Federal Institute of Sport Science

Supporting Sport

Jutta Katthage

Social Benefits of Sustainable Outdoor Sports Facilities

Indicators for existing standardized and competition-focused facilities

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Sustainability and benefits of outdoor sports facilities

1 Sustainability and benefits of outdoor sports facilities

What is sustainability?
The concept of sustainability can be traced back to Hans Carl von Carlowitz, who called for continuous, consistent and sustainable forest management, whereby only so much wood should be cut as can regrow (Kaufmann, 2004, p. 174). Sustainable use resulted in new quality standards in forestry and was intended to improve the population's economic situation (Kaufmann, 2004).

The Club of Rome's "Limits to Growth" report, which was published in 1972 to coincide with the United Nations' first conference on the environment, which was held Stockholm, established the modern-day interpretation of sustainability (Pufé, 2017). It became a popular issue as a result of the Brundtland Report published in 1987, which defines the guiding principle for a development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (Hauff, 1987, p. 46).

According to Kaufmann (2004), the concept of sustainability is a kind of forward-looking preventive and precautionary guiding principle. He explains that, whereas preventive action prevents damage and is intended to limit any damage that does occur, sustainable action is geared towards the continuous growth of natural and social processes in a way that conserves resources as effectively as possible (Kaufmann, 2004, p. 180).

This changed interpretation of sustainability is restructuring traditional political decision-making processes and their bureaucratic implementation (Kaufmann, 2004). Current decision-making processes concerning the sustainability of outdoor sports facilities pertain, for example, to planning operations regarding the "Physical Activity and Sports for All" action plan (German Federal Government, 2022), to the emission of microplastics and harmful substances from sports surfaces containing plastics (European Chemicals Agency (ECHA) 2019, 2020a, 2020b), and to the requirements relating to climate adaptation and conserving resources (European Commission, 2019).

Concept of sustainability for sports facilities
According to Eßig et al. (2015, p. 21), sustainable construction is more complex than addressing the aspects of ecology and energy efficiency. Even ecology itself is now no longer just about resources, but also atmospheric and water pollution, climate change and the decline in biodiversity (Kaufmann, 2004, p. 175). Moreover, Abu-Omar and Gelius (2020) emphasize that, in the future, sports facilities will be required that enable as many people as possible to play different sports at one facility with low overall CO_2 emissions (Abu-Omar & Gelius, 2020, p. 7).

The concept of sustainability used in this work is based on the statement by the German Council for Sustainable Development (RNE) that environmental perspectives should receive the exact same consideration as social and economic aspects (RNE, Official Journal). The International Olympic Committee (IOC) expands on this. It states that treating ecological sustainability, social sustainability and economic sustainability as separate disciplines is a common misrepresentation of the issue at hand. According to the IOC, sustainability requires an integrated and holistic approach – it cannot be segregated into component parts (IOC, Official Journal).

Social benefits of sustainable outdoor sports facilities
In microeconomics, benefits are defined as economic value or the ability of goods to meet a specific need of the consumer household (Suchanek et al., 2018). An ethical aspect is also defined, explaining benefits leading to a good feeling, social respect and individual identity (Suchanek et al., 2018).

To deliver social benefits, an outdoor sports facility must provide direct or indirect services

to create human well-being (based on: Marzelli et al., 2012). According to Marzelli et al. (2012), social benefits include services – provided by outdoor sports facilities in this case – that result in economic, material, health and psychological benefits for people. One direct benefit of outdoor for sports facilities arises, for example, from their use for sports. One indirect benefit is associated with the social requirements of stakeholders such as operators, users and local residents, in that outdoor sports facilities offer society additional services besides their use for sports.

1.1 Introduction

Germany has approximately 66,000 outdoor sports facilities (German Federal Ministry for Economic Affairs and Energy (BMWi), 2012). For the most part, municipalities pay the investment and operating costs (BMWi, 2012). In 2019, 52% of the municipalities surveyed cited a serious and significant shortfall with regard to investment in sports facilities (Krone & Scheller, 2020, p. 13). Financial support can be applied for from the funding programs of Germany's federal states and ministries.

These funding programs are intended to support a well-functioning and future-proof social infrastructure that is accessible, with few or no barriers to use (German Federal Ministry of the Interior and Community (BMI), 2021b, p. 36) – one that aims to create equal living conditions, strengthen social cohesion and the social integration of all sections of the population, and boost public health (BMI, 2021b, p. 39). However, the funding programs do not include dedicated sports function or sports facility-specific criteria relating to the sustainable construction and operation of the outdoor sports facilities to be renovated or modernized. One reason for this may be the limited scientific basis for sports-facility-specific criteria with a particular focus on sustainability and social benefits. Scientifically developed criteria for existing outdoor sports facilities are lacking.

besides sociocultural aspects, sports facilities are also particularly important from the perspective of building-related environmental and climate protection (Horst & Messari-Becker, 2021, p. 12). In the building construction sector there is, amongst other things, federal funding for efficient buildings in the form of the German Quality Seal for Sustainable Building, which takes into account sustainability aspects (BMI, 2021a). In addition to this, scientifically developed criteria for existing outdoor sports facilities are required to enhance the sustainability and social benefits of outdoor facilities constructed for the purpose of sport. Only by taking a holistic view of the ecological, economic and social aspects, including social benefits, is it possible to meet funding program requirements that relate, for example, to creating equal living conditions, strengthening social cohesion and promoting public health.

Katthage (2022) developed an agenda relating to the sustainability and social benefits of existing outdoor sports facilities (S&B Agenda). She defined the term "agenda" as an action and management framework to improve sustainability while also promoting social benefits. The agenda's sports facility-specific indicators have been developed from the results of a literature analysis, a status analysis and an expert survey and have been assessed in terms of social benefits, in line with the concept of ecosystem services (Marzelli et al., 2012; Staub et al., 2011).

Determining the social benefits of outdoor sports facilities makes it possible to plan, manage and monitor direct and indirect contributions to society. On the one hand, the S&B Agenda thus closes the scientific gap resulting from the absence of an action and management concept that includes sports facility-specific criteria relating to sustainability and social benefits. On the other hand, it provides the first ever indicators that can be incorporated in practice into funding programs, and also into local sustainability strategies and sports development plans. (Katthage, 2022)

1.2 The problem

As also defined by the New European Bauhaus initiative (European Commission, 2021), an outdoor sports facility needs to be viewed from a holistic and sustainable perspective when it comes to sports facility renovation and modernization requirements (DOSB et al., 2018; Krone & Scheller, 2020). This is necessary so that, besides their function as places to play sport, outdoor sports facilities can also provide other social benefits, such as measures for climate adaptation (Bauer et al., 2020) or health promotion (Rütten & Pfeifer, 2016).

Operators
The range of outdoor sports facilities is made available by operators – often municipalities, in some cases clubs and in rare instances commercial organizations (German Conference of Sports Ministers (Sportministerkonferenz, SMK), German Sports Confederation (Deutscher Sportbund, DSB) and Association of German Cities (Deutscher Städtetag, DST), 2002). Operators' sustainability requirements are closely linked to optimizing planning, construction, operating and dismantling costs. Besides minimizing the need for renovation and modernization of outdoor sports facilities (German Federal Parliament, 2021), other requirements for operators include using durable and environmentally compatible building materials and construction methods for sports surfaces (German Federal Parliament, 2019; Hauschild, 2017). Although these building materials must not result in any adverse environmental effects on groundwater, soil or air (DIN 18035-1:2018-09, p. 10), harmful substances such as polycyclic aromatic hydrocarbons (PAHs) and the use of microplastics in synthetic turf systems have been the subject of sociopolitical debate in recent years (German Federal Parliament, 2017b, 2020c).

Users
The demand for outdoor sports facilities comes from users who participate in sports activities there, go there as spectators or utilization them as a neighborhood meeting point. User requirements relate, amongst other things, to the utilization of sports areas for sport and recreation (Ott, 2012a), and also to properties that serve sports and protective functions by preventing risks associated with stress on the locomotor system and by reducing the risk of injury (DIN 18035-7:2019-12). The availability of outdoor sports facilities also supports organized sport and its functions for the common good (BMWi, 2012, p. 8), such as the integration function and social cohesion.

Users' demand for sports areas has changed in recent years, especially when it comes to the types of sports being played. Wetterich et al. (2009) note that, in line with the shift in the types of sports being played, the need for sports areas is also changing. Sports areas are needed for high-level competitive sport with rules and regulations, and also for the growing requirements of grassroots and leisure sport. The latter calls for decentralized outdoor sports facilities that have opening hours adapted in line with, for example, longer school hours, along with low-threshold sports offerings (Hesse State Sports Federation (Landessportbund Hessen), 2021; Wetterich et al., 2009). Users' requirements relating to the sustainability of outdoor sports facilities relate primarily to extending the potential uses of these facilities.

Local residents
As open spaces, sports grounds have an impact on the local and urban climate (DIN 18035-1:2018-09), which makes them a significant part of urban life (Cotterell & Vöpel, 2020, p. 12) with a key task when it comes to sustainable urban development (Cotterell & Vöpel, 2020, p. 12). Local residents can be affected by outdoor sports facilities – by sports noise and light emissions, for instance (German Federal Parliament, 2017b; Haase, 2018), or by emergency drainage systems (Schleifenbaum et al., 2019) and the cooling capacities of sports surfaces (Burmeister, 2020; Kastler et al., 2015). Local residents' requirements regarding the sustainability of outdoor sports facilities relate in particular to the incorporation of these facilities into urban development concepts. The environmental impact, such as the way the temperature of sports surfaces changes (regional council of Cologne's district government, 2019), is especially significant in this context.

Requirements for improving the sustainability of existing outdoor sports facilities

The various stakeholders' requirements relating to the sustainability of existing outdoor sports facilities have to date been disjointed. Individual outdoor sports facilities in cities such as Hamburg, Dresden, Cologne and Berlin are running pilot projects for the sponge city principle (Hauschild, 2018), infiltration (Kirsten, 2020), environmental and health protection (Brümmer, 2021; Laube, 2020) and inclusion (Bergmann et al., 2021; Berlin network for sports and inclusion, 2019). Outdoor sports facilities must be planned and operated on a sustainable basis to support sport's function as a significant part of social life (Cotterell & Vöpel, 2020) and also to deliver benefits to society that go beyond the use of such facilities for sports. For this purpose, the requirements of operators, users and local residents should be given equal weight so that outdoor sports facilities provide direct and indirect services for these stakeholders.

Projects rarely relate to the construction of outdoor sports facilities at new sites, but rather to renovation and modernization work (Bringmann, 2001; Neuerburg & Wilken, 2018), meaning that indicators specifically for existing outdoor sports facilities are required. Approaches to date for assessing the sustainability of outdoor sports facilities relate specifically to the planning and construction of new sports facilities (Eßig et al., 2015; Thieme-Hack et al., 2017). The *S&B Agenda* developed by Katthage (2022) offers a general scientific basis for developing existing outdoor sports facilities, in particular through the customized, practical implementation of measures.

1.3 The objective

The goal defined in Katthage (2022) was as follows: The development of an agenda to assess and improve sustainability and to promote the social benefits of existing outdoor sports facilities. Knowledge, planning and management of the sustainability and social benefits of existing outdoor sports facilities are necessary to support operators' decisions. Besides the construction and maintenance of sports areas, these decisions also relate to their availability and to the building materials and construction methods used. The requirements of users, especially relating to the types of sports played, and those of local residents, such as the integration of sports facilities into the surroundings, must also be considered.

To achieve the goal of developing indicators to improve the sustainability of existing outdoor sports facilities, Katthage (2022) created a new assessment system by adding stakeholders' requirements to established criteria from existing assessment systems. Besides being both practicable and relevant, the indicators had to be related to the actual outdoor sports facility. The relevant indicators identified in this way serve as a basis for optimizing the sustainability of existing outdoor sports facilities.

To attain the objective of establishing the social benefits of existing outdoor sports facilities, the indicators must, as forward-looking sustainability goals, contribute to human well-being as defined by the concept of ecosystem services. This involved setting out other services besides sports use that are provided by existing outdoor sports facilities.

1.4 Terminology classification system

The various terms relating to outdoor sports facilities are defined as follows:

- **Sports complexes** are sports facilities and amenities collectively (Bach, 2004).
- **Sports facilities** are facilities created specifically for sport (BISp, 2000, p. 15).
  These facilities have been constructed for competitive sport in line with the requirements of the relevant standards and regulations.
- **Sports amenities** are facilities or areas that can also be used for sport but were created for other purposes (BISp, 2000, p. 15).

- **Outdoor sports facilities** are open-air facilities that were constructed for the purpose of sport and where sports are played (DIN 18035-1:2018-09, p. 5). They are made up of the playing and sports area, the necessary supplementary (ancillary) areas and, if appropriate, areas and facilities for informal types of physical activity and exercise (DIN 18035-1:2018-09, p. 6). Golf courses and equestrian facilities are also defined as outdoor sports facilities. Sports grounds are one common type of outdoor sports facility for sports games and athletics (DIN 18035-1:2018-09). They comprise types of sports areas such as competition facilities (DIN 18035-1:2018-09) or large pitches, in some cases with the addition of small pitches or athletics areas (DIN 18035-1:2018-09).

- **Sports areas** are areas constructed and equipped in a way that makes them suitable for competitive sport, and also for informal types of sports activities, physical exercise and leisure activities (DIN 18035-1:2018-09, p. 6). The majority of large and small pitches can be used not just for competitive purposes, but also for informal types of sports activities (DIN 18035-1:2018-09, p. 15). The size of the sports areas and their marking lines indicate the types of sports to be played there. Sports areas are normally equipped with a sports surface.

- **Sports surfaces** are developed specifically for sport. They serve sports and protective functions and have the required technical properties. Typical sports surfaces at outdoor sports facilities are sports turf areas (DIN 18035-4:2018-12), tamped (granular) areas (DIN 18035-5:2021-03), synthetic surfaces (DIN 18035-6:2014-12) and synthetic turf systems (DIN 18035-7:2019-12). Other sports surfaces are made up of materials such as sand, wood chips, asphalt and concrete.

