Circular Economy and Sustainability (2022) 2:1267–1277
https://doi.org/10.1007/s43615-021-00115-z

ORIGINAL PAPER

Reimagining Sustainable Community Sports Fields of the Future: a Framework for Convergent Science-Stakeholder Decision-Making

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Received: 3 February 2021 / Accepted: 17 September 2021 / Published online: 6 October 2021

Abstract
Community-level sports fields are public spaces that provide numerous physical, mental, and societal benefits. These fields are often governed, constructed, managed, and used by various interacting groups who have different value systems and preferences that impact their decisions. While sports fields offer an opportunity for community engagement and physical activity to residents of communities, poor field quality or lack of access from misinformed decisions can increase health issues and decrease physical activity participation, especially among youth. That is in addition to decisions made regarding water and energy resources required to maintain these fields. Those who have decision-making authority should consider input from the entire community and other relevant stakeholders; however, there is a lack of convergence and breakdown in communication among stakeholders' needs and priorities. Additionally, decision-makers often lack effective tools and proper knowledge to select and manage fields to meet demand in a sustainable and just manner. The objective of this white paper is to propose an innovative framework for research that could lead to the development of a common platform for multi-stakeholder dialogue about issues related to improving the social, economic, and environmental sustainability of community-level sports fields. The framework can be implemented by innovatively bringing together physical and social scientists to (1) map and assemble pertinent stakeholders and visualize the stakeholder network, (2) measure leverage points within the stakeholder network that optimize sustainable and inclusive communication and decision-making, (3) identify perspectives surrounding decisions at the community level (through prioritizing different social, economic, and environmental

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indicators, with particular focus on health outcomes), and (4) develop a decision support tool to evaluate the trade-offs associated with different options. Subsequently, findings should promote and catalyze dialogue between diverse stakeholders to assist with making the complex decisions for these important public spaces.

Keywords Convergence · Network analysis · Sports fields · Stakeholder engagement · Turfgrass

Introduction

In the USA, approximately 24.4 million children ages 6–12 and 7.9 million high school students participated in sports during 2018–2019 [1, 2]. While the primary reason youth choose to play sports is to "have fun" [3], youth sport participants also benefit physically, mentally, and socially. For example, sport participation and physical activity reduce health risks (e.g., heart disease, diabetes, obesity) [4], boost youth participants emotional health (e.g., self-esteem, reduce stress levels) [5, 6], and enhance social skills (e.g., sportsmanship, teamwork, problem solving) [3, 5]. Conversely, sport participation and physical activity reduce chances of risky behavior (e.g., smoking, drug use, vandalism) [7, 8]. Community socialization through sport also increases a sense of bond and pride, job and volunteer possibilities, and economic potential [9, 10]. However, these benefits predominately impact higher socioeconomic and Caucasian neighborhoods [11], so it is necessary to ensure they are extended to all in the community.

Despite the benefits of sport participation, there are potential negative consequences, primarily injury risk. Sustaining a sports-related injury as a youth can be expensive for parents, but it can also lead to growth and development disturbances (physical and psychological) that can carry on through adulthood [12, 13]. There is consistent evidence that the strongest predictor of future injuries is previous injury [14]; therefore, actual injury or fear of subsequent injury may ultimately lead to a decline in youth sport and physical activity participation [15, 16]. As a result, youth sport governing bodies have a responsibility to mitigate injuries by identifying, evaluating, and controlling injury risks [17]. One of the risk factors contributing to youth sports injuries is hazardous sports field conditions [18, 19]. The field is an essential component of sports and there are two primary types: natural turfgrass and artificial turf. Natural turfgrass fields generally consist of soil and turfgrass, whereas artificial turf fields generally consist of a gravel layer, shockpad, carpet with woven synthetic fibers, and infill (i.e., rubber granules and/or sand). There has been an abundance of research investigating athlete injuries, as well as biomechanics and perceptions/preferences, between the two surfaces at the collegiate and professional levels to guide field selection and management decisions; however, very little work has been done with youth at the community level [20].

