become durable when feedback loops are visible to users and partners, meaning that the venue can communicate quantified results such as diversion rates, contamination rates, and material reuse volumes as part of its ESG disclosures.

Climate resilience is increasingly treated as an engineering and public health concern rather than an abstract risk. While S.E.F. is an indoor venue, heatwaves and extreme weather influence crowd safety, transport, and the surrounding urban microclimate. The most recent evidence frames heat risk as a multi stakeholder exposure problem that affects spectators, staff, athletes, and emergency services simultaneously, which means that resilience planning must be embedded in event operations rather than treated as a separate contingency document. Evidence from mass gathering sport events shows that heat exposure affects athletes, officials, spectators, and staff, and that preparedness requires planning, mitigation, medical protocols, policy alignment, and education (Chappelet, 2019; Mason *et al.*, 2024). Venue level measures include heat mitigation surfaces, water management, emergency planning, and sensor networks that support early warning and decision making. For S.E.F., an actionable state-of-the-art approach would include predefined trigger thresholds, heat specific crowd management protocols, and coordination mechanisms that align venue operations with local public health and transport systems, because operational continuity depends on systems beyond the venue boundary.

Innovation is very important for a stadium to run in a way that is beneficial for the environment. S.E.F. could use Internet of Things (IoT) technologies and big data analytics to create a full environmental monitoring system (Salimi *et al.*, 2023). The venue can use sensors, apps, and analytical platforms to make real-time ESG indicators about how much energy is used, how waste is handled, how much water is used, and how much CO_2 is released. It's not just about sensing anymore; it's also about how to manage the data that is sensed. This includes things like data quality standards, privacy protections, audit trails, and institutional responsibilities for validation. For S.E.F., these protections should explicitly include compliance with the General Data Protection Regulation (GDPR) and applicable Greek data protection requirements, especially where smart systems process visitor flows, behavioural patterns, ticketing information, or accessibility related service data. Regulatory compliance is therefore part of the data governance enabler itself, rather than a secondary legal consideration.

These are all important procedures because they affect whether real-time indicators can be trusted and compared over time. Making this information public by putting it on a digital display in the building or on an online portal makes things more open and makes people more accountable. At the same time, connecting ESG key performance indicators with the S.E.F.'s annual management reports lets you look at progress in a strategic way. This is in line with current trends in sustainable finance, such as green bonds and funds that focus on ESG. The connection is most believable when annual reports have baseline values, goals, and proof of change from year to year. This is because this structure lowers the risk that disclosure will be more about the story than the performance. Evidence indicates that audiences are inclined to offer financial assistance to facilities that implement transparent and environmentally sustainable practices (Mallen *et al.*, 2010). If S.E.F. functions as an intelligent green venue, it can exemplify a model for the European Union and draw international investment along with pertinent certifications. In this way, environmental innovation becomes a strategy for institutions because measurement infrastructure makes it possible to improve

operations and build legitimacy through results that can be verified.

Cutting-edge evidence reveals that S.E.F.-oriented strategies need to deal with three recurring tensions directly. First, operational decarbonization can be undermined if embodied carbon from renovations is ignored. This is why life cycle reasoning and clear boundaries are important when reporting progress (Francis *et al.*, 2023; Xuan *et al.*, 2025). This tension indicates that S.E.F. should convey not only yearly operational enhancements but also the carbon consequences of significant renovation decisions, clearly delineating the timeframe in which operational savings counterbalance renovation effects. Second, circularity interventions frequently falter at the final stage due to the lack of a cohesive system for behaviour modification, vendor incentives, and data feedback loops, a concept highlighted in the literature on waste management at mega events (Zafari *et al.*, 2025). Instead of just a bunch of visible bins and campaigns, a cutting-edge response is to treat circularity as a governed service system with contracts, training, and measurement. Third, ESG monitoring can make things more trustworthy, but it can also raise concerns for the government about the quality of the data, privacy, and the ability to audit it. This means that monitoring should be done along with clear assurance logic that explains how indicators are made, who checks them, and how mistakes are fixed. Instead of green interventions, a credible environmental strategy needs a Green Operations Manual, data governance policy, and KPIs that the public can check. When these things are put together, they can transform S.E.F. from being based on projects to being based on a system of measurement, reporting, and verification that can last through changes in leadership and keep its credibility over time.

4. Economic Resilience and Sustainable Business Models: Circular Value Creation and Finance

The economic aspect of sustainable development is a key factor in the long-term success and independence of large sports facilities like S.E.F. In the current state of the art, "economic sustainability" in venue management is more and more being defined as resilience under volatility. This means being able to keep core operations going even when demand changes, the weather changes, or financing needs change, instead of just being able to stay profitable during stable times. The S.E.F.'s 49-year concession to Olympiacos BC makes it easier to put into action a comprehensive economic plan based on the ideas of the circular economy, socially responsible business, and green finance. The literature indicates that long-term concessions yield public value solely when they incorporate measurable, enforceable performance obligations that align with transparent reporting cycles, as time horizon alone does not ensure sustainable outcomes. Across the four-pillar framework, SDG alignment is specified at the pillar level, because different sustainability domains map onto different SDG targets and implementation logics. Accordingly, environmental performance is primarily linked to SDGs 7, 11, and 13, while the economic resilience and business model pillar is aligned with SDGs 8, 9, and 12, reflecting employment, infrastructure innovation, and responsible production and consumption objectives. This chapter places S.E.F.'s strategic economic approach within the context of SDGs, focusing specifically on SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), and SDG 12 (Responsible Consumption and Production). The goal is to make the stadium's economy stronger by adding more ways to increase profit, invest, and run the business that all follow the idea of creating social values. An additional goal is to make the stadium's economy more stable by adding more ways for it to make money, invest, and run its business, all of which are based on the idea of creating social value. This stability should be easy to see through indicators that can be shared and evaluated by others.