1.5 Definition of scope

This work covers outdoor sports facilities that were constructed for the sports activities undertaken by clubs, schools, companies and individuals. It does not include facilities that were constructed for other purposes but are used for sports activities, for example woodland paths utilized by runners. Outdoor sports facilities that are used, amongst other things, for high-level competitive sport – by athletic clubs, for instance – are included. Stadiums and arenas that were built specifically for (large) sports events are not covered.

Sports and supplementary areas of outdoor sports facilities as defined in DIN 18035-1:2018-09 are included. Sports areas are normally

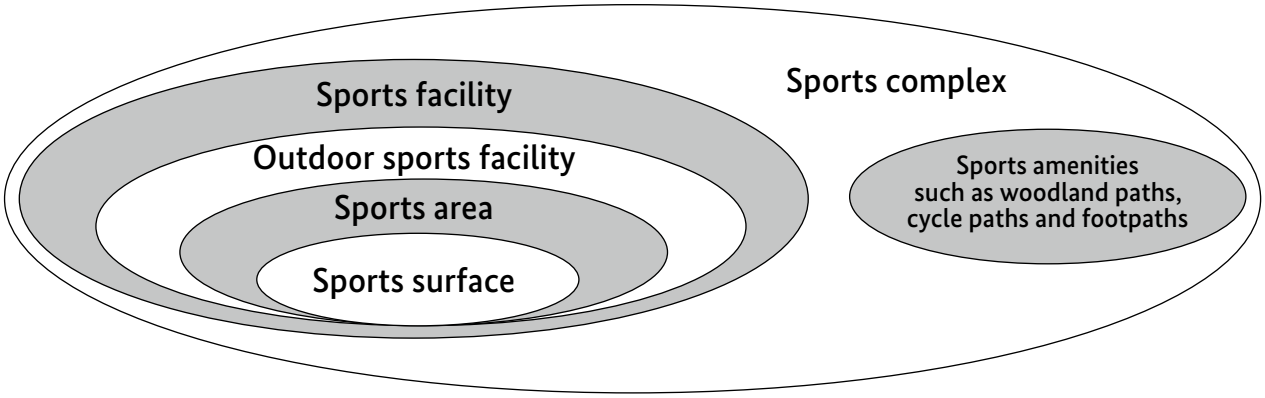

Figure 1.1: Terminology classification system for this work (Katthage, 2022)

assigned to one or more types of sport based on their size, boundaries and marking lines. Examples include football pitches and riding arenas. These areas are usually equipped with a sports surface. The term "pitch" refers to the area designated for sports use by marking lines (DIN 18035-1:2018-09). Sports areas also include the safety zones around the pitches, as defined in DIN 18035-1:2018-09. Sports surfaces are surface or flooring systems developed specifically for sport that serve a protective function (e.g. rotational resistance and shock absorption), a sports function (e.g. relating to a ball's bouncing and rolling behavior) and a technical function (e.g. resistance to frost and wear) (DIN 18035-7:2019-12).

In accordance with the guideline on sustainable outdoor facilities of the German Landscape Research, Development and Construction Society (Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau, FLL, 2018), buildings such as changing rooms or clubhouses and engineering structures such as light masts or ball stop fences are not included in the scope investigated by Katthage (2022). Consequently, she has not considered the resource consumption of buildings or the energy efficiency of lighting. The boundaries of an outdoor sports facility are normally formed by fences, vegetation, paths or other design features. Where appropriate, these boundaries also represent the limits of the scope of this work.

Given that outdoor sports facilities interact with their surroundings – as a result of footpaths and cycle paths running across the facilities or due to noise emissions, for instance – these interactions are also considered. The location of outdoor sports facilities is an important part of urban development and regional infrastructure (DIN 18035-1:2018-09). These facilities cannot therefore be considered separately from their surroundings.

The *S&B Agenda* of Katthage (2022) does not represent a means of increasing the monetary value of outdoor sports facilities. Indirect monetary value can be generated by means of the services benefiting society, such as contributions to recreation and well-being.

Katthage (2022) focuses on existing, urban outdoor sports facilities. Rural outdoor sports facilities normally have different challenges (Neuerburg & Wilken, 2019). Transferring individual *S&B Agenda* indicators to rural outdoor sports facilities is conceivable in principle. The feasibility of doing so should be investigated on a case-by-case basis.

Analyzing the sustainability of outdoor sports facilities

2 Analyzing the sustainability of outdoor sports facilities

2.1 Assessment system

Hierarchy of the assessment system
The assessment system is made up of clusters, characteristics groups and characteristics, along with quality levels and checklists for the assessment. In statistics, clusters are used to group similar characteristics for differentiating items (Weigand, 2019). Katthage (2022) has adopted this approach and combined characteristics into clusters. Since they combine all the characteristics, clusters represent the first level of detail in the assessment system. The second, more detailed level is made up of characteristics groups, while the third level comprises the characteristics, along with checklists or quality levels (Figure 2.1).

In line with the attributes used by existing assessment systems (Richter et al., 2018, p. 12), the "supply", "common good" and "climate and environment" clusters cover the characteristics groups as well as the characteristics, along with checklists or quality levels. Characteristics groups combine several related characteristics. The "location" characteristics group is one example. Characteristics include the criteria from existing sustainability assessment systems. Unlike the criteria profiles, they 1.) can be made up of subcriteria of the criteria profiles, 2.) have, in some cases, been newly combined from criteria of several assessment systems or 3.) have been newly formed based on the literature analysis. They are assessed using checklists or quality levels.

Contents of the system for assessing the sustainability of existing outdoor sports facilities
The assessment system developed by Katthage (2022) includes a total of 17 characteristics, with 54 checklists and quality levels for assessing sustainability (Table 2.1). The characteristics of the "supply" cluster relate to the selection and handling of building materials and construction methods for sports surfaces. They also cover maintenance measures to help optimize the sports surfaces' intensity of use.

The characteristics in the "common good" cluster relate specifically to the social needs of users and local residents. An open city for the many that is geared towards the common good focuses on values such as solidarity, community, self-efficacy and participation (Bruns et al., 2020). This also includes the sport, health and well-being aspects of concepts for sport-related and urban planning, along with knowledge about the physical, psychological and social impact of sport.

The characteristics in the "climate and environment" cluster summarize the contributions of sports areas and supplementary areas to conserving water resources and to preserving and encouraging vegetation so as to ensure environmentally compatible and climate-appropriate practices, planning and construction.

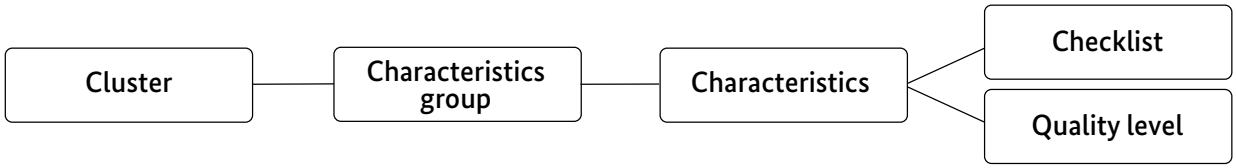

Figure 2.1: Assessment system hierarchy (Katthage, 2022)

Table 2.1: Clusters for existing outdoor sports facilities (Katthage, 2022)

Cluster	Characteristics group	Characteristic
Supply	Maintenance and dismantling	Intensity of use
		Sports function and sports surface combination
		Maintenance planning and services
		Recycling and disposal
Common good	Location	Further sports and exercise areas
		Incorporation and accessibility
		Transport concept
		Complaints
	Utilisation	Multi-use capability
		Barrier-free accessibility and orientation
		User satisfaction
Climate and environment	Vegetation	Vegetation areas
		Damage caused by trees and shrubs
		Biodiversity
	Water	Water source
		Irrigation and control technology
		Drainage

Analysis parameters

To date, Germany is lacking both valid data on the stock of sports facilities and a standard system for registering such facilities (Wallrodt & Thieme, 2021) that can be used for purposes such as extrapolations for a sustainability assessment. To analyze the sustainability of outdoor sports facilities from the random samples, it was therefore necessary to identify and evaluate influencing factors. For this purpose, Katthage (2022) defined the following analysis parameters:

a) Type of operator
b) Main sport
c) Age of outdoor sports facilities/sports areas
d) Type of sports facility
e) Type of land utilization in the land-use plan (LUP type).

Collection of data for the random sample

The Katthage (2022) study relates to data from 425 outdoor sports facilities. It therefore does not claim to provide representative statistics in the stricter sense, but it includes broad-based sample data. This is thus referred to as a random sample below.

The methodology for the analysis is described in Katthage (2022). What follows is a summary of the results.

2.2 Sports areas and sports surfaces

Sports areas consist of pitches, including the necessary obstacle-free safety distance for the relevant types of sports being played. The sports surface does not necessarily depend on the type of sport. Sports turf areas, tamped areas and synthetic turf systems are often used for football.[1]

Sports areas

Many sports areas in the random sample were constructed for just one sport, in the era of Germany's Golden Plan and network plans for sports facilities. Multi-use sports areas are normally more recent and were constructed in the periods 2000 to 2009 and 2010 to 2019 (Figure 2.2). The random sample includes large sports areas[2] that are used for combinations of football and field hockey, American football, ultimate frisbee, quidditch (quadball) or archery. One large sports area in the random sample is multifunctional. Besides being used for sport, it also serves as a school playground. The main sport played in large sports areas is normally football.

Small sports areas are often used as tennis and beach volleyball courts. In terms of their age structure and offerings for various types of sport, however, small sports areas are more versatile than large ones and have been better adapted to the needs of people who actively participate in sports. Moreover, the small sports areas in the random sample have the best multi-use credentials. However, only around one in ten small sports areas are used for more than one type of sport.

Most athletics areas in the random sample form part of a competition facility.

Sports surfaces

All types of operators offer sports surfaces, with municipalities providing the widest variety of sports surfaces. An analysis of 42 large municipal sports areas revealed that sports turf areas accounted for approximately 40% of these areas, synthetic turf systems about a third and tamped areas around a quarter. That makes municipalities the type of operator that most frequently uses synthetic turf systems and tamped areas – the hard-wearing sports surfaces.

Particular types of sports can be assigned to specific sports surfaces. For example, football is often played on filled synthetic turf systems, hockey is mainly played on unfilled synthetic turf systems and riding takes place on equestrian sands, which sometimes contain synthetic additives. Specialist monofunctional sports surfaces are available for specific sports (Hübner & Wulf, 2016).

1 The designations that follow refer to the types of sport rather than the ball.
2 Given that other sports areas besides large and small pitches were analyzed, large and small sports areas are referred to from here on.

Figure 2.2: Sports areas planned and built in the 1970s

The synthetic turf systems in the random sample were mainly created in the periods 2000 to 2009 and 2010 to 2019. Many of these are therefore more or less within their expected lifespan of 12 to 15 years (German Football Association (Deutscher Fußball-Bund, DFB), 2017). Tamped areas, on the other hand, are much older and date in particular from the periods 1976 to 1989 and 1991 to 1999. They have thus exceeded their expected 20-year lifespan (Schlesiger, 2010). Similarly, almost half of sports turf areas date from the era of the Golden Plan and the network plans for sports facilities, especially the period 1961 to 1975. Some of these have therefore been used for sports for over 50 years. Only a few new sports turf areas have been constructed in the past 20 years.

The distribution of sports surfaces for the small sports areas in the random sample is very different from that for the large sports areas. The most common sports surface for small sports areas is the tamped area for tennis, followed by sand areas for beach volleyball and synthetic and sports turf areas. Multi-use areas are more likely to have synthetic surfaces and sports turf areas (Figure 2.3). These sports areas can be adapted more quickly to the latest sports trends (Ott, 2012b). The universities in the random sample operate the most multi-use sports areas, which gives them the option of providing a wider range of sports offerings.

A total of 70% of sports surfaces for athletics disciplines consist of synthetic surfaces or a combination of synthetic surfaces, turf and sand. Sports areas for running disciplines are almost exclusively constructed with synthetic surfaces. This sports surface is required for international competitions (IAAF, 2017, Rule 140). Tamped areas for running and jumping disciplines are normally found in older outdoor sports facilities or are required for the shot-put competitions.

2.3 Results of the sustainability assessment

"Supply" cluster

The assessment results for the "supply" cluster show that, in more recent planning, operators mostly took account of previous experience relating to construction methods and building materials for sports surfaces. In the case of newer sports areas, for example, synthetically produced elastic fillers are avoided and sports surfaces are beneficially combined (Figure 2.4). However, digital IT systems are not normally used to support strategic planning or management relating to maintenance services or intensity of use (Wolfgang Lang, 2018).

Katthage (2022) notes that older sports areas on the "residential building area" LUP type have free utilization capacity, especially in the summer. Furthermore, in many cases, there is no indication of what happens to sports surfaces at the end of their services life. There is also a lack of recycling and disposal concepts (Table 2.2).

Figure 2.3: Synthetic turf system and synthetic surface with marking lines for several types of sports

Figure 2.4: Unfavorable combination of sports surfaces, with a tamped area located within an area with a synthetic surface

Table 2.2: Strengths, weaknesses and potential for the "supply" cluster (Katthage, 2022)

	Type of operator	Age of sports area	LUP type
Strengths	• Generally speaking, few sports areas have maintenance goals laid down in writing. • Few sports areas are overused.	• Experience relating to the sports function and the sports surface combination is normally taken into account in newer sports areas. • Newer sports areas often have defined maintenance goals.	• Sports areas on the "residential building area" LUP type often have defined maintenance goals.
Weaknesses	• There is normally no requirements planning. • Digital maintenance support with the aid of a GIS/GRIS is rarely used. • Especially in the summer, sports areas have unused capacity. • There are often no recycling and disposal concepts for sports surfaces at the end of their services life.	• Older sports areas have the most free capacity compared with other age categories.	• Sports areas on the "residential building area" LUP type have the highest free capacity in summer compared with the other LUP types.

	Potential for a "supply"-oriented outdoor sports facility
Potential	Use of digital systems/concepts to: • create requirement and occupancy plans, • prepare and check maintenance planning and services, and • provide information about building materials used, as well as other supporting documents for dismantling.

Use of digital systems

The potential of a supply-oriented outdoor sports facility is closely linked to digital IT systems. For example, it is possible to plan and manage maintenance schedules and services digitally using a GIS or GRIS. The process of reconciling the demand for sports areas, the capacity of sports surfaces and the actual utilization of these surfaces can also be managed digitally. The digital and geographic mapping of sports areas in a GIS or GRIS – combined with the information in a maintenance handbook, including details about the building materials used – is useful when it comes to maintaining, developing and dismantling these areas (FLL, 2019).