While injury prevention should be a top consideration at any level for selecting one sports field type over the other, there are likely additional considerations to be made at the community level. The rise in population and sheer participation rates have created high demand for community-level sports fields, not only for youth sports, but also for hosting other events (e.g., classes, county fairs, charity events). This increased demand potentially limits minority groups' access to sport and physical activity [21]. Limited availability and access also benefit higher socioeconomic youth [22], which can lead to decreased participation and adverse health outcomes for their counterparts [23]. Additionally, more events cause rapid decline in field quality, notably for turfgrass fields. Resource and labor shortages at the community level inhibit proper management if turfgrass fields are not given recovery time [24]. In order to meet

demand, a trend over the past decade has been to convert natural turfgrass fields to artificial turf. Since there has been minimal research between the two surfaces at the community level related to field safety, these types of decisions are often made with little-to-no unbiased facts.

Economically, the overall, long-term costs and return on investment of the two surfaces has been widely debated and is situational. Installation of a new natural turfgrass football field can range from $100,000 to $500,000 depending on grass species, soil type, and drainage, while installation of a new artificial turf football field can range from $750,000 to $1,000,000 (personal communication). Although installation is significantly less expensive for natural turfgrass than artificial turf, the annual cost for routine maintenance of natural turfgrass (e.g., mowing, irrigation, painting) generally exceeds the cost of artificial turf maintenance (e.g., grooming, disinfecting, carpet repair) [24]. The primary advantage of artificial turf over natural turfgrass is durability, so its biggest return on investment is likely the potential to schedule more events year-round. Regardless, the lifespan of an artificial field is generally 8–10 years, so complete disposal and installation of new artificial turf is eventually needed, while turfgrass can likely go much longer without a complete renovation if properly managed.

Each field type can also have an impact on the environment. The transportation, installation, and disposal of materials for both types emit harmful greenhouse gasses [25]. Natural turfgrass is a living organism that requires several management inputs to maintain quality, such as water, fertilizer, and pesticides. The use of these inputs, and the potential added effect of mismanaging them, can lead to depletion of natural resources, pollution of nearby water sources, and increases in greenhouse gas emissions (e.g., nitrous oxide) [24, 26]. Conversely, environmental benefits of natural turfgrass are that it can sequester atmospheric carbon dioxide, reduce surface temperatures through transpiration, trap and biodegrade certain airborne pollutants and dust, and help control soil erosion [27]. It supports insects and worms that are fed on by animals too.

Artificial turf is not a living organism, so it does not transpire, and the inability to do so leads to elevated surface temperatures. Increased temperatures subject athletes to several heat-related illnesses and can potentially reduce field use times when surface temperatures exceed certain thresholds [28, 29]. The crumb rubber infill of artificial turf contains organic contaminants and heavy metals that can runoff and/or leach into water sources or volatize into the air [25]. Furthermore, disposal of many artificial turf field components cannot be recycled or degraded [25]. As population increases, so should overall youth sports participation, and subsequently the total number of community sports fields. Thus, it is important that we better recognize and address the totality of environmental impacts that these fields have, so that the effects from field construction and management at the community level are reduced [26].

Knowledge Gaps and Pressing Societal Need

While access to and use of community sports fields have the potential to promote health and wellbeing across communities, competing priorities and ineffective communication networks among stakeholders can result in mismanagement of these public spaces and limited access to specific vulnerable populations. Decision-makers (e.g., government, school boards, social groups, individuals) at thousands of parks and recreation and K-12 facilities across the USA currently lack effective tools to properly manage large-scale projects to (re)design these public spaces of the future, while meeting the demands of the entire community in a sustainable and just manner. Several studies support the notion that decision and policy makers need a

framework by which to fully understand trade-offs and conflicts relative to their decisions [30, 31]. More specifically, there is a call for increased understanding and analysis of the interactions between sectors, stakeholders, and community members relative to decision-making in communities [31–33]. While studies have explored the structure and behavior of stakeholder communication networks before (e.g., [32, 34, 35]), there is a dearth of literature on the structure and behavior of stakeholder networks relative to sport field selection, management, and resulting health and wellbeing outcomes. Thus, based on this prior work, we propose a need to implement a similar approach, complete with an analysis of stakeholder networks and a merging of multiple disciplines, that would ultimately inform effective decision-making and inclusion of diverse community members in decisions at the community level.

