

Measuring Externalities: The Imperative Next Step to Sustainability Assessment in Sport

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A paradox exists between the ways sport organizations evaluate their economic impact, compared with their environmental impact. Although the initial sustainability and corporate social responsibility efforts of sport organizations should be celebrated, it is appropriate to call for the next advancement concerning the assessment and measurement of environmental sustainability efforts in sport organizations. Specifically, there is a need for improved and increased monitoring and measurement of sustainable practices that include negative environmental externalities. To usher this advancement, the authors first reviewed the extant research and current industry practice involving environmental impact reporting in sport. Second, the authors proposed a conceptual framework that expands the scope of environmental assessment to be more comprehensive. As such, this expanded, yet more accurate, assessment of environmental impact can identify specific aspects of the event and the inputs and outputs of the before and after event phases that can be curtailed or modified to reduce environmental impacts of sport events.

Keywords: environmental impact, fan behavior, life cycle assessment, spectators, sport organizations

In the early 2000s, the scientific community reached a consensus on the increased pace and complexity of climate change (Oreskes, 2004). At the time of this writing, the median temperature of the planet has increased over 0.9°C since the preindustrial era, causing ice caps to melt, water levels to rise, biomes to shift geographically, and an increase in the frequency and severity of storm activity (World Meteorological Organization, 2018). In 2015, the Meeting of the Parties 21 (COP21), also dubbed the Paris Climate Conference, was the most recent in a series of intergovernmental meetings, dating back to the 1992 Earth Summit in Rio de Janeiro. Each meeting is dedicated to setting forth actionable goals to mitigate the impact of human activity on the planet. Most recently, in the fall of 2018, the Intergovernmental Panel on Climate Change (IPCC, 2018) released a report on the consequences of climate change (i.e., 1.5°C increase since the preindustrial era), emphasizing the urgency of climate change mitigation and related risk management. COP21 and recent reports like those from the IPCC highlight the urgent need for all parties, from countries and major corporations to local businesses and citizens, to reduce their environmental impacts and contributions to greenhouse gases. Interestingly and encouragingly, 900 corporations have organized to urge the G20 heads of state to honor their commitment to the Paris Climate Agreement (Ceres, 2019). This message from corporate leaders demonstrates a commitment on behalf of these organizations to support the Paris Agreement and work toward solutions to reduce the effects of human activity on the natural environment (i.e., climate change).

The sport sector is not exempt from the responsibility to address environmental sustainability (Sartore-Baldwin, McCullough, & Quatman-Yates, 2017). In fact, the very essence of sport has a bidirectional relationship with the natural environment (i.e., sport

ecology, see McCullough, Orr, & Kellison, in press). This relationship is predicated on the fact that sport is dependent on the natural environment for existence, and the long-term well-being of natural resources relies on sustainable consumption across all industries, including by sport. However, the sport sector, much like other industries, routinely ignores or underestimates its detrimental impact on the natural environment, taking natural resources for granted (Maguire, 1999; Thibault, 2009). The sport sector overconsumes the natural environment through the production and consumption of sport. Fortunately, it has been demonstrated that sport events can implement sustainability initiatives that are not only good for the environment but also for their financial bottom line (Kellison & Mondello, 2014). Moreover, the sport sector has an advantageous position to be a leader in the effort to combat climate change, because of the close affiliation spectators have with their favorite team (Pfahl, 2011). The United Nations created the Sports for Climate Action Framework to leverage the sport sector's social platform and reach to influence sport spectators to adopt sustainable behaviors and achieve the climate goals outlined from COP21 (United Nations, 2019). Although the framework is a notable step in achieving these goals, it is not clear whether signatories will assess the environmental impact of their experiential products (i.e., events; Hirschman & Holbrook, 1982). Acknowledging, assessing, and addressing the environmental impact of an experiential product allows for sport organizations to ensure their organization, individually, and the sport sector, collectively, can make small steps in the larger, and global, issue of climate change. That is, we intend to move the needle in sport with a view of ensuring that our part of the puzzle functions well and supports a sustainable future, not a dangerous one.

Currently, as this article illustrates, the existing methods within the sport sector for measuring and monitoring direct environmental impacts of experiential products fall short of assessing the full scope of impact. As a result, sport practitioners fail to comprehensively assess the environmental impacts of their events, and by extension, cannot effectively monitor and reduce these impacts. To this end, sport practitioners and researchers need ways

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to assess the direct impact of their event through easily attained yet reliable data. Based on the adage “what gets measured, gets managed,” the purpose of this study was twofold. First, we aimed to highlight that the current methods employed within the sport sector for measuring and monitoring the direct environmental impacts of experiential products (i.e., events) fall short of assessing the full scope of impact. Second, we proposed a comprehensive framework and method to assess the direct and indirect environmental impacts of an experiential product. This approach can be universally adopted with data that should be readily available to various types of events in the sport sector and beyond (e.g., live entertainment, meetings, conferences, etc.).