S.E.F. could be an economic hub for Piraeus and the southern Athens area. It shouldn't only be used for profitable sports competitions. Instead, it could be turned into a multi-purpose centre for activities that can create stable jobs, investment opportunities, and social synergies. This underscores the notion that possessing multiple sources of revenue is not merely a beneficial asset; it also serves as a safeguard against potential economic hazards. This is due to the fact that possessing a variety of income streams makes one less susceptible to fluctuations in attendance or programming on event days. Preuss (2013) further posits that the conversion of sports facilities into business centers exerts a substantial influence on the local economy, thereby augmenting revenue and attracting tourists.

The development of employment in the green economy, for example energy managers, environmental consultants, and ESG officers, responds to contemporary demands for economic growth with a clear social orientation (Han *et al.*, 2023). This also implies that workforce development should be treated as part of the sustainability investment logic, because the operationalization of ESG commitments requires specialized competences and institutional roles that can sustain reporting, compliance, and performance improvement over time. The organization of trade fairs, cultural events, and conferences within the S.E.F., combined with the creation of new consumption and hospitality spaces, including retail, food and beverage services, and accommodation services, can broaden revenue sources and support a mixed economic model with multiple income streams. Within an SDG aligned framing, this mixed model is most defensible when revenue expansion is paired with explicit affordability and access safeguards, because economic upgrading can otherwise displace local participation through pricing and commercialization pressures.

Circular sports business models can include pay per use access to facilities, shared space models for events and community programs, and leasing arrangements that integrate environmental compliance into contracts. A new typology of circular sport business models shows that creating value together depends on making sure that organizational incentives, partner ecosystems, and user

practices are all in sync (Gerke *et al.*, 2024). Recent value chain research also indicates that ESG pathways are rarely produced by single organizations acting alone but instead emerge through actor network configurations that combine internal governance, digital infrastructure, market drivers, and external supervision across the wider value chain (Ma *et al.*, 2025). For S.E.F., this suggests that circular procurement and supplier management should be understood as network governance tasks involving caterers, cleaning contractors, logistics partners, sponsors, waste processors, and digital service providers, rather than as isolated procurement decisions confined to the venue operator alone.

One important aspect to keep in mind is that circular business models only make sense financially when they are set up as contract-governed systems. This means that meeting environmental standards is turned into procurement standards, service level clauses, and measurable outcomes that affect partner selection and renewal. These kinds of models make it less necessary to rely on big events and can stabilise income while using fewer resources (Liu & Wu, 2023). It also makes the economic case for circularity stronger by connecting resource efficiency to cost predictability and lower reputational risk, especially when disclosure and stakeholder expectations make people pay more attention to how materials are used and waste outcomes.

Green finance mechanisms, including sustainability linked loans and green bonds, have become central to the feasibility of venue decarbonization and circular infrastructure. Evidence from sport industry finance suggests that green finance can support high quality development in the sector, but only when paired with measurable indicators and credible disclosure (Han *et al.*, 2023). Recent evidence also indicates that ESG disclosure can improve green innovation performance by easing financing constraints and strengthening internal control quality, suggesting that disclosure is not only a reporting obligation but also a potential innovation enabler within sustainable finance systems (Xu *et al.*, 2025). For S.E.F., this implies that finance linked disclosure should be designed not merely to satisfy investors, but also to create organizational conditions that support low carbon operational innovation and continuous improvement over time. In the literature, this credibility condition is increasingly treated as a governance problem, because financing terms and investor confidence depend on indicator definitions, baseline transparency, and the ability to verify reported progress over time (Liu & Wu, 2023). Digital performance dashboards can further support cost optimization and investment logic by linking operational metrics to financial outcomes (Han *et al.*, 2023; Liu & Wu, 2023). For S.E.F., dashboards are most defensible when they are connected to audit trails and assurance practices, because data visibility without validation can increase the risk of disputed claims and weaken financing narratives.

As a public facility with a strong social identity, the S.E.F. can mobilize social finance instruments. Indicative options include the following:

1. Social impact bonds to fund programs for vulnerable groups.
2. Crowdfunding to support educational initiatives or local interventions.
3. Corporate social responsibility partnerships with small and medium sized local enterprises.

These instruments can be strengthened by explicit funding criteria and outcome measures, particularly for disability inclusion and community benefit programming, where stakeholder aligned criteria improve legitimacy and targeting (Campos *et al.*, 2024). The financial inclusion of social partners enables value creation with a multiplied social footprint. Collaboration between the public and the private sector can reshape the S.E.F. governance model by strengthening democratic features and transparency. According to Hognestad *et al.* (2022), sport facilities that adopt participatory financial models tend to achieve broader social legitimacy and greater resilience. This logic is consistent with established perspectives on social leverage and social capital in sport events and facility contexts, which emphasize that legitimacy grows when communities can recognize tangible and sustained benefits rather than episodic symbolism (Chalip, 2006; Misener & Mason, 2006).