Appropriate IT systems could provide a user interface for purposes such as recording and documenting damage, booking free time slots for sports areas, and making it clear which types of sport can be played in the sports areas or which sports offerings are available at clubs (district office for central Berlin (Bezirksamt Berlin Mitte), Official Journal). On the one hand, digitalizing property-related data about outdoor sports facilities makes it possible to plan the supply and demand of such facilities at the municipal level. On the other hand, this data can be used to set out renovation and investment requirements when applying for funding.

"Common good" cluster

In the status analysis relating to the "common good" cluster, Katthage (2022) shows that sports areas from the period 2010 to 2019 on the "residential building area" LUP type are incorporated into the surrounding area to a greater extent than is the case for other periods and LUP types. These sports areas also have a higher multi-use capability than older ones. Furthermore, despite a few shortcomings when it comes to accessibility by bike or local public transport, sports areas from the period 2010 to 2019 achieve better results for the "transport concept" characteristic. Complaints from local residents relate to parked cars and sports noise (Figure 2.5).

Sports areas in the random sample that are on the "green space" LUP type are less likely to be publicly accessible than those on other LUP types. Katthage (2022) assumes this is primarily due to the type of operator. For example, the outdoor sports facilities of clubs and universities in the random sample are often located on the "green space" LUP type. In the random sample, only municipal outdoor sports facilities are publicly accessible. However, possibilities for repurposing and adapting these sports areas are lacking. Regardless of the type of operator, though, further areas for sport and exercise often exist in the surroundings, outside the actual outdoor sports facility (Table 2.3).

Figure 2.5: High intensity of use can lead to complaints due to sports noise

Creating and using networked (open-space) structures

Creating and using networked (open-space) structures should make it possible to link further areas for sport and exercise in the surroundings to the relevant outdoor sports facility. Connecting routes should be provided for this purpose, preferably with further sports offerings such as urban furniture that encourages exercise or smaller sports areas and pieces of sports equipment. Connections to further sports areas and equipment can help facilitate exercise and promote public health by increasing a residential neighborhood's overall sports offerings (Kähler, 2020). Furthermore, outdoor sports facilities must allow public passage so that they do not create a barrier in the neighborhood. Public accessibility beyond the level identified by the status analysis in Katthage (2022) should be supported.

Table 2.3: Strengths, weaknesses and potential for the "common good" cluster (Katthage, 2022)

	Type of operator	Age of sports area	LUP type
Strengths	• Sports areas of universities and clubs are often located in or adjacent to other open-space structures such as green spaces and parks. • User satisfaction surveys from sports development planning activities are often available for municipal sports areas in the random sample. • Further sports and exercise areas are available in the vicinity of sports areas.	• Sports areas from the periods 1961 to 1975 and 2010 to 2019 are more likely to allow public passage and are more effectively incorporated into the surrounding infrastructure. • Some sports areas from the period 2010 to 2019 are multi-use areas. • Newer sports areas from the period 2010 to 2019 have better transport concepts.	• Sports areas on the "residential building area" LUP type are often well incorporated into the surrounding neighborhood. • Sports areas on the "residential building area" LUP type are more likely to be multi-use areas than those on the other LUP types.
Weaknesses	• Only municipal sports areas are publicly accessible. • There is insufficient flexibility when it comes to usability and repurposing. No concepts exist for adapting to changes in sports use. • Complaints relating to noise and parking are particularly associated with municipal and university sports areas in the random sample.	• Older sports areas, especially from the period 1961 to 1975, are seldom multi-use areas.	• Sports areas on the "green space" LUP type are less likely to be publicly accessible than those on the "residential building area" LUP type. • Sports areas on the "residential building area" LUP type often have inadequate transport concepts in terms of bikes and local public transport infrastructure. • Sports areas on the "residential building area" LUP type produce the most complaints from local residents.

	Potential for a "common good"-oriented outdoor sports facility
Potential	**Creating and using networked (open-space) structures to:** • create new sports and exercise offerings and provide links to existing ones, • incorporate the outdoor sports facility into the neighborhood and open it up to the neighborhood, and • promote footpaths and cycle paths leading to the outdoor sports facility, along with integration into local public transport infrastructure.
	Aligning supply and demand in relation to outdoor sports facilities: • conducting user surveys investigating the need for sports, • improving public usability, • expanding the range of sports offerings through multi-use sports surfaces and multifunctional or multicoded sports areas, and • developing adaptation concepts to make the use of sports areas more flexible.

The transport concepts relating to outdoor sports facilities on the "residential building area" LUP type often exhibit shortcomings. Cycle paths and footpaths leading to outdoor sports facilities and these facilities' integration into local public transport routes should form part of municipal transport planning. Good accessibility using these modes of transport can also reduce complaints about parked cars.

Aligning supply and demand in relation to outdoor sports facilities
Hübner and Wulf (2016) recommend implementing a sports development plan to align supply and demand in relation to outdoor sports facilities. Such plans use surveys to ascertain the demand for sports and compare this with the available sports facilities (Göring et al., 2018). The sustainability analysis conducted by Katthage (2022) shows that adaptation concepts and repurposing options for sports areas are not normally considered in sports development plans. These possibilities are necessary to cater to the changing demand for sports and thus increase the range of sports offerings (Ott, 2012b).

"Climate and environment" cluster
Outdoor sports facilities with a focus on the climate and environment can contribute to climate adaptation and environmental protection, especially in terms of the way supplementary areas are designed and utilized, the way irrigation and drainage systems are arranged, and the type of vegetation and sports surfaces that are used. In many sports areas, precipitation water infiltrates into the ground. Some older sports areas are connected to receiving water, which places an additional burden on municipal drainage systems during heavy rainfall events. Furthermore, drinking water is often used to irrigate older, municipal sports areas. The water-permeable design of the sports surfaces and the high water losses due to older irrigation technology and control processes result in a high demand for water. Only one outdoor sports facility in the random sample collects precipitation in a pond to irrigate the sports surfaces (Table 2.4).

The proportion of vegetation areas is lower in metropolitan regions in particular. Sports areas on the "residential building area" LUP type tend to have a lower proportion of vegetation areas. In some municipal sports areas on the "residential building area" LUP type, trees and shrubs damage fences and paths. In the random sample, there are hardly any networking structures to promote biodiversity (Figure 2.6).

Creation and incorporation into climate adaptation and environmental protection concepts
Katthage (2022) explains that outdoor sports facilities with a focus on the climate and environment offer particular potential when it comes to their incorporation into urban concepts for climate adaptation and environmental protection, such as a sponge city principle or measures to promote biodiversity. Many outdoor sports facilities in the random sample are not connected to the receiving water. Instead, precipitation infiltrates into the ground on the property, which relieves the strain on municipal disposal systems. The size of outdoor sports facilities means they can potentially be used as retention areas in the case of heavy rainfall events. Networked green structures in supplementary areas can store groundwater and also act as a cold-air production area.

To ensure sports areas and supplementary areas can assume these functions, the designs and building materials selected must not result in any additional heat stress or other damage to human health or the environment (Katthage, 2022). Besides innovations relating to sports surfaces that are suitable for intensive use – to reduce the potential of the synthetic turf systems to heat up, for instance – it is conceivable for the cooling effect of sufficiently large supplemen-

Figure 2.6: Urban outdoor sports facilities often have a low proportion of vegetation areas

tary areas to reduce or even more than cancel out the effect of sports surfaces heating up. According to the expert climate report for the new synthetic turf being planned in Cologne's outer green belt, for example, no significant conflicts with the regional plan's ecological and climate goals is expected based on the predicted temperature increase of approx. 3°C during the day, as long as the sports surface is irrigated (regional council of Cologne's district government, 2019).

Katthage (2022) notes that sports surfaces use a lot of irrigation water, even though not all sports areas are irrigated in accordance with the recommendations of DIN 18035-2:2020-09. However, the irrigation and control technology used normally operates above the ground. The positioning of the sprinklers, which are primarily installed outside the pitch, means that large throw ranges are required. In the case of high air temperatures, this results in a high level of evaporation. To minimize consumption, irrigation systems with low evaporation losses and with digital irrigation and control technology should be used. Furthermore, new sports surface construction methods with a higher water capacity (water retention capability) should be developed.

Table 2.4: Strengths, weaknesses and potential for the "climate and environment" cluster (Katthage, 2022)

	Type of operator	Age of sports area	LUP type
Strengths	• The proportion of precipitation infiltrated into the ground is high. • At individual locations, some of the water used for irrigation is taken from collected precipitation water, and weather data is taken into account to control the application of water. • Sports areas in metropolitan regions have a low proportion of vegetation areas.	• Newer sports areas are partly irrigated using collected precipitation, including weather-based control.	• On average, sports areas on the "green space" LUP type have a higher proportion of vegetation areas than those on the other LUP types.
Weaknesses	• Drinking water is often used to irrigate sports areas. • There are hardly any networking structures to promote positive effects. • Some damage to paths and fences exists in sports areas (overall, there is little damage caused by vegetation).	• Older sports areas are often drained via a connection to receiving water.	• Fences and paths of sports areas on the "residential building area" LUP type are damaged in some cases.
	Potential for a "climate and environment"-oriented outdoor sports facility		
Potential	**Creation/incorporation into climate adaptation and environmental protection concepts:** • creation of retention areas for heavy rainfall events, • infiltration of precipitation into the ground to relieve the pressure on the sewer system and encourage the formation of new groundwater, • networking of green structures, • promotion of vegetation areas, • selection of building materials based on climate adaptation and environmental protection requirements, and • use of digital irrigation and control technologies.		

2.4 Expert survey

A total of 27 specialists rated the relevance and practicability of 21 statements developed by Katthage (2022) from her literature analysis and the sustainability assessment system. Figure 2.7 and Figure 2.8 show the ranking lists based on the mean value of all the experts' ratings. The questionnaire's rating scale goes from 1 to 4, which provides the basis for calculating the mean value. A high mean value indicates a high level of agreement with the respective statement amongst the specialists. In line with the assessment categories, the ranking lists are split into "very important", "important" and "less important", and into "practicable" and "barely practicable". No mean value based on the questionnaire's 1 to 4 rating scale is given for the other categories.

The specialists regard the statement relating to building materials with no health risks and the one relating to life cycle costs as particularly relevant. Statements relating to the environment, such as those about building materials with no environmental risks and about recyclability, also have a high rating (Figure 2.7).

The statement that it should be possible to use a sports surface for several sports is at the top in the practicability ranking. Life cycle costs come second and are thus rated as "very important" and "practicable". A total of 16 statements are rated "practicable" and five "barely practicable" (Figure 2.8).

In the survey in Katthage (2022), the specialists call for sports areas that can be adapted to the requirements of people who actively participate in sports, and also for sports surfaces that meet health, climate and environmental requirements. They support making more intensive use of sports areas and improving the handling of resources.

Overall, the specialists rated statements relating to property planning, especially "building materials/health", "building materials/environment", "life cycle costs" and "recyclability" as highly relevant. In second place are the statements relating to usability, such as "in the neighborhood", "requirements planning" and "sports surface/ several sports".

The statements regarding structural and IT development, such as "sports surface/several sports", "barrier-free conversion" (accessibility), "maintenance goals" and "water source" (water losses), received a very high practicability rating.

To summarize, the expert survey shows that the specialists identified a considerable need for further development when it comes to resource consumption and reducing land use. This need was also identified in the literature analysis and the status analysis. To improve the sustainability of existing outdoor sports facilities, structural developments relating to the resource consumption of sports surfaces are therefore required, along with developments relating to sports function and planning to reduce the amount of space used for sports areas (Katthage, 2022).

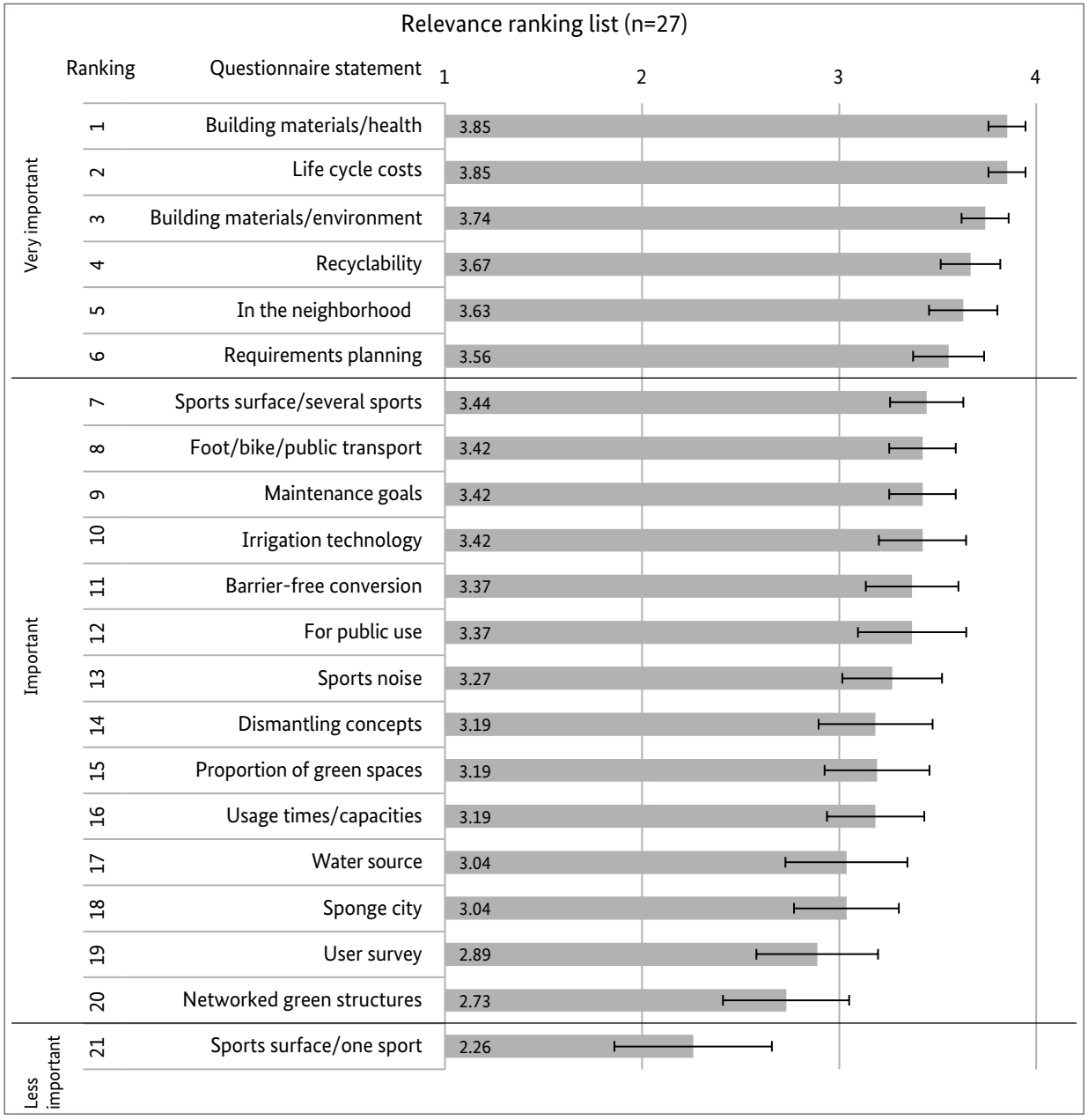

Figure 2.7: List ranking the rated relevance (mean values with variance coefficient) (Katthage, 2022)