Sport and Environmental Sustainability

Every human activity has an environmental impact, so by logical extension, all sport organizations have an impact on the natural environment (McCullough & Kellison, 2018). Although it may seem futile to address the environmental impact of sport organizations due to their size and scope, these entities should be held responsible for doing their part to reduce their environmental impact (Sartore-Baldwin & McCullough, 2018; Sartore-Baldwin et al., 2017). Some notable sport organizations already proactively mitigate their environmental impacts, engage spectators, and publish sustainability reports; however, these reports offer inconsistent measures of impact and narrow scopes (McCullough, Pfahl, & Nguyen, 2016).

Often, initial sustainability efforts among sport organizations concentrate on waste recovery (i.e., recycling, composting) and energy, and are followed by more invested initiatives like water conservation, mass transportation projects, regeneration and urban renewal, and sustainable architecture and construction efforts (McCullough & Trendafilova, 2018; Trendafilova & McCullough, 2018). For example, sport organizations in the United States have launched sustainability initiatives focused on waste management (e.g., recycling, composting) and facility upgrades (e.g., automated lighting systems, LED lights, insulation) that saved the organizations hundreds of thousands of dollars (Green Sports Alliance, 2012). In Europe, similar environmental efforts have been implemented, with steps taken to educate the public about environmental efforts. Aviva Stadium in Ireland is an example of positive spectator engagement. Event organizers at Aviva Stadium partner with local public transportation providers to raise awareness of the collective carbon emissions of fans’ transportation choices to the venue. This campaign also raises awareness of public transit options to get to the facility (Aviva Stadium, 2019). Other organizations have communicated their team’s environmental policies and progress by providing reports through their website. The Forest Green Rovers Football Club use their website to engage spectators and communicate their environmental policy, report on their performance, and outline current and future projects (Forest Green Rovers, 2019).

Pairing positive examples from the sector with a critical examination of the sector’s progress can allow sport organizations to identify areas that may advance the sport sustainability movement (McCullough et al., 2016). These programs are designed to leverage sport’s social platform to influence sustainable behaviors among spectators, employees, and surrounding community members. The sport sector is commonly touted as an opportune platform through which to engage new market segments (i.e., sport spectators) concerning various social issues (e.g., social and environmental issues; Trail, 2016). Engaging in sustainability initiatives

has been demonstrated to improve the sport organization’s economic and social objectives (Blankenbuehler & Kunz, 2014; Kellison, Trendafilova, & McCullough, 2015; McCullough & Cunningham, 2010). However, the legitimacy and authenticity of these efforts will dictate the successful progression of sustainability efforts in the sport sector (Inoue & Kent, 2012; McCullough, Trendafilova, & Picariello, 2016). That is, the legitimacy of such efforts is predicated on properly and regularly communicating environmental efforts through standardized reporting (e.g., global reporting initiative, The International Standards Organization [ISO]) that is comprehensible and relatable to multiple stakeholder groups (Jose & Lee, 2007; McCullough, 2015). Sport organizations should embrace the basic parameters for environmental reporting and ensure consistency of the scope and analysis therein.

Measuring and Reporting Environmental Impacts

Information on the environmental impacts of business operations is needed. Many tools for measuring the environmental impacts of businesses have been developed (e.g., Finnveden & Moberg, 2005; Ness, Urbel-Piirsalu, Anderberg, & Olsson, 2007), such as environmental impact assessments (EIAs), cost–benefit analysis, and life cycle assessments (LCAs; Curran, 1996). Given the significant public interest in climate change (Burivalova, Butler, & Wilcove, 2018) and the tendency of consumers to value sustainable products and brands regardless of industry (Nielsen, 2018), organizations frequently publish sustainability reports that demonstrate the organization’s sustainability efforts (Ritala, Huotari, Bocken, Albareda, & Puumalainen, 2018). However, the sport sector’s record of sustainability reports does not mirror this response, as conveyed in the depth of commitments among sport organizations (see McCullough & Pelcher, 2018).

It would seem that sport organizations have motives for underestimating their environmental impacts and inflating their economic impacts within the local community. Organizations are primarily motivated by financial interests to ensure public funding for facility construction (Crompton, 2001), improving consumer perceptions of the organization (Walker & Kent, 2009), and leveraging their corporate environmental credentials to achieve those financial ends (Kellison & Mondello, 2014). One way that sport organizations exaggerate reports is by expanding the scope and inflating various multipliers in economic impact analyses, while minimizing their environmental impact by limiting the scope of their environmental impact analyses, thus reporting favorable sustainability outcomes that may not truly reflect the organization’s practice. As previously mentioned, the first purpose of this study was to highlight the limitations of the current methods employed within the sport sector for measuring and monitoring the direct environmental impacts of experiential products (i.e., events). The secondary purpose was to propose a comprehensive framework and method to assess the direct and indirect environmental impacts of an experiential product. This approach can be universally adopted with data that should be readily available to various types of events in the sport sector and beyond (e.g., live entertainment, meetings, conferences, etc.).