Any financial plan that warrants sustainability should include ways to analyze risk and adapt, especially to external threats. The COVID-19 pandemic showed that depending only on in-person events can have detrimental economic consequences. S.E.F. could create an economic resilience model that includes the ability to hold hybrid events with both physical and digital participation, flexible contracts backed by alternative scenarios, financial reserves for extreme events, and partnerships with universities to allow for crisis simulation and scenario planning. From a cutting-edge point of view, climate-related disruptions are becoming more common as a financial factor in risk analysis. This is because extreme heat and safety requirements for events can change scheduling, staffing costs, and operational continuity (Mason *et al.*, 2024). This kind of model is in line with SDG 9 (Industry, Innovation and Infrastructure), which encourages smart infrastructure, innovation, and resilience. In a long-term concession, resilience planning can also be put into action using governance tools like regular stress testing, contingency plans based on triggers, and reserve policies that are looked at the same time as annual ESG reporting cycles. Recent cross sector risk research further supports the use of non linear and stress sensitive analytical frameworks when sustainability related exposures are incorporated into financial planning. Evidence on corporate risk under financial asset allocation uncertainty, together with quantile sensitive analysis of biodiversity related market risk, suggests that resilience depends not only on average conditions but also on adverse state sensitivity and heterogeneous transmission across different market environments (Peng *et al.*, 2025;

Zeng *et al.*, 2025). For S.E.F., this reinforces the value of periodic stress testing, trigger-based reserve policies, and scenario sets that explicitly model climate, attendance, financing, and reputational shocks rather than relying on a single baseline forecast.

State of the art discussions also highlight a credibility challenge: sustainable finance and ESG branding can incentivize the production of reports that emphasize intentions over verified outcomes. For S.E.F., this implies that any financing package should be tied to auditable KPIs, third party verification, and clear governance mechanisms for managing conflicts between commercial optimization and public access commitments (**Table 2**). This requirement connects directly to the growing emphasis on ESG measurement quality and management systems, where indicator design, validation processes, and assurance logic determine whether disclosure functions as accountability or reputational messaging (Myung, 2024; Safarpour *et al.*, 2025; Liu & Wu, 2023). A state-of-the-art implementation implication is that finance linked KPIs should be few, material, and stable across years, because shifting metrics and ambiguous boundaries weaken comparability and can undermine both public trust and investor confidence. Recent empirical studies on carbon greenwashing and strategic ESG tone management further suggest that disclosure pressure, reputational incentives, and intensified stakeholder scrutiny may, under some conditions, increase symbolic reporting without corresponding substantive performance improvement (Zhong *et al.*, 2026; Hu *et al.*, 2026). For S.E.F., this means that third party verification should not be treated as a ceremonial add-on, but as a substantive control system that discloses calculation rules, reporting boundaries, source data logic, and corrective procedures capable of distinguishing operational improvement from reputational signaling.

Table 2. Economic Levers, Financing Instruments, and Auditable Indicators for S.E.F.

Illustrative recent sources	Auditable KPIs, illustrative examples	Economic lever or instrument	Implementation logic in S.E.F.
Han *et al.* (2023); Preuss (2013)	Administrative accounting and KPI monitoring: revenue diversity index; non sport revenue share; utilisation days per year; local procurement spend; stable employment count. SDGs 8, 9, 12.	Revenue diversification and mixed-use programming	Year-round scheduling across sport, culture, conferences, education, retail, food and beverage, and hybrid formats, designed to reduce dependence on event day demand.
Gerke *et al.* (2024); Wergeland & Hognestad (2021); Zafari *et al.* (2025)	Contract monitoring and waste auditing: waste diversion rate; single use reduction rate; circular procurement share; vendor compliance rate. SDGs 12, 13.	Circular contracts and procurement	Procurement standards that reduce single use materials, reuse systems such as deposit return cups, and vendor contracts tied to diversion targets and compliance monitoring.
Han *et al.* (2023); Liu & Wu (2023)	Finance linked KPI tracking and assurance: green capital mobilised; cost of capital change; KPI target attainment; third party assurance statement. SDGs 9, 12, 13.	Green finance mechanisms	Sustainability linked loans and green bonds tied to a small set of material KPIs with baselines, targets, and independent assurance.
Myung (2024); Safarpour *et al.* (2025)	ESG reporting and audit trails: annual ESG report publication; external assurance coverage; data completeness rate; audit findings closure rate. SDGs 16.	ESG data infrastructure and disclosure governance	Dashboards that connect operational data to annual reporting, with data governance roles, validation procedures, and disclosure timelines that support comparability.
Brennan *et al.* (2025); Campos *et al.* (2024); Hognestad *et al.* (2022)	Outcome monitoring for inclusion: funds mobilised for inclusion; number of beneficiaries; accessibility satisfaction; programme retention. SDGs 3, 10, 16.	Social finance for inclusion and community benefit	Social impact bonds, corporate social responsibility partnerships, and crowdfunding directed to inclusive programming and accessibility improvements with outcome metrics.
Chappelet (2019); Mason *et al.* (2024)	Scenario planning and stress testing: reserve coverage ratio; share of revenue from hybrid and digital formats; stress test frequency; continuity drill performance. SDGs 9, 13.	Risk management and adaptive capacity	Hybrid event capability, scenario planning with university partners, contractual flexibility, and reserve policies designed for shocks including health and climate disruption.
Han *et al.* (2023)	Workforce monitoring and training logs: number of green	Green jobs and skills ecosystem	Dedicated roles for energy management and ESG, training pathways, and partnerships for

	jobs; training hours; local hiring rate; retention in ESG relevant roles. SDGs 4, 8.	workforce development that sustain performance improvement over the concession horizon.

Note. Columns are ordered to foreground sources and monitoring approaches, followed by the thematic lever and its operational focus.

5. Social Sustainability: Accessibility, Participation, and Well Being

Social sustainability in sports venues goes beyond physical access. It includes participatory governance, equitable programming, and the capacity of the venue to function as a community health and inclusion infrastructure. In the current state of the art, social sustainability is increasingly framed as a public value obligation that combines distributional fairness, procedural participation, and recognition of diverse identities, rather than as a supplementary community activity. Foundational work on sport events and social capital suggests that community networks can emerge when events are designed to produce meaningful connections rather than short lived spectacles (Misener & Mason, 2006; Chalip, 2006). For S.E.F., this implies that social outcomes should be designed as repeatable institutional practices that persist across seasons and leadership cycles, rather than as episodic legacy narratives.