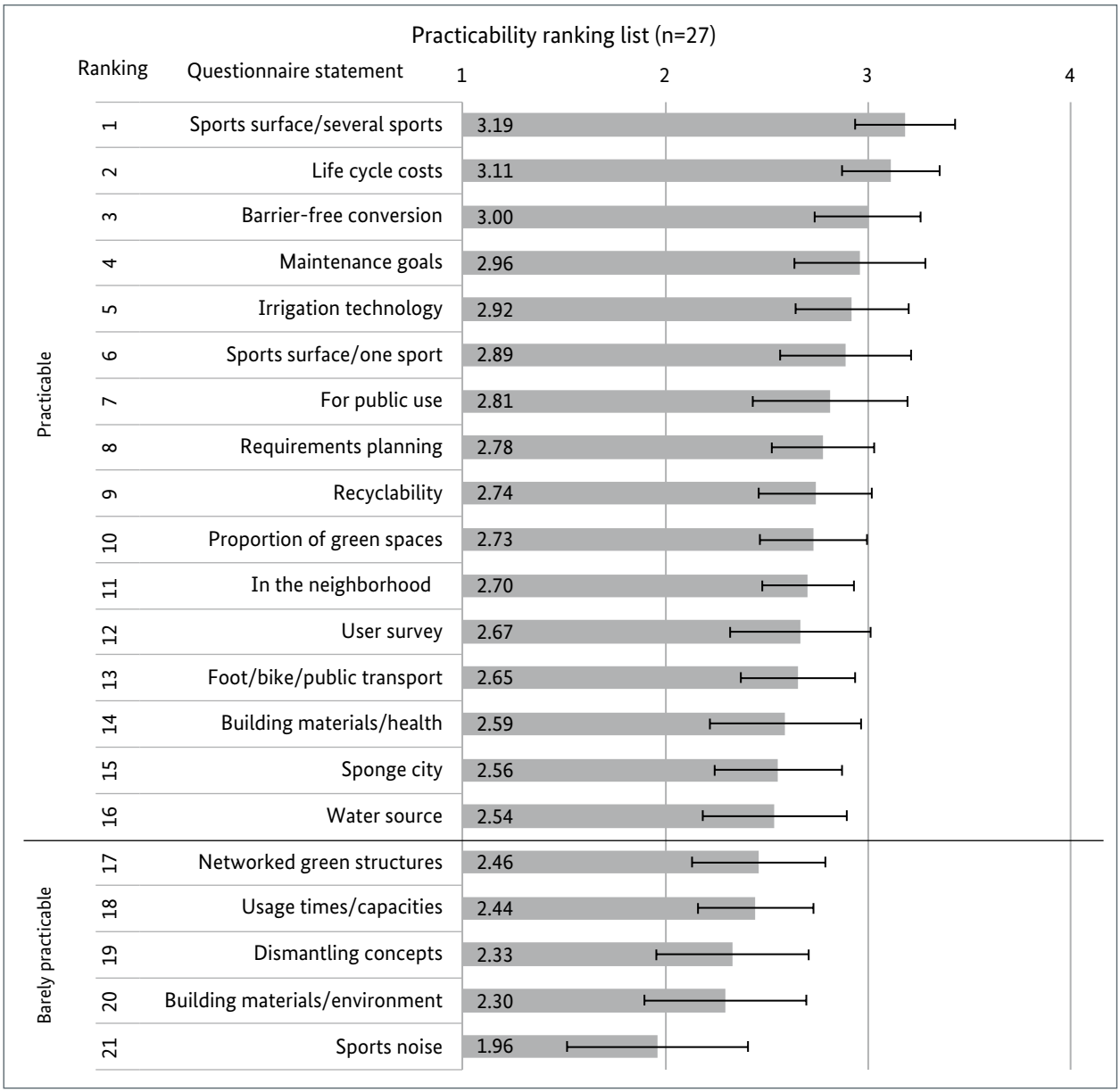

Figure 2.8: List ranking the rated practicability (mean values with variance coefficient) (Katthage, 2022)

Determining the social benefits of outdoor sports facilities

3 Determining the social benefits of outdoor sports facilities

3.1 Concept of ecosystem services

The definition of benefits based on the concept of ecosystem services is used to determine the social benefits of outdoor sports facilities. Ecosystem services are direct and indirect contributions of ecosystems to human well-being (Marzelli et al., 2012). Defining benefits based on the concept of ecosystem services is appropriate for determining out the social benefits of outdoor sports facilities, because the concept represents a key step towards socially, ecologically and economically sustainable urban development (Kowarik et al., 2016, p. 41) – a step that takes into account the services on the supply side as well as the social needs on the demand side (Kowarik et al., 2016).

Staub et al. (2011) devised a system for developing and operationalizing welfare-related environmental indicators. Rosenbusch et al. (2020) used this system to determine the ecosystem services and thus the social benefits of golf courses. The system is therefore appropriate for determining the social benefits of the indicators relating to the sustainability of outdoor sports facilities. (Katthage, 2022)

Services categories
Both Boyd and Banzhaf (2007) and de Groot et al. (2010) explain that ecosystem services can benefit people. According to Marzelli et al. (2012), these benefits can arise through nature-related services that have economic, material, health and psychological benefits for people. The services are split into four categories:

- Provisioning services, e.g. food, drinking water, wood and fiber, fuel
- Regulating services, e.g. climate regulation, flood regulation, water purification
- Cultural services, e.g. aesthetic, spiritual, health, educational and recreational
- Supporting services, e.g. nutrient cycling, soil formation, primary production.
  (Kowarik et al., 2016, p. 22)

The first three categories benefit people directly. Boyd and Banzhaf (2007) therefore refer to these as final ecosystem services, i.e. ecosystem goods and services that people enjoy, consume or use directly (Staub et al., 2011). Supporting services, on the other hand, have basic supporting functions for provisioning, regulating and cultural services (Kowarik et al., 2016).

The benefits of ecosystem services for society are derived from their contribution to human well-being. Aspects of human well-being are as follows:

- Safety, e.g. personal safety, guaranteed access to resources
- Basic material requirements, e.g. reasonable means of livelihood, adequate supply of food and nutrients, accommodation, access to goods
- Health, e.g. vitality, well-being
- Good social relations, e.g. social cohesion, mutual respect
- Freedom of choice and action, e.g. possibility of leading a self-determined life. (Kowarik et al., 2016, p. 22)

Kowarik et al. (2016) emphasize that an ecosystem services is worthwhile if it benefits society and is utilized. The significance of the benefit can be different for individuals, various groups and society as a whole. In terms of outdoor sports facilities, this means that such facilities can benefit the various stakeholders for different reasons. These include:

- Benefits for society, e.g. as a retention area or a producer of fresh air
- Benefits for operators, e.g. due to sports surfaces that are suitable for long-term use
- Benefits for people who actively participate in sports, e.g. by giving them access to sports areas. (Katthage, 2022)

Benefits – categories, description and type
Staub et al. (2011) describe four benefit categories – health, safety, economic services and natural diversity. These benefit categories represent cross-sectional functions with regard to the services categories (Table 3.1). In accordance with CICES (2018), only final ecosystem services are listed in Table 3.1 so as to rule out duplication with supporting services (Staub et al., 2011). The "natural diversity" benefit category is the most difficult to incorporate into the classifications of Reid et al. (2005) and CICES (2018), as natural diversity can, in principle, generate a benefit (Staub et al., 2011).

Staub et al. (2011, p. 26) suggest classifying ecosystem services indicators into benefit categories based on a description of the benefits and on the type of benefits. The description of the benefits explains the benefits for society or part of society, for example as a result of:

- Prevention, recreation, well-being for the "health" benefit category
- Protection against … for the "safety" benefit category
- Existence of … for the "natural diversity" benefit category
- Contribution to … for the "economic services" benefit category.
  (Staub et al., 2011, p. 29)

In accordance with Katthage (2022), the social benefits of the indicators for sustainable outdoor sports facilities are determined based on the following principles:

- The services categories, as specified by Reid et al. (2005)
- The benefit categories and the description of benefits, as defined by Staub et al. (2011)
- The classification of economic value, as set out by Marzelli et al. (2012).

The social benefits of existing outdoor sports facilities can differ depending on the extent to which they are used by the individual stakeholders and the significance of these stakeholders. Besides the benefits relating to actually participating in sports, the use of a sports area can benefit society in that it saves money by keeping people healthy (Ding et al., 2016). The building materials used can also influence this, for example by minimizing the risk to health or the environment and, at the same time, optimizing the life cycle costs for outdoor sports facilities.

Services categories for outdoor sports facilities
The services categories defined by Reid et al. (2005) have been adapted to the system for assessing the sustainability of existing outdoor sports facilities (Katthage, 2022) so that they illustrate the services outdoor sports facilities offer society. For this purpose, besides the three final ecosystem services – provisioning, regulating and cultural services – Katthage (2022) lists a new services category referred to as constructional-functional services. This category includes indicators that influence resource-optimized operation of the outdoor sports facility, such as "life cycle costs", "maintenance", "building materials/health" and "building materials/environment". The new services category is necessary because outdoor sports facilities are planned and built properties and therefore do not constitute an environment that has developed naturally. The resource-optimized preservation of the sports, protective and technical functions (DIN 18035-7:2019-12) forms the basis for assessing the social benefits of the constructional-functional services of an outdoor sports facility.

Sports function refers to the properties of sports surfaces that ensure the various techniques of

Table 3.1: Benefit categories [from: Staub et al. (2011) based on the system of Reid et al. (2005) and CICES (2018)]

		Services categories		
Reid et al. (2005)		Supporting services		
		Provisioning services	Regulating services	Cultural services
CICES (2018)		• Food and beverages • Materials • Energy	• Waste recycling processes • Hazard prevention • Biophysical conditions • Biotic environment	• Information • Examples to follow • Reports on experiences
Benefit categories (Staub et al. (2011))	Health		• Microclimate • Air quality • Peace and quiet • Limited radiation	• Recreational services • Identification
	Safety		• Avalanche protection • Flood prevention • CO_2 storage	
	Economic services	• Drinking water • Fodder plants • Timber growth • Wildlife • Renewable energy • Genetic resources • Biochemical active ingredients	• Spraying and pest control • Fertile soil • Cooling during production • Reduction and storage of residual materials	• Natural and cultural landscapes with touristic value
	Natural diversity	Existential value of natural diversity		
		^	^	^
		Biodiversity as a prerequisite for all ecosystem services		

the individual sports can be applied to optimum effect. The sports surfaces should reduce the stresses on the locomotor system and the amount of physical energy expended. Protective function refers to the property of a sports surface that serves to relieve the strain on the locomotor and musculoskeletal system of people who actively participate in sports, and also to reduce the risk of injury. Technical function refers to the property of a sports surface that maintains the sports and protective functions over the long term, for example wear and ageing behavior, water permeability and dimensional stability. (DIN 18035-7:2019-12)

Benefit categories of existing outdoor sports facilities

The benefit categories are the areas of application of the social benefits. Indicators of the "constructional-functional services" services category are commonly assigned to the "economic services" benefit category because, for example, these indicators often help to conserve resources and reduce land use (Table 3.2). This services category's indicators primarily relate to decisions about building materials for the sports surfaces and the usability of sports areas – property planning, in other words.

The indicator relating to building materials is assigned to the "health" benefit category. The "building materials/health" subindicator relates to the selection of building materials that give

Table 3.2: Social benefits of indicators (Katthage, 2022)

Indicator	**Services category** (based on Reid et al. (2005))	**Action level** (benefit category)	**Description of benefit** (Staub et al. (2011))
Barrier-free accessibility	Cultural services	Health	Identification, social relations
Building materials/health and environment	Constructional-functional services	Health	Prevention of harmful substances and environmental pollution
Requirements planning/ sports function	Constructional-functional services	Economic efficiency	Reduction of land use
Irrigation technology	Constructional-functional services	Economic efficiency	Contribution to conserving resources
Biodiversity	Cultural services	Safety and biodiversity	Existence of numerous species
Green spaces, trees and shrubs	Regulating services	Safety and biodiversity	Protection against heat, improvement of well-being
Maintenance	Constructional-functional services	Economic efficiency	Conserving resources
Life cycle costs	Constructional-functional services	Economic efficiency	Conserving resources
Multifunctional sports surface	Constructional-functional services	Economic efficiency	Reduction of land use
User survey/ satisfaction	Cultural services	Health	Social relations
Intensity of use	Constructional-functional services	Economic efficiency	Reduction of land use
Public accessibility	Cultural services	Health	Social relations, recreation
Dismantling and recycling	Constructional-functional services	Economic efficiency	Conserving resources
Sponge city (ability to absorb heavy rain)	Regulating services	Safety and biodiversity	Protection against flooding, heat and microclimate formation, improvement of well-being
Neighborhood sports areas	Cultural services	Health	Recreation and well-being
Sports noise	Cultural services	Health	Well-being, recreation, peace and quiet
Transport concept	Cultural services	Health	Prevention of injuries, improvement of wellbeing, peace and quiet
Water source	Provisioning services	Economic efficiency	Drinking water, conserving resources

no cause for concern regarding risks to human health and thus to preventive protection against harmful substances and/or health risks. The "building materials/environment" subindicator is similar and relates to the selection of building materials that avoid environmental pollution on a preventive basis.