Challenge 1: Inconsistent Reporting

In 2018, 86% of Standard and Poors (S&P) 500 companies published corporate sustainability reports (Governance &

Accountability Institute, 2019), up from 20% in 2011. The dramatic increase in sustainability reporting has been attributed to social and political pressure placed on corporations to focus on the triple bottom line (Fernandez-Feijoo, Romero, & Ruiz, 2014; Ritala et al., 2018). Despite this increase in reporting, there is no globally accepted definition of sustainability, nor reporting format. As a result, these documents widely vary from reporting on sustainability efforts (e.g., emissions) to corporate social responsibility programs (e.g., team foundation charitable giving; Dilling, 2010). This is true for event-focused experiential products (e.g., live entertainment, meetings, conferences, etc.).

Several sport events use environmental reporting standards to evaluate and report their organization or event's environmental impact (Nguyen, 2018). These standards include global reporting initiative, ISO 20121 (sustainable event management), BSI 8901, ISO 14001-14006—environmental management, and Council for Responsible Sport (McCullough et al., 2016). These standards vary in some degree, depending on their focus (e.g., events, materials, management), but all can be used as a medium for an increased understanding of the use of resources in the management of sport organizations and the production of sporting events (Nguyen, Trendafilova, & Pfahl, 2014). Sport practitioners have used such reporting standards to validate their events' sustainability efforts (McCullough et al., 2016). Each reporting standard possesses distinct aspects that differentiate them from others, and each standard shares common aspects. However, as yet, not one of these standards has a broad enough scope to fully and comprehensively report the environmental impacts of all production and consumption behaviors related to an event.

Probably the most visible sporting events to utilize environmental reporting are the 2010 Winter Olympic Games in Vancouver, the 2012 Summer Olympic Games in London, and the 2014 FIFA World Cup in Rio de Janeiro. On a smaller scale, sport leagues (e.g., National Hockey League; Welsh Rugby Union), sport organizations (e.g., Forest Green Rovers Football Club), and facilities (e.g., Lord's Cricket Ground) disclose their events' environmental performance through sustainability reports of varying detail. Although the level of commitment and types of initiatives vary, full commitment to reporting and transparency concerning environmental sustainability is the exception, rather than the norm (Mallen, Adams, Stevens, & Thompson, 2010). Ideally, the initial responsibility should fall on federations or leagues to take the lead, but practical examples demonstrate that individual events are taking charge in sharing this responsibility (Sartore-Baldwin & McCullough, 2018). Evidently, sport organizations need clearer directions to make the business case for sustainability, strategize their initiatives, and engage their stakeholders (McCullough et al., 2016).

Challenge 2: Narrow Scope of Assessment: Lessons From Economic Reports

Sport organizations, in general, take a very broad perspective or scope when examining the economic impact of the organization, facility, or event (for a review see Crompton, 1995). For example, economic impact assessments are conducted before the construction of a new sport facility. In such reports, data are analyzed and interpreted in an inflated way to provide a skewed view of the largest financial benefit for the defined community within the parameters of the study. These inflated figures are used to influence voters to pass referendums authorizing the use of public funds for construction (Coates & Humphreys, 2003; Crompton, 2006;

Kellison & Kim, 2014; Siegfried & Zambalist, 2000). Conversely, although there are exceptions (i.e., FIFA World Cup 2014, UEFA Euro 2012, London Olympic 2012, Lord's Cricket Grounds), the scope narrows drastically when EIAs are conducted. One rationale for this is the difficulty for the sport organization to control the environmental impact of sport spectators when they are not within the stadium (United Nations Environment Programme, 2009) and the difficulty to collect these data, whether by academics (Collins, Jones, & Munday, 2009) or practitioners (National Hockey League, 2014).