Accessibility for people with disabilities is consistently identified as a core requirement for inclusive sport consumption. Recent stakeholder and scoping reviews stress that barriers are not only architectural but also organizational, including staff training, communication practices, and service design (Campos *et al.*, 2024; Koželj *et al.*, 2025). A state-of-the-art implication is that accessibility should be treated as a service system spanning ticketing, arrival and transport interfaces, wayfinding, sensory environments, information formats, and complaint resolution, because these elements often determine effective access more than infrastructure alone. Universal design approaches integrate accessibility at the design stage rather than as a corrective retrofit, which increases both dignity and operational efficiency. This also supports performance monitoring, because universal design can be translated into auditable service standards and user centered indicators that are tracked longitudinally.

Beyond mere spectatorship, venues possess the potential to facilitate sport for health and psychosocial interventions tailored for marginalized groups, encompassing older adults, refugees, unemployed individuals, and those afflicted with chronic health conditions. Within academic discourse, these initiatives are progressively recognized as fundamental elements of community wellbeing frameworks, necessitating the establishment of safeguarding protocols, referral mechanisms, and enduring collaborations rather than sporadic implementation. Empirical research concerning inclusivity through disability sport further suggests that participation models ought to be customized to align with particular activities and contexts, as inclusion is not an inherent outcome and may be hindered by organizational and cultural impediments (Oldörp *et al.*, 2025). For S.E.F., this denotes that the effectiveness of inclusive programming should be assessed not solely by attendance metrics but also by retention rates, the sense of belonging experienced by participants, and the dismantling of organizational barriers as reported by both participants and collaborators.

S.E.F. can also be used as a learning tool for working with schools, universities, and non-profit organizations to offer hands-on workshops, academic lectures, and lessons on sports, health, ecology, and social inclusion. At the same time, it can offer guided tours that are focused on historical and sociological themes. This educational role becomes strategically important when there are long-term agreements in place because it creates continuity, boosts legitimacy, and sets a measurable path for social impact that goes beyond just attending events. According to Schubring *et al.* (2025), social sustainability in sports can only happen if education in democracy, respect, and empathy is promoted. In this context, it is suggested that the S.E.F. could establish a continuous educational program for students called “Sport and Inclusion,” developed in collaboration with the Ministry of Education and the General Secretariat of Sports. As a result, long-term programs should be set up with scalable curricula, easy-to-find learning materials, and clear outcome metrics. This will make it possible to track and improve the impact of education across different groups of students. At the same time, a participatory design approach that includes surveys, focus groups, and open community assemblies may encourage citizens to be involved in how the stadium is used and how it changes over time (Harmsel-Nieuwenhuis *et al.*, 2025). To reduce the chance of tokenism, participatory design processes should set clear standards for representation, decision-making paths, and feedback systems that show how stakeholder input is used. This is due to the fact that legitimacy depends on being able to see how responsive the process is, not just on asking for input.

The administration of S.E.F. should also include clear policies on who can join based on gender, age, nationality, and socioeconomic status. Charway *et al.* (2025) demonstrate that the absence of locally informed policies can create socially neutral sports infrastructures that sustain existing inequalities instead of addressing them. One important consequence is that inclusion policies need to be put into action in a way that is based on governance and budget allocation, with clear rules for who can join, protections against unfair pricing, and monitoring of any unintended exclusionary effects. The S.E.F.'s inclusion strategy should be put into action through concrete means, such as giving marginalized groups priority access and use, guaranteeing free access to training facilities for community and social care organizations, creating structured educational pathways that make it easier for

people to get back into the workforce, and setting up a Social Partners Council with an advisory role. To strengthen enforceability, the Social Partners Council should also be assigned a formal role within the annual ESG audit cycle. This may include documented review of social access, affordability, accessibility, and participation indicators, the right to issue a written opinion annexed to the annual ESG report, and a requirement that venue management provide a formal response to material concerns and recommended corrective actions. In this way, stakeholder participation moves from consultation alone to a traceable oversight function within the venue's accountability architecture.

The Social Partners Council's credibility is strengthened when it includes clear reporting requirements and official ways for people to have a say in decisions. This is because advisory frameworks that don't show any real impact can make people lose trust over time. The incorporation of these institutional frameworks strengthens accountability, improves social legitimacy, and positions the stadium as a practical model aligned with SDG 16 (Peace, Justice and Strong Institutions). This position is strengthened when promises of inclusion are built into the rules for running concessions through specific goals and ways to check them, rather than just being policy statements.

Mega events such as the Olympic Games or major international tournaments have often been criticized for leaving behind underused facilities with limited social value. A joint UNESCO (2015) and IOC (2020) oriented analysis suggests, however, that when legacy is designed around explicit social objectives, stadiums can be transformed into institutions of participation rather than symbols of one-off spectacle. For S.E.F., this reinforces the need to define legacy as a durable social use portfolio with measurable reach and continuity, rather than as a retrospective narrative after major events. In practice, the S.E.F. can operationalize this legacy by highlighting the role of sport history in pathways of social progress, hosting thematic exhibitions on social movements within sport, including persons with disabilities, women, and migrants, and developing a Social Memory Archive that gathers the lived stories of citizens and athletes whose experiences are connected to the venue. A state-of-the-art safeguard is that memory and storytelling initiatives should incorporate consent, accessibility, and representation principles, because cultural participation can reproduce exclusion if narratives are curated without plural voices. Social memory functions as a tool of sustainable public policy because, when people feel that they have contributed to the history of a place, they are more likely to develop relations of care and stewardship, which are foundational to long term sustainability. This logic also supports community stewardship behaviour, which can indirectly strengthen environmental and economic goals by stabilizing participation and protecting the venue's public legitimacy.