Besides the "constructional-functional services" services category, many indicators of the *S&B Agenda* developed by Katthage (2022) are also assigned to the "cultural services" services category. These indicators often relate to the "health" benefit category, because they concern contributions to the recreation and well-being of users and local residents or promote social relations. The indicators in the "cultural services" services scategory primarily involve use-based reconciliation between supply and demand in relation to outdoor sports facilities, and location-based reconciliation between the outdoor sports facility and the surrounding area. (Katthage, 2022)

The "biodiversity" indicator is also assigned to the "cultural services" services category, as a high level of biological diversity, especially in the supplementary areas, can help increase the number of different species of flora and fauna and thus biodiversity.

The "sponge city", "green spaces" and "trees and shrubs" indicators are assigned to the "regulating services" services category and the "safety" benefit category (Staub et al., 2011), as they help protect against heat and flooding. The "water source" indicator is included in the "provisioning services" services category because of its contribution to conserving drinking water. The indicators in the "regulating services" and "provisioning services" services categories deliver significant social benefits in terms of climate adaptation measures.

Action levels relating to social benefits
Assigning the indicators to the benefit categories defined by Staub et al. (2011), while also taking into account the three pillars of sustainability, produces three action levels to promote social benefits (Table 3.3). These action levels combine indicators with similar social benefits (Table 3.2).

3.2 Indicators relating to the development of outdoor sports facilities

Classifying the results of the status analysis and the expert survey in four-field tables results in the indicators being prioritized into must-have, should-have and can-have ("must", "should" and "can") categories (E DIN 820-2:2022-03) as a recommendation for decision-makers. The prioritization is based on the following assumptions:

Table 3.3: Action levels as areas of application for social benefits (Katthage, 2022)

	Action level		
	Economic efficiency (economic)	**Health** (social)	**Safety and biodiversity** (ecological)
Indicator	• Requirements planning/sports function • Irrigation technology • Maintenance • Life cycle costs • Multifunctional sports surface • Intensity of use • Dismantling and recycling • Water source	• Barrier-free accessibility • Building materials/health and environment • User survey/satisfaction • Public accessibility • Neighborhood sports areas • Sports noise • Transport concept	• Biodiversity • Green spaces, trees and shrubs • Sponge city

- To minimize weaknesses, indicators from the *S&B Agenda* developed by Katthage (2022) must deliver added value for the development of existing outdoor sports facilities. “Must” indicators make big contributions when these weaknesses are reduced.

- Since the potential rated highly by the specialists has not usually been confirmed for the outdoor sports facilities in the status analysis, putting in place “should” indicators could also make considerable contributions to improving sustainability. Implementing the sustainability goals of these indicators can thus improve sustainability and promote social benefits in the future.

- To optimize the sustainability of existing outdoor sports facilities, it is necessary for current weaknesses to be reduced and for potential to be increased. “Must” indicators and, normally, “should” indicators therefore need to be incorporated into specific sustainability strategies or sports development plans, or funding bodies need to make this a requirement for the institutions submitting applications.

- To further increase existing strengths, it is recommended that “can” indicators are taken into account in a local application. They have a lower priority, as they are deemed to have less development potential for improving sustainability through the identified strengths in the status analysis.

Table 4 lists and prioritizes the indicators, also describing how they help improve sustainability and promote social benefits.

Table 3.4: Prioritized indicators of the *S&B Agenda* (Katthage, 2022)

Indicator	Priority	Contribution to *S&B Agenda*
Economic efficiency		
Requirements planning/sports function	Should	Newer, large sports areas in the random sample normally have favorable sports surface combinations. Requirements planning based on transparent criteria is only carried out in isolated cases, although the specialists deem this to be "very important". The policy committee for the upkeep of sports grounds (RWA "Sportplatzpflege") (FLL, 2014) provides criteria relating to the suitability of various sports surfaces, but not a utility matrix that weights the criteria (Kleine-Bösing, 2016). Requirements planning that considers criteria relating to the sports function can reduce land use by optimizing the capacity utilization of available areas.
Irrigation technology	Should	The irrigation technology used in the random sample is often from past decades and technical enhancement is required so that, for example, water losses can be reduced. Innovative irrigation technology is necessary to conserve water resources, and especially drinking water.
Maintenance	Should	When it comes to maintenance, the status analysis shows that systematic maintenance planning based on the requirements of green space management systems is barely used in practice (FLL, 2019). Furthermore, hardly any digital planning systems are in use. Presumably, maintenance planning without digital systems works satisfactorily for operators or no digital planning systems are available to them. However, it is harder to produce customized plans for achieving maintenance goals in the absence of any digital documentation about the sports surfaces, for example in the form of a GIS-based registry for sports complexes along similar lines to a tree registry (FLL, 2019).
Life cycle costs	Should	No life cycle cost calculations are available for the outdoor sports facilities in the random sample. Funding bodies do not currently ask for such calculations. Most of the subsidies and funding approved are for investment costs. Operating costs are normally not considered when granting funds. In order to establish the widespread introduction of life cycle cost calculations in practice, there will need to be, amongst other things, changes to the way funding and subsidies are granted, including the award criteria for public tenders. Given that the specialists rate the relevant statement as "very important" and "practicable", making a life cycle cost calculation a mandatory criterion when awarding public funding is presumably possible.
Multifunctional sports surface	Should	Multi-use sports surfaces are necessary to facilitate adaptation to a changing demand for sports (Ott, 2012b). Multifunctional sports surfaces help reduce land use – besides their use for sports, they can also be utilized for non-sports purposes such as events (Clüver, 2021).

Indicator	Priority	Contribution to *S&B Agenda*
Intensity of use	Must	In both winter and summer, athletics areas and, in particular, small sports areas are used for a fewer number of hours than is recommended by the policy committee for the upkeep of sports grounds (RWA "Sportplatzpflege") (FLL, 2014). A closer look at the individual times of use reveals that there is hardly any free capacity during the late afternoon or the evening, when the capacity utilization of sports areas is normally high. It is difficult or impossible for sports clubs to use available free periods, as these are outside the regular training times of recreational sports clubs and are normally reserved for school sports. To ensure a contribution to reducing land use, the utilization of times when free capacity is available must be optimized. For this purpose, users other than clubs and schools must be given the opportunity to book slots. Digital allocation systems would be helpful so that, besides self-organized individuals, kindergartens or groups of senior citizens can potentially use these sports areas. Standardized and transparent criteria based on the requirements of local stakeholders are needed for the booking and allocation of slots so that the sports areas can be used for a wide variety of sports and non-sports purposes.
Dismantling and recycling	Should	Hahn (2020) noted that the recycling of synthetic turf systems accounts for only a small proportion of sports surface disposal in practice. A number of commercial enterprises are currently developing recycling processes for synthetic turf systems, with a particular focus on separating and reusing materials. The composition of the synthetic materials used plays a key role when it comes to the quality of the recycled material (FLL, 2022). No nationwide regulatory or normative requirements or technical processes currently exist for recycling sports surfaces in Germany. These need to be developed and established so that the building materials can be reused, thereby helping to conserve resources.

Indicator	Priority	Contribution to *S&B Agenda*
Water source	Should	The specialists rated the practicability of not using drinking water for irrigation critically in some instances but considered it to be "important". The most common water source is the drinking water supply. Individual pilot projects demonstrate that irrigation making exclusive use of collected precipitation water is possible. Above-ground or underground storage capacity must be available for this purpose. Alternatively, grey water – collected from washbasins and showers, for instance – or treated water from water treatment plants can be used to irrigate sports areas in the future (Drewes, 2022). In light of the irrigation recommendation in accordance with DIN 18035-2:2020-09, it should also be investigated during the actual planning whether other water sources or storage capacities are feasible (Menz et al., 2020).
Health		
Barrier-free accessibility	Should	The sports areas in the random sample only meet a small number of the requirements relating to outdoor sports facilities that offer barrier-free accessibility. The specialists rated the statement about modifying outdoor sports facilities to ensure their barrier-free accessibility as "important" and "practicable". The literature analysis underlines the need for research and development work. A number of different authors indicate requirements relating to the design of sports facilities that offer barrier-free accessibility (Bergmann et al., 2021; Berlin et al., 2018; Schmieg et al., 2010; Berlin Senate Department for the Interior and Sport (Senatsverwaltung für Inneres und Sport), 2020).
Building materials/ health and environment	Must	The risks resulting from sports surfaces must be minimized to protect the environment and the health of the people using them. Many risks to the environment and human health resulting, for example, from dioxins, PAHs and microplastics only became apparent after the outdoor sports facilities were commissioned. The entities responsible for these facilities, such as operators, must know and be able to clarify which materials have been used so that they can respond when risks are reassessed or precautions are taken. To make this possible, these materials should be documented during the planning and construction phase. It would be conceivable to have a product passport for sports surfaces that is similar to the one for products used in building construction. For example, the European Carpet and Rug Association (ECRA) has developed a product passport for carpets in the form of a voluntary undertaking by manufacturers (Recyclingportal, 2020), and the Association for Environmentally Friendly Carpets (Gemeinschaft umweltfreundlicher Teppichboden, GUT) has developed test criteria for harmful substances, emissions and odors from carpets (GUT, 2020).

Indicator	Priority	Contribution to *S&B Agenda*
User survey/ satisfaction	Should	In some cases in the random sample, user satisfaction surveys are conducted as part of public surveys associated with sports development plans. Some sports development plans have been updated to factor in user needs during the utilization phase. Individual outdoor sports facilities in the random sample that have sports development plans improve social relations by asking users about their needs. This can increase the acceptance and utilization of outdoor sports facilities. Furthermore, the positive impact of sport supports social cohesion, integration, inclusion and mutual respect.
Public accessibility	Should	Public accessibility means a large number of people can use the outdoor sports facilities. The specialists rate it as "important" that sports facilities receiving public funding are publicly accessible. Many outdoor sports facilities in the random sample are located on the "residential building area" or "green space" LUP type. If members of the public cannot enter or pass through such facilities without the operator's permission, they are unable to use them for sports purposes or as a connecting route. Appropriate requirements should be included in the funding conditions to support the public accessibility of sports areas. That also means creating regulations regarding the legal duty to maintain safety and the prevention of vandalism (Thieme-Hack et al., 2017).
Neighborhood sports areas	Can	Many sports areas in the random sample are located in or border on residential areas and are thus within easy reach in principle.
Sports noise	Must	Plans for dealing with sports noise are necessary (North Rhine-Westphalia State Chancellery (Staatskanzlei des Landes Nordrhein-Westfalen), 2019) so as not to disturb the peace and quiet or well-being of local residents. An appropriate change to the law would allow sports facilities to exceed the limits specified in German legislation (Eighteenth Ordinance for the Implementation of the Federal Immission Control Act (18. BImSchV), 1991). Complaints about the sports areas in the random sample relate not just to noise emissions resulting from sport and associated activities, such as barbecues and parties, but also to dust emissions caused by inadequately irrigated tamped areas and to light emissions from the lighting. Besides ensuring public involvement, for example in the form of workshops during the participative planning process (Wetterich et al., 2009), it is conceivable that conflict could be minimized by making changes through legal regulations. One example would be to grant privileged status to noise from children at outdoor sports facilities in the same way this is done for playgrounds (German Federal Parliament, 2011).
Transport concept	Should	Transport concepts cannot be considered separately from urban planning. Instead, sustainable citywide transport concepts must ensure outdoor sports facilities are within easy reach (Schade, 2019). Transport concepts help facilitate safe travel to and from these facilities, for example by bike, using local public transport or on foot. If a transport concept prevents disturbances from cars driving past or parking, it will also increase peace and quiet and the sense of well-being enjoyed by local residents.
Safety and biodiversity		
Biodiversity	Must	Biodiversity is hardly promoted at all in practice. Improving biodiversity also provides better protection for insects and other animals in urban areas. In particular, this can be achieved through the way supplementary areas are designed (Berlin Green League (Grüne Liga Berlin), 2013).

Indicator	Priority	Contribution to *S&B Agenda*
Green spaces, trees and shrubs	Should	The positive impact of green spaces, trees and shrubs in terms of providing protection against heat and thus contributing to human well-being outweighs the small amount of damage to parts of facilities such as sports surfaces, fences and paths, which was identified in the random sample. In the event of high air temperatures, supplementary areas provide particular protection against the heat by cooling the air through evaporation, which improves human well-being.
Sponge city (synthetic surfaces and turf systems)	Must	The "sponge city" indicator considers an outdoor sports facility as part of the sponge city principle. The focus is on aspects relating to the heat generated by sports surfaces and to measures associated with heavy rainfall events. Given a sports surface's big influence on the "sponge city" indicator, the prioritization should depend on the sports surfaces used. Due to the potential high surface temperatures of synthetic sports surfaces and the possibility of designing these sports areas to act as a storage area for heavy rainfall events, this is classified as a "must" indicator. If precipitation infiltrates into the ground where it falls or forms, this does not represent an additional burden on the sewer system in the event of heavy rain. Model projects using sports areas for the emergency drainage of circulation areas could also be implemented at other locations. This potential currently remains untapped for the outdoor sports facilities in the random sample.
Sponge city (tamped and sports turf areas)	Can	Tamped and turf areas are classified as a "can" indicator because using these sports surfaces for emergency drainage by routing precipitation water from the surrounding area to them and storing it there is not possible in the same way as it is with synthetic sports surfaces. In addition, tamped and turf areas are likely to have lower surface temperatures than synthetics sports surfaces.

Sustainability and social benefits of outdoor sports facilities

4 Sustainability and social benefits of outdoor sports facilities

There is much public discussion about sustainability at present. This reflects the concern about having a future that is worth living – on an ecological, social and economic level. The requirement to think and act sustainably is a response to changed global conditions and tougher ecological and economic challenges (Martens & Obenland, 2017, p. 10). Sustainability has thus also become a focal point of urban planning and landscape architecture due to the New European Bauhaus (European Commission, 2021), the Green Deal (European Commission, 2019) and the New Leipzig Charter (BMI, 2020a), for example.