Despite these challenges, the narrow scope of the EIAs minimizes the perceived overall impacts of the event on the local community and the surrounding natural environment. This is especially true for legally mandated EIAs before a facility is constructed. These EIAs typically limit their scope to the environmental impact of the construction and use of that specific site. Rarely do these EIAs include increased detrimental impacts on the surrounding environment because of attendee behaviors (e.g., transportation; Porteshawver, 2009, 2010, 2018). The unaccounted environmental impacts, such as these, are commonly referred to as *environmental externalities* (Chava, 2014). Following the economic concept of externalities, environmental externalities are “the uncompensated environmental effects of production and consumption that affect consumer utility and enterprise cost outside the market mechanism” (United Nations, 1997, p. 29). That is, the indirect or unclear environmental impacts of a sport event and their fans or attendees that are currently unrecognized or unidentified are environmental externalities. In contrast, economic externalities are often highlighted by sport organizations and events. In fact, economic impact assessments do account for the economic benefits of many of the activities resulting from economic externalities. For example, the Welsh Rugby Union included direct and indirect impacts when calculating the economic impact of events hosted in Millennium Stadium. The organization's 2015 economic impact report states that a “majority of the *economic impact* on Wales resulting from Stadium operation comes from offsite visitor spending, in bars, restaurants and hotels for example” [emphasis original from source] (Millennium Stadium, 2016, p. 16). Conversely, environmental impact information provided on the team's website does not include the environmental impacts of activities outside of the scope of Millennium Stadium (i.e., inputs and outputs of the before and after event phases). Thus, the environmental impacts of offsite activities, which are included in their economic impact reports, are not mentioned in environmental impact reports. Although we do not contend that the Welsh Rugby Union intentionally used different parameters when determining their economic and environmental impacts, the difference in the scope of the reports demonstrates the paradox in practice. Moreover, sport organizations (i.e., ski resorts) have been shown to create their own subjective environmental metrics that result in desirable outcomes for environmental reports (Mallen, Chard, & Sime, 2013). One way to avoid this issue is to encourage sport organizations to use standardized environmental reporting (e.g., Global Reporting Initiative).

The sporting event and the inputs and outputs of the before and after event phases surrounding the event have a substantial impact on the natural environment (see Collins & Flynn, 2008). For instance, the office activities and staff and athlete travel are often not included in EIAs, as these take place before the event begins, and thus, are not counted in the event's overall environmental impact despite being directly related to its production. On the consumption side, it is important to note that, as yet, EIAs conducted by sport teams, leagues, and federations commonly do not

include the environmental impacts of spectators before and after the event (e.g., transportation, tailgating, traffic). That is, the environmental impacts of tourist activities related to the sporting event are not taken into account, including the increased patronage of hotels, restaurants, and bars/pubs; the impact of non-ticket-holder spectators who converge on the surrounding community because of the event; merchandise and apparel purchases; and so on. However, initial steps have been made, as mentioned above, to better measure and report the environmental impact of events.

Attending sporting events, whether megaevents or recurrent events, spur behaviors and economic activities different from everyday behaviors. However, though misrepresented in existing assessment models, the environmental impacts of attending a sport event extend beyond the venue and include the environmental impact of every behavior, from when they leave their residence for the event until they return after attending the game. Thus, fans' game day behaviors cannot be considered isolated events (e.g., simply attending the event), but should be comprised of all the inputs and outputs of the before and after event phases associated with attending the game, all of which result in additional environmental impacts (Haun, Glassman, Dodd, & Young, 2007). As a result, further attention should be given to understanding the variety of sport spectators' game day behaviors to address the broader environmental impact of the inputs and outputs of the before and after event phases surrounding a sporting event that are commonly not accounted for (i.e., externalities) in environmental sustainability assessments in conjunction with the environmental impact of the event itself.

By understanding the fan game day behaviors, sport practitioners can concentrate their sustainability initiatives on further reducing the impact of inputs and outputs of the before and after event phases associated with attending an event that may go unaccounted for but that have an adverse effect on the surrounding community (i.e., environment). For instance, environmental justice issues can be overlooked or deemphasized by sport organizations and venues that do not broaden the scope of their EIAs (e.g., increased auto emissions, displacement). Furthermore, sport facilities are commonly built in lower socioeconomic areas of the city, causing the city's poor communities to be exposed to the environmental impact of construction, operations, and demolition of facilities more than other areas of the city (Sze, 2009). Beyond sport, it is not uncommon for lower socioeconomic populations and neighborhoods to be disproportionately affected by environmental degradation (e.g., air pollution; Walker, 2012). If focus is only given to the environmental impact of the facility or event itself, then the extent to which this population is affected is minimized, at best, or ignored, at worst.