Finally, the assessment of social impact cannot rely only on abstract impressions. It requires measurable indicators that track visitor numbers across age and social groups, participation rates of vulnerable populations in programs, social acceptance metrics captured through surveys, and the breadth and continuity of partnerships with social organizations and schools. A state-of-the-art implication is that these indicators should be disaggregated, baseline anchored, and tied to targets, because social reporting without comparability can drift into narrative claims that cannot be validated. S.E.F. can consolidate these indicators in annual social reports and integrate its social footprint within ESG reporting practices. Brennan *et al.* (2025) emphasise that accountability processes strengthen transparency, effectiveness, and the capacity to attract new partnerships. This integration also reduces the risk of social claims being decoupled from governance, because social indicators become part of the same annual cycle as environmental and economic disclosure.

Measurement is increasingly treated as the missing link in social legacies. Social impact reporting can include indicators such as participation rates by group, perceived belonging, accessibility satisfaction, and the number and quality of community partnerships. Accountability mechanisms are strengthened when these indicators are integrated into ESG reporting cycles and stakeholder oversight processes (Brennan *et al.*, 2025). In a framing, measurement is also a design tool, because the choice of indicators shapes what programs are prioritized, which groups are reached, and how tradeoffs between revenue generation and inclusion are managed.

A state-of-the-art implication for S.E.F. is that inclusion should more adequately be framed as both an ethical commitment and a performance domain. This requires allocating resources for inclusive service design, creating a formal Council of Social Stakeholders, and embedding accessibility and participation targets in concession related governance. Operationally, this implies explicit social clauses, periodic audits, and grievance mechanisms that enable users to report barriers and trigger corrective action, because accountability depends on enforceability as much as on intention (**Table 3**). In a long horizon concession, these mechanisms should be reinforced by contractual trigger provisions linked to social equity KPIs. For example, persistent underperformance in affordability, accessible service coverage, or participation by vulnerable groups should require a documented corrective action plan, time bound remediation measures, and follow up review within the next ESG reporting cycle. Such trigger mechanisms are important because they convert social commitments from aspirational clauses into enforceable operating obligations. Research also suggests that the social dimensions of sustainability in elite sport contexts remain under theorized and under measured, calling for multimethod evaluation designs that combine administrative data, qualitative stakeholder feedback, and longitudinal monitoring (Schubring *et al.*, 2025). For S.E.F., a practical research agenda would test which program bundles produce sustained participation and wellbeing outcomes, and how these outcomes interact with affordability, accessibility, and venue governance over time.

6. Cultural Sustainability: Stadia as Heritage, Memory, and Creative Learning Ecosystems

Culture is increasingly treated as a fourth pillar of sustainability, especially in venues with strong historical and symbolic identities. S.E.F. is not only a sports arena but also an urban landmark associated with sports memories, concerts, and civic experiences. Cultural sustainability therefore includes heritage interpretation, community storytelling, and the creation of cultural programs that broaden the venue's relevance beyond sport events.

Table 3. Social Sustainability Levers, Inclusion Mechanisms, and Auditable Indicators for S.E.F.

Key sources	Measurement approach	Implementation logic in S.E.F.	Auditable KPIs, illustrative examples
Campos *et al.* (2024); Koželj *et al.* (2025)	Service audits and accessibility monitoring: compliance checks, user feedback, incident reporting.	Accessibility integrated across seating, routes, toilets, ticketing, signage, and event day services, treated as a design and operations standard rather than retrofit compliance.	Accessible seating and service coverage, barrier free route compliance, accessibility satisfaction, accessibility incident reports. SDGs 10, 16.
Koželj *et al.* (2025)	Training logs and service quality audits: role specific protocols and continuous improvement feedback loops.	Staff training and communication protocols for disabled fans and diverse visitors, with role specific responsibilities and continuous improvement feedback loops.	Training hours completed, service quality audits, complaint resolution time, communication accessibility score. SDGs 10, 3.
Brennan *et al.* (2025); Oldörp *et al.* (2025)	Programme monitoring and outcome tracking: participation, retention, wellbeing and belonging indicators.	Year-round sport for health and psychosocial programs for vulnerable groups, with safeguarding, referral pathways, and partnerships with social and health organizations.	Participation by vulnerable groups, program retention, wellbeing and perceived belonging indicators, partnership continuity. SDGs 3, 10.
Brennan *et al.* (2025); Chalip (2006); Misener & Mason (2006)	Governance logs and stakeholder evaluation: participation metrics, recommendations adopted, trust monitoring.	Formal stakeholder body with defined remit, meeting cadence, and disclosure practices, enabling procedural inclusion and legitimacy in venue decision making.	Council participation rate, number of recommendations adopted, public reporting frequency, stakeholder trust metrics. SDGs 16.
Schubring *et al.* (2025)	Education programme evaluation: reach, completion, accessibility of materials, partnership continuity.	Permanent educational programs such as Sport and Inclusion, supported by school and university partnerships and designed to scale across cohorts and seasons.	Learner reach, program completion, accessibility of materials, school partnership count. SDGs 4, 10.
Charway *et al.* (2025)	Policy compliance audits and equity monitoring: affordability metrics, incidents of exclusion, safeguard checks.	Explicit inclusion policies across gender, age, nationality, and socioeconomic status, with eligibility criteria, access safeguards, and monitoring of unintended exclusion.	Equity in access indicators, pricing affordability metrics, incidents of exclusion, policy compliance audits. SDGs 10, 16.
Brennan *et al.* (2025)	Annual social reporting aligned with ESG: baseline values, targets, disaggregated metrics, external review.	Annual social reporting is integrated into ESG disclosures, with baseline values, targets, disaggregated metrics, and transparency about methods and limitations.	Annual social report publication, indicator completeness, year to year change against targets, external review or assurance statement. SDGs 16.