This development also affects existing outdoor sports facilities. Until now, however, there have been no scientific studies that transfer the concept of sustainability to these facilities. The *S&B Agenda* developed analytically by Katthage (2022) remedies this situation. Along the same lines as the United Nations 2030 Agenda (Martens & Obenland, 2017), it formulates goals for the sustainable development of existing outdoor sports facilities in the form of an action and management framework. In addition, it explains the social added value that outdoor sports facilities can produce in terms of economic efficiency, health and the environment. In order to meet the requirement for a future-proof economic and social system (Martens & Obenland, 2017), this is followed by recommended actions relating to from both the analysis of sustainability and the determination of the social benefits of outdoor sports facilities. The S&B Agenda recommends practical actions based on the theoretical analysis.

The *S&B Agenda* comprises the "supply", "common good" and "climate and environment" sustainability clusters and the "economic efficiency", "health", and "safety and biodiversity" action levels as areas of application in terms of social benefits (Figure 4.1). Requirements relating to sustainable outdoor sports facilities have been identified from the literature analysis and characteristics for assessing sustainability have been defined for this purpose. The practicability and relevance of these characteristics is rated based on an expert survey. The social benefits are clarified on the basis of an expanded ecosystem services concept. Combining the analytical steps results in assessments in the form of prioritized indicators. Based on these indicators, the *S&B Agenda* can be formulated in terms of sustainability and social benefits. (Katthage, 2022)

The goals of the indicators form the basis for the forward-looking development of existing outdoor sports facilities. This must be specifically adapted to the local requirements. As overarching areas of application, the action levels help define the social benefits. Analyzing strengths

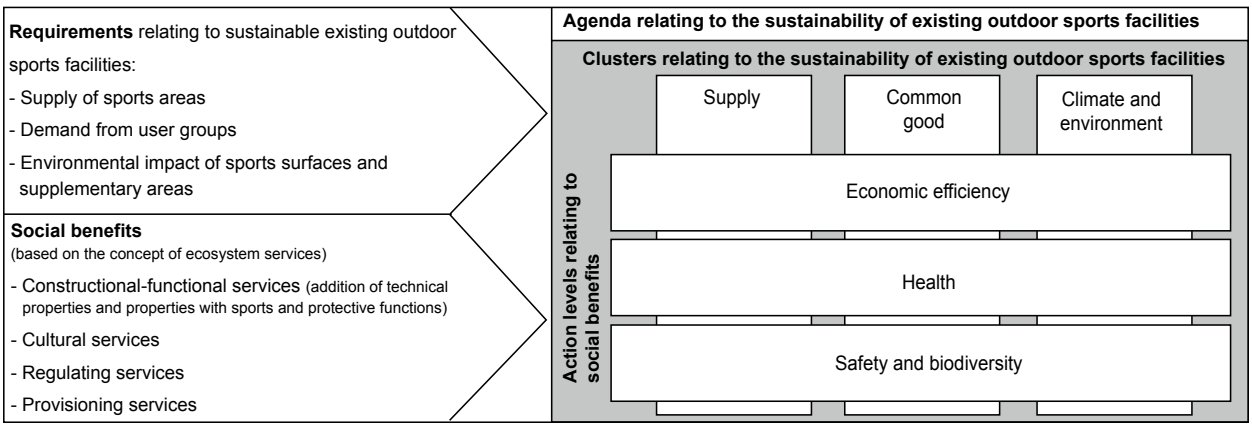

Figure 4.1: Agenda relating to the sustainability and social benefits of outdoor sports facilities (Katthage, 2022)

and weaknesses using the portfolio concept results in a classification into "must", "should" and "can" indicators in order to recommend how to apply the scientifically developed *S&B Agenda* in practice. (Katthage, 2022)

Added value through a combination of sustainability and social benefits

By using the results of the status analysis and expert survey to develop sports facility-specific indicators, Katthage (2022) offers a new tool that can be put into practical operation. To fully leverage the added value of the *S&B Agenda* for society, the environment and economic efficiency, Katthage (2022) calls for the following overarching measures to be implemented:

- Introduction of standardized product documentation that operators can access during operation. If risks are identified at a later stage (e.g. relating to dioxins, PAHs, PFCs, microplastics, etc.), information about the substances used will this be available.
- Requirements that the life cycle of an outdoor sports facility be taken into consideration, which would mean that life cycle cost calculations and plans for meeting maintenance goals would have to be submitted in order to obtain funding.
- Promoting of outdoor sports facilities that can be used by the public for a variety of sports requirements, with multi-use, multifunctional sports areas that minimize barriers to access.
- Use of digital technologies and concepts for requirements planning, better sports area capacity utilization, user surveys and reductions in resource consumption.
- Implementation of climate adaptation measures, for example in order to lower the surface temperature of sports surfaces and reduce the impact of heavy rainfall in the surrounding neighborhood.

Furthermore, the *S&B Agenda* offers an unprecedented basis for local sustainability strategies and provides recommendations for integrating sports development planning into urban planning concepts. Sports facility-specific indicators have been developed as forward-looking sustainability goals. By applying these indicators in practice, outdoor sports facilities can help promote health, reduce land use, conserve resources, support climate adaptation and maintain the biodiversity of flora and fauna. This provides administrative and political decision-makers with a basis for shaping their decisions relating to the resource consumption associated with sports surfaces, the design of supplementary areas and the choice of location. (Katthage, 2022)

4.1 Approaches to improving sustainability

Location and situation

Sports areas in the random sample that are located on the "residential building area" LUP type have poorer links to cycling infrastructure and local public transport infrastructure than is the case for other LUP types. Furthermore, the "residential building area" LUP type produces more complaints from local residents about private motor vehicle parking than is the case with other LUP types.

Sports areas on the "residential building area" LUP type are less well incorporated into other open-space structures than those on the "green space" LUP type. For example, the random sample includes one outdoor sports facility that is almost completely surrounded by buildings on all four sides. In some cases, the balconies of these buildings face onto the outdoor sports facility (Figure 4.2). This physical proximity can increase the likelihood of complaints from local residents due to sports noise. The specialists consider the way sports noise is handled to be "important". However, they regard relevant measures to be "barely practicable" in urban areas.

Outdoor sports facilities in the random sample on the "residential building area" LUP type can more frequently be used by the public than sports areas on the "green space" LUP type. This is due to the type of operator, as only municipalities provide sports areas for public use here

Figure 4.2: Complaints about light and noise emissions can restrict sports areas' intensity of use

(Figure 4.3). Municipal outdoor sports facilities in the random sample are more likely to be located in residential neighborhoods, and outdoor sports facilities run by other types of operators are increasingly situated on the outskirts or in green spaces. The specialists rated neighborhood sports areas for public use as "very important" and "practicable". In most cases, it is ensured that municipal outdoor sports facilities in residential neighborhoods are within easy reach on foot so that sport and exercise can be promoted and thus play a role in keeping the population healthy.

Despite the size of outdoor sports facilities in the form of sports parks, many of the examples in the random sample do not create a physical barrier in the urban space, because these facilities normally have connecting paths for the pedestrians and cyclists who cross them. In some cases, metropolitan regions have outdoor sports facilities that are partly for public use and mostly allow public passage. Outdoor sports facilities that allow public passage create connecting routes between neighborhoods and can provide a place to spend time. These facilities can therefore assume further functions beyond their role as a place for sports.

Building materials and construction methods for sports surfaces

It is apparent from the 425 sports areas in the random sample that experience regarding building methods and construction materials was taken into account when constructing sports surfaces. It is also evident that, especially in the case of municipal outdoor sports facilities, structural defects are regularly documented (Figure 4.4). However, there are often no strategic plans in place relating to the maintenance of sports surfaces and what happens to them at the end of their services life. Digital registers of outdoor sports facilities are being developed in isolated cases. One example is the digital sports complex atlas for Germany (Digitaler Sportstättenatlas für Deutschland, DSD) compiled by the Federal Institute of Sport Science (BISp).

In the expert survey, the specialists emphasize the high relevance of recycling and dismantling sports surfaces, but also the low practicability. Even though commercial enterprises are currently making progress with appropriate tech-

Figure 4.3: Opening up sports areas and linking them to other open spaces can expand the range of sports offerings

Figure 4.4: The penalty spot on a football pitch is a common site of damage on sports surfaces

Figure 4.5: Dismantling of a synthetic turf surface (source: Benjamin Müller)

nical processes, these are not yet in widespread use. Municipalities offering the most durable sports surfaces – such as synthetic turf systems, synthetic surfaces and tamped areas – point to the further need for processes to recycle sports surfaces, also with a view to reducing resource consumption for the building materials being used.

In newer sports areas in the random sample, all precipitation is infiltrates into the ground where it falls or forms. Precipitation in older sports areas is often drained into the sewer system. One outdoor sports facility in the random sample collects precipitation and uses it to irrigate the sports areas (Figure 4.6). In total, around three-quarters of large sports areas and 42% of small sports areas are irrigated. Especially during the summer months, this results in a high level of drinking water consumption – even though in most cases, contrary to what is recommended in DIN 18035-2:2020-09, it is just sports turf areas or, in the case of small sports areas, just tamped areas that are irrigated. Another way in which drinking water is potentially wasted is that the irrigation and control technology is often operated manually and irrigation takes place above the ground, which increases the likelihood of evaporation.

Design of supplementary areas

Supplementary areas contribute to human well-being in line with the concept of ecosystem services, for example with large-crowned trees and shrubs that provide shade or with permeable ground for storing water. The cooling effect of shade on days when the air temperature is high promotes human well-being, especially in the case of sports surfaces with potentially high surface temperatures. Particularly in high-density metropolitan regions where the effects of the urban climate are intensified, outdoor sports facilities have a low proportion of vegetation areas. This is also a result of the sports surfaces used and the size of the plots. Due to their high intensity of use, large sports areas in metropolitan regions often have sports surfaces that can contribute to higher surface temperatures. These sports surfaces can therefore even be a contributory factor in the formation of urban heat islands, unless vegetation areas in the supplementary areas are used to provide a counteracting cooling effect.

The parameters defined for the status analysis – type of operator, main type of sport, age of sports area, type of sports facility and LUP type as a factor influencing sustainability – have shown that

municipal outdoor sports facilities from the period 1945 to 1960 of the large pitch type that are located on the "residential building area" LUP type have particularly low proportions of vegetation areas and thus limited potential in terms of a cooling effect. Due to the decreasing availability of space in urban areas, surrounding buildings have gotten closer to the sports areas over the decades. The supplementary areas of these outdoor sports facilities also exhibit low biodiversity. In many cases, they consist of mown grass areas, hedges and trees (Figure 4.7). Only a small number of outdoor sports facilities have areas with shrubs that promote insect protection and biodiversity.

Besides their ecological effects, supplementary areas can also assume sports functions if they provide storage areas for sports equipment (in the same way as an equipment room in a sports hall) or further options for playing sports and spending time. The random sample does not include any examples of ecological enhancement or of supplementary areas being used for sport. Some outdoor sports facilities have storage containers for maintenance equipment and machinery, but rarely for sports equipment. Three facilities include wood-chip tracks that are intended for sports use (Figure 4.8).

Figure 4.6: Pond for collecting precipitation water

In the expert survey, the specialists indicate that outdoor sports facilities are also an excellent place to spend time for purposes other than sport. Apart from facilities for spectators, most outdoor sports facilities in the random sample do not provide any other options for non-sports use, for example simply spending time and relaxing (Figure 4.9). There is just one university outdoor sports facility that has a landscaped outdoor area with a hut for barbecues.

Improving sustainability and promoting social benefits

"Economic efficiency" action level indicators also make it possible to improve sustainability by means of the sports surfaces used. With the exception of the three indicators "multifunctional sports surface", "irrigation technology" and "water source", all the indicators in the assessment system of Katthage (2022) belong to the "supply" cluster. Reducing land use and conserving resources are particular ways in which the indicators promote social benefits.

Most "health" action level indicators require stakeholders to coordinate on the location and sports surface. Reconciling the requirements for outdoor sports facilities to be within easy reach, and for sports areas to be available for public use and offer barrier-free accessibility, with the selection of building materials that do not present any health or environmental risks specifically improves sustainability in the "common good" cluster. In this context, participating in sports promotes social benefits specifically through the positive effects on health.

Decisions for the "safety and biodiversity" action level relate to location and supplementary areas. In the assessment system of Katthage (2022), these indicators normally belong to the "climate and environment" cluster. In particular, they benefit society through measures relating to climate adaptation and climate and environmental protection.

To sum up, decisions relating to location and supplementary areas – including the availability of outdoor sports facilities within easy reach – and also to the functions of vegetation areas help keep the population healthy. The decision relating to the location also determines how the facility contributes to climate adaptation, and which climate and environmental protection measures will be required for the surrounding area. Outdoor sports facilities on the "residential building area" LUP type have a higher adaptation and protection requirement than those on the "green space" LUP type. The building materials and construction methods selected by operators for sports surfaces influence costs and the use of resources during the life cycle. The size of the area required for an outdoor sports facility results in specific building materials and construction methods being selected. This is due to the different intensities of use of sports surfaces. The building materials used also have a decisive influence on human health and the environment – due to the damaging environmental effects of releasing harmful substances or discharging microplastics, for example, and the effects that result from high surface temperatures.

Figure 4.7: Supplementary areas are often made up of paved areas, mown grass areas, trees and shrubs

Figure 4.8: A wood-chip track provides additional possibilities for sports use

The analysis of existing outdoor sports facilities in Katthage (2022) demonstrated that several indicators need to be considered to achieve the goal of improving sustainability and promoting social benefits. This is the only way to make appropriate decisions regarding location, the selection of building materials and construction methods for the sports surfaces, as well as the design of supplementary areas. The main aspects to consider when making these decisions are environmental, social and economic aspects, in line with the basic principle of the German Council for Sustainable Development (RNE).