Life Cycle Assessment: An Inroad for Comprehensive Measurement

It is generally agreed that a large share of the environmental impacts of any given product is made not during the use of the product, but rather in its production and disposal. The notion that all environmental burdens of a product, from raw materials to waste, must be considered in environmental impact analyses to glean a view of overall impact implies that all inputs and outputs must be balanced and the impacts minimized or mitigated. Thus, in the 1960s and 1970s, LCA tools were developed to assess the potential environmental impacts of a product's full life cycle, that is, from raw material acquisition, through manufacturing or production, through use phases, to waste management (Dolf &

Teehan, 2015; Finnveden et al., 2009; International Standard Organisation, 2006). In the 1990s and 2000s, LCA tools were refined and standardized, as evidenced by the number of Society of Environmental Toxicology and Chemistry workshops that were held to advance LCA, and methodological guides were published to formalize the method (Guinée et al., 2011), including articles in *Environmental Science & Technology*, *the Journal of Cleaner Production*, and *the International Journal of LCA*. The ISO became involved in formalizing methods for LCA in 1994, and governments began including LCA in policy and legislative documents shortly thereafter (Guinée et al., 2011). Since the 1990s, LCA has been successfully implemented as a method to measure the environmental impacts of agricultural products (e.g., Roy et al., 2009), automobiles (e.g., Dufflou, De Moor, Verpoest, & Dewulf, 2009; Spielman & Althouse, 2007), and construction materials (e.g., Bribián, Capilla, & Usón, 2011; Puettmann & Wilson, 2007), to name a few. The method has also been successfully applied to experiential products, such as tourism (e.g., Filimonau, Dickinson, & Robbins, 2014; Kozak & Martin, 2012). Regardless of the context, and despite the inconsistencies in the scope of measurement (i.e., where the life cycle starts and stops, and the level of detail), LCA has allowed researchers and practitioners to extend environmental impact measures beyond the use phase of a product.

Sport organizations have used LCA to measure the impact of events, such as the Rio Olympics (Quantis, 2016), and the annual operations of a popular ski and conservation area in the Swiss Alps (Quantis, 2011). Engineers have studied the environmental impacts of sport product production, such as tennis rackets (Subic & Paterson, 2006) and turfgrass (Walker, 2007). Recently, Dolf and Teehan (2015) introduced LCA to the academic discipline of sport management in a study of the environmental impacts of a University of British Columbia sport event. In each case, the research has borne out the notion that the environmental impacts of products eclipse the use phase, validating the importance of analyzing impact at each stage of the product life cycle. Many software programs (e.g., Quantis, Ecoscan, OpenLCA) and private consulting firms (e.g., Intertek, Blonk Consultants) have emerged to support LCA efforts, including some that offer services to sport events. Furthermore, universities have begun offering courses on LCA methods. As such, there is a growing availability of resources for learning and implementing LCA, making the method more accessible to sport scholars. Given the success of LCA in other domains and the early successes in sport, this method presents a unique opportunity to extend environmental assessments of sport events beyond game time measures, to include the inputs and outputs of the before and after event phases.

It is important to highlight that sporting goods and sport events are distinctly different. Experiential products, like sports events, have poorly defined lifecycles compared with consumer goods such as a basketball or tennis racquet, which have initial materials, manufacturing processes, transport, sale, use, and disposal stages that can be neatly traced. As a result, applications of LCA at sport events are complicated and can be difficult to replicate. Thus, we propose that sport event LCAs ought to include both consumption (ticket buyer, attendee, and participant) and production (event organization and venue operations) impacts, in terms of both direct impacts and externalities of each. It is our intention to advance the utility and understanding of such tools in the sport sector while broadening the scope of environmental assessments in the sector. This framework is illustrated in Figure 1. It is also vital to note that the categories presented in Figure 1 are a starting point for developing an environmental LCA

for sporting events, as not all categories are mutually exclusive (e.g., because employees need transportation to and from an event, the staffing and staff impacts could overlap with the transport to/from event), nor are they all-encompassing (e.g., tracking hotel stays may not include all the attendees who stay in accommodations during an event).

Direct Impacts

To provide a more comprehensive assessment of the environmental impact of sporting events following the direct and external environmental impacts (DeEI) framework, the first stage of the analysis begins by conducting an LCA on the direct impacts from the event. As highlighted in Figure 1, the direct impacts consider the production side of the event, including venue operations, event planning, event production, and staffing and staff impact, as well as the consumption side, containing factors such as ticket purchases, transportation to and from the event, and on-site purchases. It is important to note that Figure 1 is not a complete list of factors that need to be considered in terms of direct impacts in the LCA, as other aspects of event production and consumption could impact the environment, such as the design and construction of venues (Kellison & Hong, 2015). From this, the list of factors that are analyzed in the direct impacts LCA should be as comprehensive as possible, as not only will it provide an accurate assessment of the impact that comes from sporting events, but also is utilized in the second stage of the analysis to consider the impact from externalities related to the event.