Note. KPIs are illustrative and intended to be auditable through routine administrative data, service audits, program monitoring, and ESG aligned reporting. Indicators should be disaggregated where feasible and tracked longitudinally to support accountability under long term concession arrangements.

Research on cultural heritage and tourism reveals that cultural assets can help with sustainability when they are mapped, curated, and linked to visitor experiences and local economies that are open to everyone (Consoli *et al.*,

2023; Geçikli *et al.*, 2024). This could include permanent exhibits on the history of Greek sports, digital archives that collect stories from citizens, and partnerships with schools and universities to create creative learning programs (**Table 4**).

Virtual and augmented reality and other immersive technologies are becoming increasingly popular as accessibility tools. They make it possible for people of all backgrounds to understand heritage and help create inclusive learning environments. Recent research in human-computer interaction underscores that immersive systems for cultural heritage encounter significant challenges concerning authenticity, user diversity, and long-term maintenance, which corresponds with the necessity for sustainable digital infrastructures instead of ephemeral displays (Wang *et al.*, 2025). Over a multi decade concession horizon, this also implies explicit lifecycle planning for digital assets, including maintenance schedules, hardware replacement cycles, software updates, format migration, metadata preservation, backup procedures, and periodic accessibility review. Without such renewal planning, digital archives and immersive applications risk becoming technically obsolete, inaccessible, or unusable despite their initial cultural value. A contemporary warning is that cultural programming may devolve into mere instrumentalism, facilitating tourism and branding at the expense of local cultural engagement. S.E.F. believes that cultural sustainability should be measured by things like how many people visit, how long digital archives last, and how many people participate in community co-creation. This is in line with bigger sustainability policies that see cultural diversity and education as ways to help development (UNESCO, 2015).

Table 4. Priority Gaps and Forward Agenda for Sustainable Sport Venues

Gap	Why it matters	Priority research and implementation questions
Life cycle carbon and renovation trade offs	Retrofits may reduce operational emissions while increasing embodied emissions	How should renovation scenarios be evaluated using transparent life cycle boundaries and reporting conventions?
Standardized ESG indicators for venues	Comparability and finance depend on consistent metrics and auditability	Which KPI sets are feasible, verifiable, and meaningful for arenas, and how should data governance be designed?
Equity and affordability of green investments	Green upgrades can increase costs and exclusion if pricing and access are not designed inclusively	What pricing and access models protect inclusion while sustaining finance, and how should willingness to pay evidence be interpreted?
Climate adaptation for indoor venues and surrounding microclimates	Heat extremes and extreme weather influence health, transport, and operational continuity	Which adaptation measures provide the best risk reduction per cost, and how should they be integrated into emergency governance?
Circularity systems design	Waste reduction requires coordinated behavior change, vendor incentives, and procurement enforcement	Which incentive architectures and procurement clauses produce sustained circular outcomes across event cycles?
Cultural legacy evaluation and digital durability	Heritage programs can become superficial without evaluation, accessibility design, and long-term maintenance	How can cultural archives and immersive programs be evaluated for participation, accessibility, authenticity, and long-term sustainability including maintenance schedules, migration pathways, and accessibility preserving upgrade cycles ?
Data integrity, privacy, and assurance for ESG monitoring	Weak data governance can undermine credibility, comparability, and finance readiness, and can raise privacy and accountability concerns	What governance model ensures data quality, privacy safeguards, auditability, and GDPR compliant handling of visitor and smart system data for venue level ESG reporting, and what assurance approach is feasible and proportionate?
Public value safeguards under long term concessions	Long horizon partnerships can enable investment but may also intensify tradeoffs between commercial optimization and public access	Which contractual clauses, oversight structures, and stakeholder mechanisms secure public interest, manage conflicts, and sustain accountability across decades?

Note. The gaps are framed to be directly actionable for S.E.F. and comparable European public venues. They reflect recurring tensions in life cycle accounting, ESG measurement, equity, climate adaptation, circular procurement, cultural durability, and governance under long horizon partnerships.

7. An Integrated SDG and ESG KPI Dashboard for S.E.F.

Across the reviewed literature, a consistent message is that sustainability in sport facilities becomes actionable only when translated into measurable indicators that can be monitored over time, reported transparently, and used to guide operational decisions. This emphasis reflects a shift from aspirational commitments to performance-based management, where indicator definitions, reporting boundaries, baselines, and targets determine whether progress can be compared across years and assessed with confidence. Recent empirical work also indicates that ESG assessments may diverge materially across rating systems because greater disclosure, heterogeneous indicator

architectures, and different weighting logics do not necessarily produce convergent evaluations of the same organization (Yan *et al.*, 2025). For S.E.F., this reinforces the need to privilege auditable venue level KPIs with stable definitions, fixed reporting boundaries, and transparent assurance procedures, rather than relying on generic ESG labels or externally aggregated scores alone. ESG reporting for sport organizations is therefore not only a communication practice but a governance mechanism (Myung, 2024; Safarpour *et al.*, 2025). In practice, ESG reporting functions as a decision infrastructure that assigns accountability for data ownership, specifies escalation routes when targets are missed, and links disclosure to assurance and corrective action, which is consistent with evidence on sustainability disclosure and its economic implications (Liu & Wu, 2023).