Figure 4.9: The supplementary areas of outdoor sports facilities are rarely an inviting place to linger

4.2 Sports use and social benefits

Marzelli et al. (2012) make a distinction between direct and indirect benefits. Direct benefits relate primarily to people who actively participate in sports. These effects vary a great deal depending on the individual. Indirect benefits relate to society as a whole and can therefore be made objective. They are based on the interaction of stakeholders' interests. According to Bruns et al. (2020), a continuous process of negotiation between these stakeholders is necessary so that different and conflicting interests can be considered. If stakeholders are involved, operators should be able to understand how existing outdoor sports facilities contribute to human well-being and then put this into practice. By combining property planning, sports planning and urban development planning, the S&B Agenda developed by Katthage (2022) creates an evidence-based negotiation framework so that outdoor sports facilities can support a town or city that is geared towards the common good and focuses on values, such as solidarity, community, self-efficacy and participation (Bruns et al., 2020).

Analyzing the social benefits based on the concept of ecosystem services shows that existing outdoor sports facilities satisfy, in particular, the requirements of the "constructional-functional services" services category additionally developed by Katthage (2022) by conserving resources and reducing land use. They also provide a cultural services by contributing to health promotion. The use of sports areas for sports activities benefits people who actively participate in sports through the associated physical, psychological and social effects (Figure 4.10). The social benefits lie in sparing society the healthcare costs resulting from a lack of exercise (Ding et al., 2016).

Further social benefits of existing outdoor sports facilities arise from the contributions to human well-being, for example through the indicators belonging to the "economic efficiency" and "safety and biodiversity" action levels. Services for society take the form of:

- constructional-functional services relating to the "economic efficiency" action level,
- provisioning services relating to the "economic efficiency" action level,
- regulating services relating to the "safety and biodiversity" action level, and
- cultural services relating to the "safety and biodiversity" action level. (Katthage, 2022)

Indicators belonging to the newly defined sports facility-specific "constructional-functional service" services category produce direct and indirect benefits. Direct services with social benefits are provided when the availability of sports areas motivates users to exercise. Indirect services for society are also provided. These include reduc-

Figure 4.10: Sports activities can promote positive physical, psychological and social effects

ing land use and conserving resources by utilizing multifunctional or multicoded sports areas. The benefits for society lie in the fact that in the long term, financial or natural resources are conserved and processes are optimized, even though initial costs can be higher.

Direct services through health promotion

According to Katthage (2022), the indicators that promote direct services for individuals through participation in sports belong to the "health" action level (Table 4.1).

Katthage (2022) notes that aspects relating to the location and situation of outdoor sports facilities – good access, availability and satisfaction of both users and local residents – are more likely to be fulfilled than aspects relating to the multi-use capability of sports areas. The number of sports areas available in urban areas is satisfactory. For example, the sports areas in the random sample on the "residential building area" LUP type are located no more than 500 m away from other sports and exercise areas. This indicates a high quantitative level of supply. The times that are actually available for sports activities are to viewed in qualitative terms. Especially in the late afternoon and early evening, large municipal sports areas hardly have any free capacity. Free slots are available in the morning and early afternoon, and also during the spring and summer months (Figure 4.11).

Katthage (2022) notes that large sports areas are often monofunctional and used for football only. Utilizing these areas more flexibly or adapting the sports surfaces for different types of sports is often not an option, for one thing because free slots cannot be booked digitally and for another because there is no way of temporarily adapting the surfaces for multiple sports. Small sports areas are more versatile and are used for several sports. Repurposing the sports surfaces or using the sports areas more flexibly is not envisaged. In many cases, sports areas of existing outdoor sports facilities are constructed with a single sports surface for one type of sport. They have a limited ability to adapt to the speed of change in the types of sports being played, and they use up a large amount of resources and take up a lot of land when capacities are not fully utilized.

Katthage (2022) concludes from this that more versatile usage that is geared towards the needs of society and goes beyond purely sports use is necessary to boost the social benefits of existing outdoor sports facilities. Besides the beneficial physical, psychological and social effects, for example, playing sports can also optimize the reduction of land use. Large sports areas are normally only available to a small number of user groups. Multi-use facilities with marking lines for football and American football, for instance, increase the possibilities for utilization (Figure 4.12). Besides opening up outdoor sports facilities to additional sports activities such as individual sports, non-sports uses for society at large must also be possible in order to encourage more versatile usage. Options include use by kindergartens and groups of senior citizens during times when the facilities are less busy, and utilization as a retention area in the case of heavy rainfall events (Clüver, 2021; Reul, 2022).

Table 4.1: Indicators with direct services relating to social benefits (Katthage, 2022)

Indicator	Services category	Action level
Building materials/health and environment	Constructional-functional services	Health
Barrier-free accessibility	Cultural services	
User survey/satisfaction		
Public accessibility		
Transport concept		
Neighborhood sports areas		
Sports noise		

Sports use plays a key role in the social benefits of existing outdoor sports facilities, because it facilitates recreation, well-being and social relations. The social benefits resulting from direct services thus relate first and foremost to social aspects of sustainability. When it comes to playing sports, however, these contributions of existing outdoor sports facilities to human well-being especially benefit people who:

- are members of a club,
- play elite/competitive sports,
- belong to a profession such as the armed forces, or
- attend a school or university.

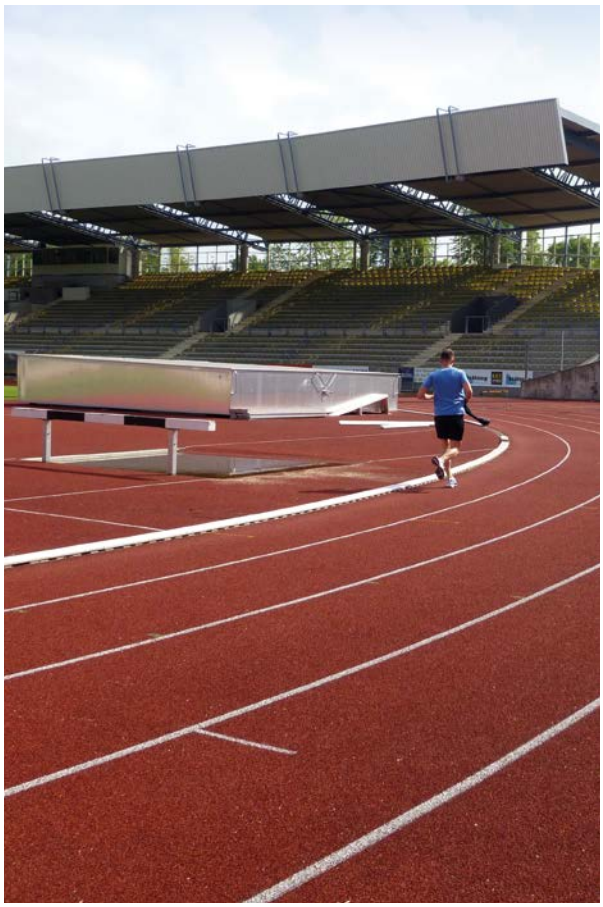

Figure 4.11: The intensity of use often varies a great deal during the course of the day

Individual sports are normally only practiced in small sports areas in the random sample (Figure 4.13). Consequently, the positive contribution only benefits part of society.

To improve the sustainability and promote the social benefits of existing outdoor sports facilities, it is necessary to expand the range of user groups and the types of use in terms of both sports and non-sports activities. Katthage (2022) regards this goal as readily achievable, as the random sample indicates that the availability of neighborhood sports areas is high, but only a small number of people who actively play sports are allowed to use them. Expanding the range of user groups and the types of use will increase the number of people who use sports areas. To achieve this, the usability of these areas needs to be changed, for example by opening up the out-

Figure 4.12: The track and large multi-use pitch of a sports competition facility

door sports facilities to self-organized people and groups, creating multi-use sports areas and selecting sports surfaces that are suitable for intensive use without any negative effects on health or the environment.

Indirect services through further functions

Katthage (2022) explains that indicators associated with indirect services for human well-being enhance the social benefits of existing outdoor sports facilities, as their contributions here benefit all stakeholders equally. These indicators primarily relate to the economic and ecological aspects of existing outdoor sports facilities. Property-related operating processes are listed under the "economic efficiency" action level (Table 4.2). Measures to reduce the use of land and resources deliver social benefits. The aspects listed under the "safety and biodiversity" action level mainly relate to the surroundings, for example the climate adaptation functions of vegetation areas, including what happens to precipitation and irrigation water (Werner Lang et al., 2020; Trapp & Winker, 2020).

Sports areas and supplementary areas can provide regulating services if they contribute to climate adaptation by protecting against the effects of heat and heavy rain. Existing outdoor sports facilities are already helping with climate adaptation. In many sports areas in the random sample, for example, precipitation infiltrates into the ground where it falls or forms, although there are also older sports areas with sewer-based drainage that is not in keeping with the concept of sustainability. Sports turf areas use a particularly large amount of water, with irrigation water often being taken from the drinking water supply. The measures designed to protect against the effects of heat and heavy rainfall events also offer untapped potential. Examples include the sponge city principle, increasing the biodiversity of flora and fauna, and planting large-crowned trees and shrubs that provide shade in the supplementary areas.

In the expert survey, the specialists emphasize the need for the technical development of processes for operating and dismantling existing outdoor sports facilities. At present, there are hardly any measures of this kind in practice. Ecological measures relating to climate and environmental protection are needed to promote the social benefits of existing outdoor sports facilities.

Katthage (2022) explains that improving the sustainability of existing outdoor sports facilities provides both direct and indirect services that benefit society. Sustainability and social benefits are thus mutually dependent. Besides benefits associated with playing sports, existing outdoor sports facilities deliver further social benefits, as the indicators also identify health, economic and ecological improvements as sustainability goals to be put into practice.

Table 4.2: Indicators with indirect services relating to social benefits (Katthage, 2022)

Indicator	Services category	Action level
Biodiversity	Cultural services	Safety and biodiversity
Green spaces, trees and shrubs	Regulating services	
Sponge city (mineral or synthetic sports surfaces)		
Requirements planning/sports function	Constructional-functional services	Economic efficiency
Irrigation technology		
Maintenance		
Life cycle costs		
Multifunctional sports surface		
Intensity of use		
Dismantling and recycling		
Water source	Provisioning services	

Figure 4.13: Equipment and areas for strength training and other exercises can often be used by the public

4.3 Agenda classification system

The main considerations of the stakeholders involved when it comes to existing outdoor sports facilities in urban areas are as follows:

- Availability of areas and competition with other forms of land use,
- Aspects relating to the choice of location, such as accessibility and noise emissions,
- Development of sports facilities within the framework of urban planning,
- Need for renovation as a result of structural conditions,
- Increasing the number of sports played while the number of people actively participating in sports stays the same,
- Necessity to adapt sports areas and sports surfaces to this change,
- Positive effects on the environment as a result of climate adaptation measures, and
- Negative effects due to health and environmental risks of building materials.

The three clusters of the assessment and categorization system developed by Katthage (2022) – "supply", "common good" and "climate and environment" – address these considerations, and appropriate characteristics have been defined to assess the sustainability of existing outdoor sports facilities. At present, the "common good" cluster's characteristics fare best in the sustainability assessment. When it comes to meeting the stakeholders' requirements identified in the literature analysis, the particular aspects to consider for the "supply" cluster are the building materials and construction methods used, for the "common good" cluster the use and design of sports areas, and for the "climate and environment" cluster the design of supplementary areas and the irrigation and drainage of sports areas.

The expert survey conducted by Katthage (2022) to rate the practicability and relevance of statements relating to sustainability revealed that the specialists see a great need for research and development work focusing on the future approach to building materials and construction methods for sports surfaces in property planning. Besides technical research relating to the environmental and health effects of the building materials used, they are also calling for IT developments to improve the usability of sports areas, for example in the form of digital systems to plan maintenance and allocate free slots to users.

Based on the three planning levels defined by Katthage (2022), the specialists' requirements are as follows:

- Property planning:
  - Selection of sports surface building materials and construction methods that do not present any health or environmental risks
  - Optimization of cost and maintenance planning
  - Development of innovative building materials and construction methods with regard to resource consumption and high intensity of use.
- Sports planning:
  - Modernization of sports areas in line with the change in the types of sports being played (multi-use capability and barrier-free accessibility)
  - Provision of access to sports areas for a variety of user groups.
- Urban planning:
  - Availability of areas for sports and non-sports use (multifunctionality) and for climate adaptation (multicoding)
  - Requirements planning relating to the location (e.g. provision of specific sports areas in the same municipality or a neighboring one).

The specialists' responses focus on sports use. In addition, non-sports functions of outdoor sports facilities relating, for example, to climate adaptation and to climate and environmental

protection are rated as less relevant by the specialists. One possible reason for this is the lack of any conceptual link between sports complex planning and urban development planning. Another is that additional non-sports functions for sports areas do not play a relevant role in practice – for example in funding programs.

Applying the *S&B Agenda* as a contribution to integrated planning

Table 4.3 assigns the indicators to the various stakeholders and planning levels. It can be seen that indicators relating to property planning and sports development planning often necessitate coordination between users and operators and aim to optimize sports activities. The urban planning indicators, in particular, relate equally to all stakeholders given that the operators – with the involvement of further stakeholders such as local government officials – can promote the design of outdoor sports facilities in such a way as to achieve a positive impact on human well-being.

The first step in promoting human well-being is to work on the "must" and "should" indicators, because weaknesses and/or research and development requirements were revealed for these indicators in the status analysis, and a need for action was identified in the expert survey. For example, the multifunctionality analysis shows that only one sports area in the random sample allows for non-sports use. The specialists, by contrast, consider multi-use sports surfaces to be very important. Sports surface innovations are needed to promote the multi-use capability, multifunctionality and multicoding of sports areas in practice. Based on the example of football and field hockey, currently available multi-use sports surfaces normally display disadvantages for both sports in terms of their sports functions (Budy et al., 2020).

Katthage (2022) concludes that none of the indicators relate to just one stakeholder. Cooperation between stakeholders is therefore required. These coordination processes are good for sustainability because the stakeholders negotiate on the basis of their different requirements. The sustainability goals developed for the indicators by Katthage (2022) can serve as guidelines for improving the sustainability of each individual outdoor sports facility.