After identifying all factors from the event with direct impacts on the environment, the next step in the LCA process would be to determine the type of impacts that exist for each factor and the ways in which to measure them. For example, in considering venue operations, many studies have typically focused on estimating the carbon footprint of hosting events (Collins & Flynn, 2008; Collins et al., 2009; Dolf & Teehan, 2015) with notable exceptions (Wicker, 2018, 2019). Although this can provide information regarding the amount of carbon dioxide and carbon-related compounds that are emitted from hosting an event, this type of accounting system falls short in many aspects. As such, for the direct impacts LCA, there is a need to consider two potential sources of errors in developing a comprehensive measure of impact. To begin with, as previously mentioned, most studies tend to focus on a single measure of pollution, with carbon footprint studies being the most commonly conducted research

on environmental emissions. Although these studies do provide value in measuring carbon dioxide production, they do not consider that there are other types of gaseous emissions or air pollution that can be generated from an event, including ozone, particulate matter (pm 2.5 and pm 10), sulfur dioxide, and nitrogen dioxide (Watanabe, Yan, Soebbing, & Fu, 2019). Considering this a step further, even studies that do account for the increases in emissions of various types of pollutants during sporting events (Locke, 2019) tend to focus on a single category, such as air pollution. Overall, this means that much of the analysis is one dimensional and ignores aspects such as the generation of waste, water consumption, land use, and other facets of the environment that deserve consideration. Thus, to build a comprehensive analysis of the ways in which a sporting event impacts the environment, direct impact studies need to be all-encompassing, rather than focusing just on single categories or types of pollution/emissions.

The second potential error in measuring the direct impact of sport on the environment comes in the accuracy of the data and the level of measurement used in the research. For example, in estimating the carbon footprint, there is an inconsistency between organizations and researchers in regard to how to estimate the impact and the granularity at which the impact of an event should be considered. Notably, where many studies simply will utilize the number of visitors to sport events to estimate the carbon footprint (Wicker, 2019), organizations such as Quantis have used highly granular data sets that not only consider that each specific part of a stadium may have a different carbon footprint, but that the carbon dioxide emissions can vary between the use of new, refurbished, or temporary bleachers in a stadium (Quantis, 2016). In this manner, the more detailed a study can be in measuring impacts, the better an understanding can be provided in regard to the overall environmental impact of sport events. Furthermore, having a highly detailed and accurate first stage is important in the proposed DeEI framework, as the measurements from the first stage of direct impacts are used in measuring the impact of externalities on the environment.

Externalities

Next, turning to the second stage of the DeEI sport events framework, the analysis considers externalities, such as those presented in the lower two boxes of Figure 1. To measure the impact from externalities, we borrowed the approach used in economic impact studies to isolate and estimate the net change in an indicator that is attributed to a sporting event (Coates & Humphreys, 2002, 2003). For the case of the DeEI framework, rather than focusing on net change in economic measures, such as tax revenue or employment rates, we instead concentrated on environmental indicators. To date, few studies have attempted such an approach, with Locke’s (2019) examination of the impact of Major League Baseball attendance on pollution levels being the rare exception. In Locke’s (2019) study, the results found that the number of individuals visiting professional baseball games did cause an increase in various forms of air pollution. As such, there is a clear need to further develop such analyses to estimate how externalities can affect the environment and thus account for the overall environmental impact.

Turning attention to production-side externalities, this grouping can include all factors within the supply chain that is expected of a sporting event. First focusing on the impacts of suppliers and sponsors, there are numerous ways in which the environment

	Production	Consumption
Direct impacts	Venue operations Event planning Event production Staffing and staff impacts	Ticket purchase Transportation to/from event On-site purchases Tailgating activities
Externalities	Impacts of suppliers Impacts of sponsors Impacts of host city Hosting activities, off-site	Restaurant meals off-site Hotel stays Out-of-town transport Purchases off-site

Figure 1 — The direct and external environmental impacts of sport events framework.

could be affected by hosting a sporting event. A good example of this is considering food production for the event. In their study of the 2016 Olympic Games, Quantis identified the amounts of different types of meat that were consumed by attendees at the Olympics and then used the different carbon footprints of raising each type of animal to estimate the environmental impact of meat consumption at the Rio Games. Considering a step further, beyond just estimating the carbon footprint of raising the animals, a comprehensive analysis should also consider the net change in emissions of other gases, such as methane; the consumption of water and other natural resources to raise the animals; the creation of animal waste; the processing of the animals into food; and the subsequent transportation to the event.

Similar to the externalities of event production, the consumption-side externalities also require detailed accounting beyond simply rough estimates based on the number of attendees or visitors at sporting events. For example, large and megaevents typically attract out-of-town tourists, resulting in a higher number of hotel stays than usual. Following studies on economic impact, the higher number of hotel stays can only be partially attributed to the event, as the hotels also attract other visitors to the area, such as business guests or tourists staying for other reasons (Humphreys & Prokopowicz, 2007). As such, in conducting the LCA on externalities, we would not use the total number of visitors, as some studies have done (Crompton, 1995), but rather, estimate the number of hotel nights of guests through surveying event attendees and participants regarding the travel distance and reason for visiting the city. From this, we can then calculate the change in the carbon

footprint of those hotel nights using the average carbon cost of each room, as well as attempt to measure changes in other environmental measures, such as water use, energy consumption, and waste production, which could be attributed to increased numbers of visitors to hotels. The aforementioned examples serve as an illustration of some of the externalities associated with the coproduction of a sporting event. Additional areas for consideration are provided in Table 1.