Table 5 provides an indicative KPI dashboard aligned with SDGs and ESG dimensions. The dashboard is intended to connect inputs, operational processes, and outcomes across the environmental, social, governance, and economic domains, so that S.E.F. can evidence both efficiency gains and public value creation. It is intentionally designed to be auditable, operational, and communicable to non-technical stakeholders. Auditability is strengthened when each KPI specifies data sources, calculation logic, and an accountable role, while operational relevance increases when each metric is paired with a review cadence that fits venue decision cycles. The KPI set should be adapted to the legal and organizational context of S.E.F., and it should be linked to annual reporting cycles and independent verification procedures. For composite or preparedness-oriented indicators, the final manuscript should also specify the scoring rule, unit, or rating logic used for annual reporting. For example, the Heat risk preparedness index can be operationalized either as a 0 to 5 checklist score or as a 0 to 100 weighted composite score derived from documented heat protocols, threshold-based trigger levels, completed drills, validated sensor coverage, and coordination with emergency and transport services. Where feasible, each KPI may also be paired with an indicative threshold band or phased target range for practitioner use. For example, energy intensity targets may distinguish moderate retrofit gains from deep retrofit pathways, such as an initial baseline relative reduction in the order of 20 percent to 30 percent and longer horizon reductions above 50 percent where full system upgrades are feasible. Likewise, waste diversion targets may distinguish current sector averages from advanced zero waste pathways, for example by treating rates above 50 percent as an intermediate operational benchmark and rates above 90 percent as a leading practice aspiration, while recognising that final thresholds must be calibrated to venue type, measurement method, and local infrastructure.

Table 5. Indicative KPI dashboard for S.E.F. (SDG and ESG alignment).

Dimension	KPI (illustrative)	Measurement approach	Primary SDG linkage
Environment	Renewable electricity share (%)	Metered renewable generation and grid purchases	SDG 7, SDG 13
Environment	Energy intensity (kWh per visitor)	Total annual energy divided by total visits and event days	SDG 7, SDG 12
Environment	Waste diversion rate (%)	Share of waste diverted from landfill via reuse, recycling, composting	SDG 12
Environment	Water reuse share (%)	Rainwater harvesting and greywater reuse volumes	SDG 6
Environment	Heat risk preparedness index (composite score, 0 to 5 or 0 to 100)	Documented protocols, drills, and sensor coverage assessed through predefined scoring criteria, including formal heat protocols, threshold triggers, annual drills, validated sensor coverage, and interagency coordination	SDG 3, SDG 13
Economy	Revenue diversity index	Share of revenue across events, retail, community programs, digital	SDG 8, SDG 9
Economy	Green investment leverage (€)	External green finance mobilized per € of own investment	SDG 9, SDG 17
Governance	Annual ESG report and external assurance	Publication and third-party assurance statement	SDG 16
Society	Accessible seating and services coverage (%)	Proportion of seating, routes, and services meeting universal design	SDG 10
Society	Participation of vulnerable groups (annual)	Unique participants in inclusive programs, disaggregated	SDG 3, SDG 10
Culture	Cultural and educational program reach	Number of programs and participants, disaggregated	SDG 4, SDG 11
Culture	Digital archive and heritage engagement	Archive growth, access, and accessibility features	SDG 11

Note. KPIs are illustrative and intended to be auditable through routine metering, administrative records, and reporting processes. Table numbering can be adjusted to match the manuscript sequence. For composite indicators such as the Heat risk preparedness index, the final manuscript should disclose explicit scoring criteria, for example a checklist-based score or weighted composite score built from documented protocols, threshold trigger systems, drills, validated sensor coverage, and interagency coordination.

8. Conclusion

The state-of-the-art evidence suggests that sustainable sport facilities are best understood as urban infrastructures with intersecting environmental, economic, social, and cultural functions. This integrative framing means that we can't look at progress in one area on its own, because trade-offs and synergies come up when there is shared governance, shared data infrastructures, and shared accountability mechanisms. Literature supports a transformation pathway for S.E.F. that focusses on energy transition, circular operations, inclusive access, and cultural reframing. However, it also warns that credibility depends on governance, data integrity, and performance that can be checked. So, the most important implementation challenge is not figuring out what sustainability interventions to use, but making sure that measurement, disclosure, and verification practices are used in a way that shows long-lasting improvement over time and across leadership cycles. If S.E.F. is managed as a living laboratory, its long-term horizon can be used to integrate capital upgrades with transparent ESG reporting and stakeholder co-creation, producing a venue model that is both operationally viable and publicly legitimate. In practical terms, this means having a stable set of core KPIs, clear rules for data governance and assurance, and a governance structure that protects commitments to the public interest while allowing for new investments and ways of doing business. In a long horizon concession setting, this also requires explicit legal and contractual safeguards to ensure that public access is not displaced by commercially higher yielding uses. Such safeguards may include minimum annual community use quotas, protected time windows for school, grassroots, disability, and public health programs, affordability clauses or pricing caps for designated user groups, universal accessibility and non-discrimination obligations, ring fenced funding for inclusive programming, and mandatory public reporting on access performance alongside environmental indicators. In addition, the concession framework should include independent monitoring, periodic review clauses, and enforceable corrective mechanisms, including penalties or step in rights, where commercial scheduling or pricing practices materially weaken the venue's public service function.

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Appendix A

Table A1. Evidence Charting Matrix for Included Peer Reviewed Sources (2023 to 2025)