Need for Deep Integration of Disciplines

Multiple disciplinary perspectives are necessary to fully integrate and evaluate the dynamic relationships required for effective sustainable and inclusive selection and management of community sports fields (Figure 1). It is suggested that scientists with diverse research backgrounds, yet with mutual research interests, collaborate to address and promote sustainable development (i.e., social, environmental, and economic) of these public spaces within communities. This may include, but is not limited to the following:

Health Safety and accessibility of sports fields affect the health and well-being of individuals and communities. Sports field availability and use could yield more physical activity, which results in physically and mentally healthier populations. Therefore, it is important to take a scientific approach in understanding what type of field optimizes activity and limits injury (e.g., natural turfgrass versus artificial turf), as well as how to create health equity through sports field use.

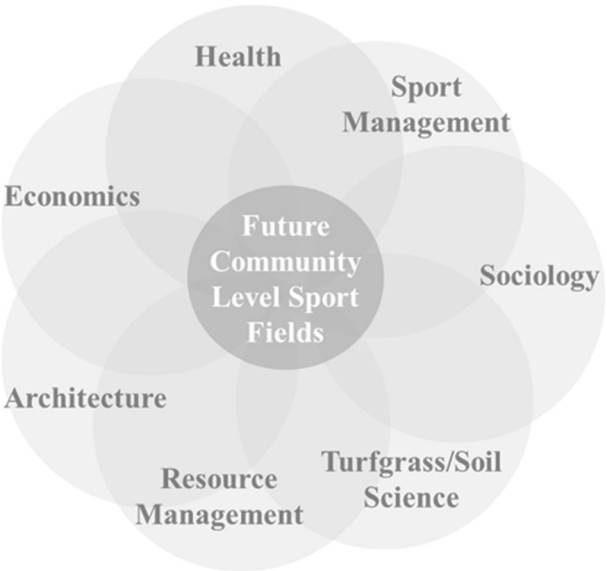

Fig. 1 Potential deep integration of disciplines for sustainable community level sports fields of the future

Sociology Through community-based participatory research, a team of researchers and community stakeholders work together to identify pressing community needs and create an equitable, community-informed solution to meet community needs, improving community capacity in the process. Further, social network analysis could examine ways in which structures of groups and organizations interact within different contexts and identify key leverage points within communities to optimize health, equity, and accessibility.

Sport Management Sport for development and peace (SDP) has become an integral part of the broader sport management academic discipline [36]. Sport for development researchers seeks to leverage the United Nations Sustainable Development Goals in and through sport. Specifically, good health and well-being (SDG 3), reduced inequalities (SDG 10), sustainable cities and communities (SDG 11), and peace, justice and strong institutions (SDG 16), all of which are applicable to the following proposed framework. Community-based sport organizations especially ought to remove barriers to mass sport participation to improve the community's health and well-being [37]. Our research provides a framework in this area to create a process to identify and eliminate bureaucratic barriers and decision-making blind spots that prevent mass participation within our own local communities but relies heavily on other content areas and experts to fully empower the practical and theoretical implications from health, turfgrass, among others.

Turfgrass and Soil Science Further research in turfgrass science (which includes artificial turf) is needed to improve the design and construction of natural turfgrass and artificial turf sports field surfaces to meet the demand and expectations of a community. For example, this may include breeding efforts for more wear tolerant turfgrasses with high recovery rates or testing of infill materials that reduce artificial turf surface heat. Stakeholders should be educated on the resources (e.g., labor, equipment, infrastructure) needed to implement best management practices (e.g., proper application of irrigation, fertilizers, pesticides) to reduce any negative environmental, health, and social impacts of managing a given field type, while also increasing field playability.

Resource Management Better allocation of human, natural, and capital resources and understanding of financial boundaries to operate within to develop scenarios that are feasible to implement.

Architecture Development of designs that would be socially engaging, while remaining in harmony with the surrounding environment and space.

It is particularly important to involve researchers who may have an extensive network to access and engage diverse stakeholder groups necessary for robust data to inform the resulting decision model of the proposed framework (e.g., a turfgrass extension specialist who regularly communicates with turfgrass professionals and the general public about sports fields and facilities) and to capitalize on how these various research areas overlap.