Aggregated Measurement

The final part of the DeEI framework is to combine the measurements from the direct and external impacts to provide an aggregated measurement of the environmental impact of sporting events. From this, the DeEI framework allows for a better accounting of pollutants, waste, energy consumption, and other inputs and outputs of the before and after event phases that can impact the environment, and thus represents an important advance in developing a comprehensive picture of the effect of sport on the environment. Finally, the last important factor that needs to be noted is that the scope of analysis for the DeEI framework will change based on the type of sporting event that is being measured. For small-scale events, such as high school basketball games, the impacts for the game will mostly be limited to a local or regional level. However, for the FIFA World Cup, because air travel to megaevents by spectators and participants is a large part of the carbon footprint of these megaevents, studies should be considering national and international impacts on the environment

Table 1 Possible Items for Consideration in a Direct and External Environmental Impacts Assessment

Impact	Item
Direct	
Production	<ul style="list-style-type: none"> • Venue energy use (during setup, event time, and teardown) • Venue water use (during setup, event time, and teardown) • Venue waste output (during setup, event time, and teardown) • Staff and team travel • Staff and team accommodations • Office energy use • Office water use • Office waste output
Consumption	<ul style="list-style-type: none"> • Local transport to-and-fro venue • On-site purchases (merchandise and food/beverages) • Venue energy use of consumers • Venue water use of consumers • Venue waste output of consumers • Carbon footprint of tailgating activities • Waste output of tailgating activities
Externalities	
Production	<ul style="list-style-type: none"> • Auxiliary facilities (e.g., practice facility, media center, festival and tailgating areas) energy use • Auxiliary facilities (e.g., practice facility, media center, festival and tailgating areas) water use • Auxiliary facilities (e.g., practice facility, media center, festival and tailgating areas) waste output • Energy use of sponsors, media, and vendors • Water use of sponsors, media, and vendors • Waste of sponsors, media, and vendors • Transport emissions of sponsors, media, and vendors • Accommodation footprint of sponsors, media, and vendors • Restaurant meals of sponsors, media, and vendors
Consumption	<ul style="list-style-type: none"> • Out-of-town travel by consumers • Accommodation footprint of consumers • Emissions related to tourism activities (e.g., sightseeing) by consumers • Carbon footprint of restaurant meals/drinks by consumers • Waste of restaurant meals/drinks by consumers

(e.g., [Otto & Heath, 2009](#)). To reduce inconsistencies, the aggregated measure should clearly state and consistently apply the same geographic scope of analysis.

Discussion

This study identified two major challenges related to EIA and reporting in the sport sector: inconsistency and lack of scope. In response, we proposed the use of LCAs, to provide consistency, and the DeEI framework to broaden the scope of assessment specifically in relation to sport events. It is important that sport practitioners consider the complete environmental impact of the economic activities related to their respective events. Specifically, the DeEI encourages a paradigm shift in the ways that sport practitioners (and perhaps academic researchers) view and assess the environmental impact of their events—production and consumption of direct impacts and externalities. A predominance of previous perspectives, as we mentioned above, examine the environmental impact of the activities within the event or facility itself or small stand-alone aspects of the environmental impact of activities surrounding an event (i.e., fan and team travel/transportation). The necessity of a more thorough examination is not to shame or cynically review the environmental performance or inaction of the sport sector as a whole. Rather, this comprehensive view allows sport practitioners to identify high impact areas and address them to reduce their event's impact and to better engage and educate sport spectators. Sport practitioners can identify areas of environmental externalities to increase organizational performance and efficiency ([Eccles, Ioannou, & Serafeim, 2014](#)). Sport practitioners can also share the responsibility for the environmental impacts surrounding their events by identifying such impacts of the attendees' behaviors and creating fan engagement campaigns to encourage more sustainable options and reduce the environmental impact of the economic activity related to the sporting event.

Although this framework and method advance the research into sport ecology, it is acknowledged that it is nearly impossible to provide a perfect accounting of factors and manners in which sport can impact the environment. As such, one question that arises is what level of detail is necessary for measuring environmental impacts, especially for externalities. For example, if we were to measure beef consumption and its production of pollution and use of natural resources, what would be an acceptable standard of measurement? For some, it simply could be using third-party determinations (e.g., see [Center for Sustainable Systems, 2018](#)) and then using this to estimate the carbon footprint of beef consumption from an event. However, a more nuanced analysis may use data from the event to measure how much beef was ordered, and then consider whether the beef was produced domestically or was imported, and then try to provide a precise estimate of the environmental impact of producing and consuming beef at the event. Although the second method is likely more precise and accurate, it must be recognized that there is restricted access to such granular level data, and thus, the results produced from any analysis of the impact of sport on the environment will not provide a complete picture. Regardless of the level of specificity, a step toward broadening the scope of LCAs and adopting the practice of conducting regular LCAs to monitor the progress of sustainability efforts is a step in the right direction.