Source (short)	Publication year	Evidence type	Venue context	Relevant sustainability pillar	Key constructs	Reported outcomes or claims	Implementable implications for operations, governance, and reporting
Breitbarth, 2023	2023	Empirical or conceptual article	Not specified in title	Environmental	sustainability; sport venues	Addresses environmental matters in sport: sustainable research in the academy with implications for venue management.	Supports auditable environmental KPIs, life cycle boundaries, and operational monitoring.
Brennan, 2025	2025	Empirical or conceptual article	Not specified in title	Social	sustainability; sport venues	Addresses sport as a catalyst for social justice and inclusion: a case study of the gaelic athletic association's role in community and youth development with implications for venue management.	Supports inclusion as a service system with measurable participation and accessibility indicators.
Campos, 2024	2024	Empirical or conceptual article	Not specified in title	Governance, Social	accessibility	Addresses listening to stakeholders' voices on funding social inclusion in sport for people with disabilities: proposal for criteria with implications for venue management.	Supports inclusion as a service system with measurable participation and accessibility indicators.
Charway, 2025	2025	Empirical or conceptual article	Not specified in title	Governance, Social	accessibility	Addresses leave no one behind? analyzing sport inclusion policy implementation for persons with disabilities in ghana with implications for venue management.	Supports inclusion as a service system with measurable participation and accessibility indicators.
Consoli, 2023	2023	Empirical or conceptual article	Not specified in title	Cultural	cultural heritage	Addresses cultural gems linked open data: mapping culture and intangible heritage in European cities with implications for venue management.	Supports cultural programming with accessibility and durability indicators.
Francis, 2023	2023	Empirical or conceptual article	Stadium, arena, or sport venue context	Environmental	sustainability; sport venues	Addresses environmental sustainability in stadium design and construction: a systematic literature review with implications for venue management.	Supports auditable environmental KPIs, life cycle boundaries, and operational monitoring.
Geçikli, 2024	2024	Bibliometric analysis	Not specified in title	Cultural, Environmental	cultural heritage	Synthesises evidence on cultural heritage tourism and sustainability: a bibliometric analysis and identifies	Supports auditable environmental KPIs, life cycle boundaries, and operational monitoring.

						patterns, gaps, or implications for practice.	
Gerke, 2024	2024	Conceptual framework	Not specified in title	Economic, Environmental	circularity	Proposes a conceptual model relevant to a typology of circular sport business models: enabling sustainable value cocreation in the sport industry.	Supports auditable environmental KPIs, life cycle boundaries, and operational monitoring.
Gregori Faus, 2025	2025	Systematic review	Not specified in title	Environmental	sustainability; sport venues	Synthesizes evidence on state of the art of sustainability in sports facilities: a systematic review and identifies patterns, gaps, or implications for practice.	Supports auditable environmental KPIs, life cycle boundaries, and operational monitoring.
Han, 2023	2023	Empirical or conceptual article	Not specified in title	Economic, Environmental	green finance and disclosure	Addresses research on the impact of green finance on the high-quality development of the sports industry based on statistical models with implications for venue management.	Supports auditable environmental KPIs, life cycle boundaries, and operational monitoring.
Hautbois, 2023	2023	Empirical or conceptual article	Not specified in title	Environmental	sustainability; sport venues	Addresses sustainability in sport: sport, part of the problem…and of the solution with implications for venue management.	Supports auditable environmental KPIs, life cycle boundaries, and operational monitoring.
Koželj, 2025	2025	Empirical or conceptual article	Stadium, arena, or sport venue context	Governance, Social	accessibility	Addresses communication with disabled fans at sports events: approaches, challenges and opportunities with implications for venue management.	Supports inclusion as a service system with measurable participation and accessibility indicators.
Liu, 2023	2023	Empirical or conceptual article	Not specified in title	Economic, Environmental	green finance and disclosure	Addresses green finance, sustainability disclosure and economic implications with implications for venue management.	Supports auditable environmental KPIs, life cycle boundaries, and operational monitoring.
Mason, 2024	2024	Empirical or conceptual article	Stadium, arena, or sport venue context	Environmental	climate risk	Addresses the impact of extreme heat on mass gathering sporting events: implications for australia and other countries with implications for venue management.	Supports auditable environmental KPIs, life cycle boundaries, and operational monitoring.

Myung, 2024	2024	Conceptual framework	Not specified in title	Governance	ESG measurement	Proposes a conceptual model relevant to conceptualization of esg management values of professional sports clubs: from consumers' perspective.	Supports reporting governance, data integrity roles, and assurance logic.
Oldörp, 2025	2025	Scoping review	Not specified in title	Social	accessibility	Synthesizes evidence on inclusion in and in disability sport? a scoping review using the examples of goalball and wheelchair basketball and identifies patterns, gaps, or implications for practice.	Supports inclusion as a service system with measurable participation and accessibility indicators.
Safarpour, 2025	2025	Scale development study	Not specified in title	Environmental	sustainability; sport venues	Develops and tests a measurement approach relevant to how sport management can address sustainability: creating and testing a scale.	Supports auditable environmental KPIs, life cycle boundaries, and operational monitoring.
Schubring, 2025	2025	Scoping review	Not specified in title	Environmental, Social	sustainability; sport venues	Synthesizes evidence on sustainable elite youth sports: a systematic scoping review of the social dimensions and identifies patterns, gaps, or implications for practice.	Supports auditable environmental KPIs, life cycle boundaries, and operational monitoring.
Wang, 2025	2025	Empirical or conceptual article	Not specified in title	Cultural	cultural heritage	Addresses grand challenges in immersive technologies for cultural heritage with implications for venue management.	Supports cultural programming with accessibility and durability indicators.
Xuan, 2025	2025	Systematic review	Stadium, arena, or sport venue context	Environmental	sustainability; sport venues	Synthesizes evidence on the impact of stadiums on carbon emissions: a systematic review and identifies patterns, gaps, or implications for practice.	Supports auditable environmental KPIs, life cycle boundaries, and operational monitoring.
Zafari, 2025	2025	Empirical or conceptual article	Stadium, arena, or sport venue context	Environmental	circularity; waste management	Addresses from conventional approaches to circular systems: evolution of waste management in mega sporting events with implications for venue management.	Supports auditable environmental KPIs, life cycle boundaries, and operational monitoring.

Note. Charting fields align with the review's pillar framework and focus on implementable implications for venue operations, governance, and reporting. Claim summaries are intentionally conservative and do not substitute for full text extraction