Proposed Convergence Framework

The aim of the proposed framework is to develop a better understanding of the current decision-making processes that surround selecting and maintaining community sports fields,

as they relate to sustainable management and inclusion goals. As is the case in former research [30, 34], our framework will integrate disciplines and methodologies in order to grasp sports field selection and management from multiple socioecological levels. To accomplish this, we propose a framework that uses social network analysis, stakeholder mapping, surveys, focus groups, and workshops, all of which are ways to understand community-level problems across disciplines, to investigate the structure and interactions present within the stakeholder network, as well as convergence between and among decision-makers and stakeholders concerning the use of these public recreational spaces. In doing so, it can identify leverage points within stakeholder networks that prioritize sustainable and inclusive practices related to sports field construction and management, especially among vulnerable and underserved populations, and develop a data-informed strategy/tool to optimize stakeholder communication and decision-making now and in the future.

Addressing such complex and interconnected questions requires the adoption of a participatory approach with different disciplinary experts and stakeholders. This allows for the identification of the scenarios to be considered, as well as the appropriate metrics needed to evaluate the trade-offs between those scenarios. Figure 2 provides a conceptual representation of a decision support tool which would be used to evaluate multiple scenarios being considered, including those related to the types of playing surfaces, water sources, and energy sources. The sustainability of the different scenarios needs to include social, economic, and environmental metrics that reflect the interests of the diverse stakeholders. These metrics could take into consideration the circularity of different resources and practices being considered. For example, at a given community field scale, the analytics developed by such a tool would quantify the impact of various design and management decisions on co-identified sustainability metrics and would support answering questions like how does investing in natural grass versus artificial turf impact the number of injuries, and at what financial cost? What impacts do implementing technologies like rainwater harvesting and solar energy have on the facility's carbon footprint and return on investment? Each of these decisions has trade-offs which need to be evaluated and quantified. The utility of developing such an analytical tool would allow for quantifying such trade-offs with the goal of supporting a multi-stakeholder dialogue about different alternatives. Figure 2 provides an example of such envisioned scenarios and evaluation metrics which ultimately need to be customized to the area of study through a continuous engagement process throughout the project.

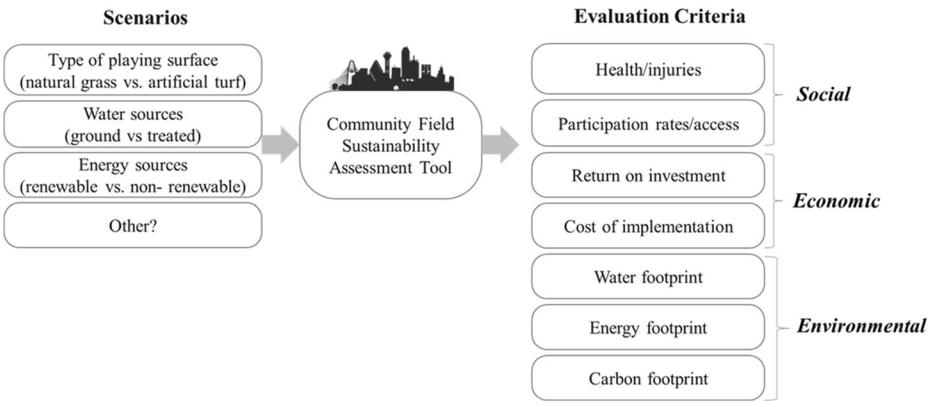

Fig. 2 Preliminary structure for assessing sustainability of community level sports fields

Mechanisms for Bringing Together Intellectually Diverse Researchers and Stakeholders

A conceptual model to bring together diverse researchers and stakeholders is presented in Figure 3. This builds on an extensive body of literature of participatory approaches and stakeholder engagement [38–44]. It first begins with a stakeholder mapping exercise that identifies key stakeholders and decision-makers connected with community sports fields in the community of interest. Once the key stakeholders and decision-makers are identified and the stakeholder network is specified, social network data will be collected. A network analysis will then be completed to assess the communication structure and relationships present within the stakeholder network. This analysis will identify leverage points that can be used to promote inclusion of diverse stakeholders, improve communication across stakeholders, and prioritize sustainable relationships related to community sports field management [33, 45, 46]. The network analysis is followed by the formation of a representative focus group including key players according to the network analysis to guide the development of a survey. The survey will be distributed to evaluate the priorities and perspectives of stakeholders regarding different field selection and management decision-making processes, including sustainability criteria. After conducting and analyzing the survey, a stakeholder engagement workshop will take place. Survey results will be shared with stakeholders to learn more about field selection and management decision-making processes that they do, or would like to, implement in their community. This workshop should also include sessions that allow stakeholders to share the sustainability criteria of importance to them when selecting and maintaining their fields. This input will be used to develop the decision support tool for assessing the scenarios discussed at a subsequent workshop (similar to Figure 2). A select focus group involving participants from the initial workshop is recommended for feedback as the tool is being developed. The final stakeholder engagement meeting will be where the scenario trade-offs developed by the tool would be communicated. This workshop will include dialogue sessions around the trade-offs associated with different field selection and management decisions.