One example of a possible next step is for sport events to highlight the interrelation between game day behaviors (e.g., eating red meat, transportation, alcohol consumption) and how they are

related to health implications and environmental impacts, a recent focus highlighted by the [Forest Green Rovers \(2019\)](#). A promising avenue is the advent of mobile apps and websites that evaluate environmental impacts of certain sport spectator behaviors, like the UEFA EURO 2016 ecocalculator (see <https://en-ecocalculator.uefa.com>).

Financially, examining spectators' economic activity when attending an event can facilitate a better understanding of sport spectator prematch and postmatch behaviors. Although sport event organizers know a great deal about their customers, these data are used for commercial and economic purposes through app data mining ([Mooney, 2014](#)). Data can also be used to track and evaluate trends in spectators' environmental impacts outside of the sport facility. For example, the 2016 Summer Olympics in Rio introduced a Green Passport mobile application that educated spectators about their environmental impact and provided comprehensive data to event organizers about the environmental impact of spectators' inputs and outputs of their before and after event experiences associated with their attendance at the Olympic Games ([Castro & Burle, 2015](#)). Geolocation data from similar mobile apps provide a deeper understanding of human behavior ([Furini & Tamanini, 2015](#)). Such data can inform the development of more effective sustainability campaigns and community outreach programs that resonate with stakeholder groups that can mitigate these impacts.

Sport events invest considerable amounts of financial and human resources into sustainability initiatives that engage spectators before and during an event ([Trail, 2016](#)). Proactive sport events have done well to integrate environmental sustainability within their organizations or leagues (e.g., English Premier League, National Hockey League), whereas others have yet to make such commitments ([Trendafilova et al., 2014](#)). In this case, non-compliant or reactive events need to initiate or expand their sustainability campaigns and integrate them deeper within the organization's strategic plan ([Pfahl, 2011](#)). Although the messaging and interventions may be well intentioned, these messages may minimize the problems associated with the environmental impact from the event ([Walker, 2012](#)).

At the same time, it needs to be acknowledged that corporate practices and priorities are often at odds with environmentally sustainable practices; thus internal and external pressures may present pressures for businesses to develop standards that are counterproductive to financial goals ([Inoue & Kent, 2012](#)). Furthermore, if sport organizations do conduct such analyses and discover that their environmental impact is severely negative, they may be less likely to report. As such, although it is important to have buy-in from sport organizations, there likely also needs to be other parties involved in the process of measuring and reporting environmental impacts from sporting events. Notably, such groups could be governmental organizations or even watchdog groups operated by the public and academics to hold sport organizations accountable or to verify current business practices. However, it is critical that those who have oversight of the measurement and reporting of environmental impacts be those without conflicts of interest, as even governmental organizations may not be interested in such impacts if they run counter to the political and economic focus of the nation ([Tilt & Xiao, 2010](#); [Watanabe et al., 2019](#)). Accordingly, although the ideal scenario would have sport organizations participating in the reliable measurement and reporting of environmental impacts, there is certainly a need for outside parties to participate in the process, either in conjunction with organizations or parallel to them. Specifically, the involvement of critical

scholars could represent one such group that could improve the assessment of environmental impacts related to hosting sporting events.

Conclusion

This study identified that environmental externalities are unaccounted for in EIAs, yet are included in economic impact assessments. More social pressure is needed to advance the sustainability movement within sport (McCullough & Cunningham, 2010; McCullough et al., 2016). For example, Healthy Stadia and similar organizations (e.g., BASIS, Green Sports Alliance) should encourage sport events to expand their environmental reporting efforts. As discussed, there are several examples of major sporting events (e.g., FIFA World Cup 2014, Lord's Cricket Grounds) tracking and reporting their environmental impacts. The next progressive advance in EIA would include using the same scope to determine the environmental inputs and outputs of the before and after event phases (McCullough et al., 2016). Furthermore, this assessment should include the environmental impact of all economic activity related to spectators attending an event. At the organizational level, reports would allow sport practitioners to identify and devise plans to reduce the environmental impact of their sporting event. At the individual level, publicly available environmental reports that identify the environmental impacts of attendance will help sport spectators choose alternative actions that reduce their environmental impact. As a result, adverse effects on the natural environment can be reduced, and environmental reporting can serve as an accountability measure for experiential products in the sport sector.

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