Participatory Approaches in Practical Issues

Overall, participatory approaches consider diverse perspectives to gather data to minimize biases to make better informed decisions that maximize benefits to stakeholders. In prior research, participatory approaches across various business sectors have focused on different conceptual frameworks [47] and empirical studies [48, 49]. Dyer and colleagues [47] focused on incorporating strategies to understand the diffusion of innovation, leading to implementing a procedure for a circular economy. Their conceptual framework was informed through participatory approaches of businesses to consumers and business to business lines of

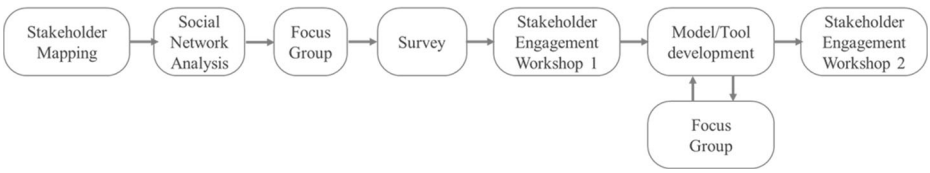

Fig. 3 Conceptual model to bring together intellectual diverse researchers and stakeholders

communication and active participation. Bertino and colleagues [48] focused on the input from various stakeholder groups with specific content expertise to inform the decision-making processes for sustainable pop-up living systems. Their approach sought to identify drivers for such collaborations and ways to overcome barriers to specific outcomes. Ricón-Moreno and colleagues [49] examined the perspectives of various stakeholder groups to promote a circular economy. Their approach is similar to that of the two previous studies. Each has its value to address a practical issue from a theoretically driven process to resolve it. All three approaches are unique to the specific topic. This involves identifying pertinent stakeholders, gathering data, and analyzing it to determine the best course of action to resolve the identified problem.

Our approach considers an issue that identifies a practical problem informed by various academic disciplines. The respective disciplines in this framework inform the decision process based on the gaps identified in prior research (e.g., availability and accessibility to fields) and the resulting outcomes (i.e., economic savings and revenues, community health outcomes). Thus, it is necessary to formulate new evaluation models and processes based on decision-making structures (e.g., city councils) and relative stakeholder groups (e.g., turfgrass management professionals, community members) to better address practical problems to achieve desired outcomes. In short, developing a circular economy or the best ways to design sustainable public spaces requires caveats specific to the issue. Furthermore, the value of these models relies on their application to new contexts (e.g., city council information gathering and decision-making processes in different municipalities, city types, states, countries) focusing on related topics.

Conclusions and Potential Impact on Society

Community-level sports fields are important public spaces that supply numerous benefits to residents of a community. These benefits extend to all aspects of sustainability including social [50, 51], economic [23, 52, 53], and environmental [54, 55] benefits. Since they are governed, constructed, managed, and used by various interacting groups, there are often competing priorities and issues of importance among these stakeholders. Furthermore, there are currently no known tools to assist decision-makers in properly selecting and managing their sports fields to meet demand in a sustainable and just manner, which could lead to decreased access for all and physical activity participation, as well as increased health issues within the community, water and energy use, and unforeseen costs. The proposed framework for convergent science-stakeholder decision-making could lead to the development of a common platform for multi-stakeholder dialogue about issues related to improving the social, economic, and environmental sustainability of community-level sports fields. It innovatively brings together physical and social scientists to map and assemble pertinent stakeholders, measure leverage points within the stakeholder network, identify perspectives surrounding decisions, and ultimately develop a decision support tool that can be used to evaluate the trade-offs associated with different options. Findings should promote and catalyze dialogue between diverse stakeholders within communities to assist with making the complex decisions for these important public spaces.

Code Availability Not applicable.

Data Availability Not applicable.

Declarations

Ethics Approval Not applicable.

Consent to Participate Not applicable.

Consent for Publication Not applicable.

Conflict of Interest The authors declare no competing interests.

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