Parameters and types of areas as control variables

By applying the assessment system to the outdoor sports facilities in the random sample, Katthage (2022) ascertained that decisions relating to large sports areas and supplementary areas are key in terms of improving the sustainability and promoting the social benefits of existing outdoor sports facilities. Particularly for the "maintenance and dismantling", "location" and "water" characteristics groups, differences in the sustainability assessment emerged between the "type of operator", "age of sports area" and "LUP type" parameters. To ensure the targeted conceptual design of a local sustainability strategy or sports development plan, the following points must be clarified:

- Use of digital IT systems to optimize maintenance and sports use
- Information about building materials used, as well as other supporting documents for dismantling
- Incorporation into surrounding open-space structures; links to transport concepts
- Improvement in the usability of sports areas by ensuring outdoor sports facilities are publicly accessible, and by creating multi-use and multifunctional sports areas
- Integration into concepts with climate adaptation measures in order to protect against the effects of heavy rain and heat using multicoded sports areas
- Promotion of biodiverse vegetation areas in supplementary areas.

By combining sustainability and social benefits, Katthage (2022) developed an *S&B Agenda* with indicators that, in practice, can improve the resource consumption, durability and area utilization of outdoor sports facilities, while also

Table 4.3: Assignment of indicators to stakeholders and planning levels (Katthage, 2022)

Planning level	Stakeholders		
		a) Operators and users	b) All stakeholders
Property planning: structural engineering and construction industry	a)	Irrigation technology (economic efficiency) Maintenance (economic efficiency) Life cycle costs (economic efficiency) Intensity of use (economic efficiency) Dismantling and recycling (economic efficiency)	
	b)	Building materials/health and environment (health) Water source (economic efficiency)	
Sports development planning: balancing existing facilities with requirements	a)	Barrier-free accessibility (health) Requirements planning/sports function (economic efficiency) Multifunctional sports surface (economic efficiency) User survey/satisfaction (health)	
	b)	Public accessibility (health) Neighborhood sports areas (health)	
Urban planning: concepts and strategies for society	b)	Biodiversity (safety and biodiversity) Green spaces, trees and shrubs (safety and biodiversity) Sponge city (safety and biodiversity) Sports noise (health) Transport concept (health)	

contributing to human well-being and environmental/climate adaptation. In this context, the "type of operator", "age of sports area" and "LUP type" parameters, and the "large sports areas" and "supplementary areas" area types have emerged as key control variables for shaping sustainability and social benefits.

Katthage (2022) created a scientific basis by combining a sustainability assessment system – which has been verified by a status analysis and expert survey – with the identification of social benefits based on the concept of ecosystem services. The *S&B Agenda* developed can be used in practice for the planning, monitoring and management of sustainability and social benefits, as the indicators have been used to define forward-looking sustainability goals.

Recommendations for practical and scientific consideration

5 Recommendations for practical and scientific consideration

5.1 Practical recommendations

Some municipalities pursue a municipal sustainability strategy (City of Bonn, 2019) or a sports strategy (Klos et al., 2016). Incorporating indicators from the S&B Agenda developed on a theoretical and scientific basis by Katthage (2022) into local sustainability strategies or into recommendations for local sports development plans means that the potential contributions of existing outdoor sports facilities to human well-being can be realized and that the requirement for equal living conditions set out federal funding programs (BMI, 2021b) can be met.

5.1.1 Recommendations for putting indicators into practice

The aspects referred to by Katthage (2022) for putting the S&B Agenda indicators relating to the planning, management and monitoring of sustainability into practice are as follows:

1. The social benefits of outdoor sports facilities arise from the services categories of the ecosystem services (cultural services, regulating services and provisioning services), and also from the newly defined sports facility-specific constructional-functional services. This newly defined service category normally promotes economic efficiency by factoring in contributions to conserving resources and measures for reducing land use.

2. Efforts should be made to take into account all clusters and action levels. Considering just one cluster or action level does not result in the sustainable development of existing outdoor sports facilities.

3. The "must" and "should" indicators represent forward-looking sustainability goals that are to be taken into account as a fundamental principle or generally speaking, depending on the prioritization. "Can" indicators refer to existing strengths that should be built on. The possibility of applying them in a local sustainability strategy or sports development plan is therefore to be investigated on a case-by-case basis.

4. The stakeholders involved in property planning, sports planning and urban development planning are to be coordinated in a project organization that enables the sustainability goals to be implemented across units, offices and departments. Further stakeholders with other specializations – such as urban water management companies, water authorities, energy suppliers, parks departments and urban planning offices – are to be involved as required by the relevant project.

5. In the status analysis, correlations emerged between the assessment results for the random sample and the "type of operator", "age of sports area" and "LUP type" parameters. Nonetheless, it is still relevant to take stock of the requirements of local stakeholders and the structural condition of outdoor sports facilities on a case-by-case basis.

Process steps for putting indicators into practice

In order to introduce the S&B Agenda into a local sustainability strategy or sports development plan, it is necessary to systematically consider how existing outdoor sports facilities can be further developed in a neighborhood, municipality or region in the long term with regard to their ecological, economic and social impact. To implement the indicators that have been developed in a local strategy, Katthage (2022) proposes four process steps based on a sports complex development planning approach (BISp, 2000):

1. A comprehensive status analysis using the indicators referred to in this work is needed to obtain a complete picture of the structur-

al condition of the facilities and the requirements of the stakeholders involved.

2. Besides applying the "must" and "should" indicators, a committee made up of operators, users, local residents and further stakeholders should select "can" indicators for the local sustainability strategy or sports development plan.

3. Local sustainability goals (Table 5.1) and a goal monitor for implementation in a local sustainability strategy or sports development plan are to be defined. It is necessary to decide which measures relating to the indicators are to be implemented, and to what extent and within what period, and to then launch implementation by way of a controlling system. This system of goals in the local sustainability strategy or sports development plan forms the basis for municipal renovation and modernization planning.

4. The local sustainability strategy or sports development plan is to be monitored and updated so that the contents can be adapted to future developments.

Table 5.1: Measures for putting indicators into practice (Katthage, 2022)

Action level		**Examples of implementation measures in practice**	
	Indicator	**Operators**	**Funding bodies/legislators**
Economic efficiency	Requirements planning/ sports function	Including the selection of sports surfaces in requirements planning relating to sports use, for example within the framework of sports complex development planning (BISp, 2000, p. 23ff.).	Incorporating a further funding criterion relating to sports surface capacity utilization and sports requirements (BMI, 2021b, p. 36).
	Irrigation technology	Using irrigation and control technology that prevents high water losses, for example through underground storage, along with irrigation control based on current weather conditions.	Initiating research on the water capacity/storage capability of sports surfaces (DIN 18035-4:2018-12, p. 9). Incorporating the research results into standards (DIN 18035-4:2018-12, p. 9; DIN 18035-3:2006-09).
	Maintenance	Introducing a maintenance handbook that is regularly reviewed and updated in line with local conditions (FLL, 2019, p. 25; DIN 18035-1:2018-09, p. 20).	Granting funding for the operation and dismantling of outdoor sports facilities in addition to funding investment costs.
	Life cycle costs	Calculating life cycle costs per sports surface and hour of use.	Calculating life cycle costs as an extra funding criterion in addition to the criteria of a substantial and above-average investment volume (BMI, 2021b, p. 36) and long-term usability (BMI, 2021b, p. 36).

Action level		Examples of implementation measures in practice	
	Indicator	**Operators**	**Funding bodies/legislators**
Economic efficiency	Multifunctional sports surface	Planning and constructing multi-use, multifunctional or multicoded sports surfaces and sports areas.	Combining sports and non-sports use, and sports surfaces with further climate adaptation functions as an additional funding criterion (BMI, 2021b, p. 36).
	Intensity of use	Considering the potential intensities of use of sports surfaces in requirements planning, for example within the framework of sports complex development planning (BISp, 2000, p. 23ff.), and also in property planning (FLL, 2014, p. 19ff.).	In line with the "requirements planning/sports function" indicator: Incorporating a further funding criterion relating to sports surface capacity utilization and sports requirements (BMI, 2021b, p. 36).
	Dismantling and recycling	Applying recommendations for dismantling and recycling sports surfaces (Hahn, 2020, p. 62 and 65f.).	In line with the "maintenance" indicator: Also granting funding for the operation and dismantling of outdoor sports facilities.
	Water source	Complementing the "irrigation technology" indicator: Using collected precipitation water or treated grey water (Breitenstein, 2016, p. 69; Drewes, 2022; FLL, 2018, p. 105).	Making the "climate protection" funding criterion (BMI, 2021b, p. 36) more specific in terms of avoiding the use of drinking water to irrigate sports surfaces.
Health	Barrier-free accessibility	Applying requirements and recommendations relating to the structural design of sports areas and supplementary areas that offer barrier-free accessibility (DIN 18040-3:2014-12; Schmieg et al., 2010; Berlin et al., 2018; Berlin Senate Department for the Interior and Sport (Senatsverwaltung für Inneres und Sport), 2020; Bergmann et al., 2021).	Making the "absence/reduction of barriers to access" funding criterion (BMI, 2021b, p. 36) more specific with regard to standardized requirements for converting outdoor sports facilities to ensure their barrier-free accessibility.
	Building materials/health and environment	Documenting building materials and building products used (FLL, 2019, p. 25; DIN 18035-1:2018-09, p. 20).	Requirements relating to a standardized environmental product declaration regarding building materials and building products for outdoor sports facilities (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), 2019, p. 40ff.).
	User survey/ satisfaction	Conducting user surveys to ascertain sports requirements within the framework of sports development planning (Göring et al., 2018).	Documenting sports requirements/ satisfaction, for example through sports development planning, as an additional funding criterion (BMI, 2021b, p. 36).
	Public accessibility	Opening up municipal outdoor sports facilities to the public (Bach et al., 2018, p. 8) and creating neighborhood connecting paths running across outdoor sports facilities (FLL, 2018, p. 30).	Making public accessibility an additional funding criterion (BMI, 2021b, p. 36).
	Neighborhood sports areas	Expanding the range of available sports areas by creating new neighborhood sports areas (Bach et al., 2018, p. 9), for example on roofs (Bellevue di Monaco, Official Journal) or under bridge structures (City of Cologne, Official Journal).	Expanding the "long-term usability" criterion (BMI, 2021b, p. 36) to include the multi-use capability, multifunctionality and multicoding of sports areas.

Action level		Examples of implementation measures in practice	
	Indicator	**Operators**	**Funding bodies/legislators**
Health	Sports noise	Involving local residents in planning and redesigning outdoor sports facilities (Eckl, 2007, p. 241).	Adapting emission protection limits relating to sports and leisure noise in Germany's Federal Immission Control Act (German Federal Parliament, 2017a).
	Transport concept	Creating incentives for using low-emission modes of transport such as bikes (Neuerburg & Wilken, 2017).	Expanding and improving infrastructures for using low-emission modes of transport (Federal Ministry for Digital and Transport (BMDV), 2022, p. 26).
Safety and biodiversity	Biodiversity	Promoting and preserving biodiversity, especially in supplementary areas (Berlin Green League (Grüne Liga Berlin), 2013).	Initiating research on improving biodiversity in supplementary areas. Incorporating the research results into standards and regulations (FLL, 2014; DIN 18035-1:2018-09).
	Green spaces, trees and shrubs	Introducing and preserving green spaces, trees and shrubs in supplementary areas.	Establishing requirements relating to green spaces, trees and shrubs in supplementary areas, for example based on ways of making confined spaces green (Haury et al., 2021, p. 66).
	Sponge city (synthetic sports surfaces)	Reviewing the sports-related necessity of sports surfaces made from synthetic materials (Hübner & Wulf, 2016, p. 41; Itten et al., 2020, p. 40) and applying climate adaptation measures such as the type of emergency drainage measures introduced in Hamburg (Schleifenbaum et al., 2019, p. 464ff.).	Providing more specific details on the requirement for above-average technical quality, especially in terms of climate protection (BMI, 2021b, p. 36), through research on climate adaptation measures relating to outdoor sports facilities.
	Sponge city (tamped and sports turf areas)	Giving sports surfaces with low surface temperatures preference over other sports surfaces as far as this is possible based on considerations relating to sports function.	In line with the "irrigation technology" indicator: Initiating research on the structural adaptation of sports surfaces in terms of their water capacity. Incorporating the research results into standards (DIN 18035-4:2018-12, p. 9; DIN 18035-3:2006-09).

5.1.2 Measures for putting the indicators into practice

Based on the results obtained by Katthage (2022), Table 5.1 suggests potential measures to be implemented in practice in order to improve the sustainability and social benefits of existing outdoor sports facilities. A distinction is made here between operators on the one hand and funding bodies/legislators on the other. Operators should implement the measures relating to the sports facility-specific indicators, while funding bodies/legislators must create the implementation framework.

5.2 Future scientific research

Besides the need for research to extend the funding criteria of funding bodies, Katthage (2022) identified two key areas for promoting human well-being through sustainable existing outdoor sports facilities. These are as follows:

1. Health promotion and area utilization of sports areas
   - Benefits for individuals actively participating in sports arise, amongst other things, as a result of personal health promotion, and also through a monetary advantage (Pawlowski et al., 2021) and benefits for society in that a physically active society will have lower health costs (Ding et al., 2016).
   - To ensure these contributions to human well-being benefit a great many people, sports areas must have a high level of usability, which is primarily achieved through multi-use and/or multifunctional sports areas that offer public accessibility for wide-ranging user groups. This also improves area utilization.

2. Resource conservation and contributions to climate adaptation made possible by sports surfaces
   - To promote human well-being, building materials with no health or environmental risks must be used. Furthermore, new sports surface construction methods for climate adaptation are required with regard to multicoding. The supplementary areas are to be ecologically upgraded so that they help maintain the biodiversity of flora and fauna. (Katthage, 2022)

To improve human well-being, further research and development projects are required relating to the building materials and construction methods used for sports surfaces. Furthermore, no generally applicable building approval process exists for building materials used in outdoor sports facilities. As a result, it is currently unclear to what extent the building materials and construction methods used meet the requirements of the Green Deal European action plan as regards making efficient use of resources through a circular economy, restoring biodiversity and combating environmental pollution (European Commission, 2019). Sports surfaces are needed that:

- in order to help keep people healthy and reduce land use:
  - can be utilized for several sports and by people with limitations,
  - enable a high intensity of use and
  - cannot cause any health risks due to the building materials used or as a result of surface temperatures;
- in order to help conserve resources:
  - use innovative building materials as an alternative to plastics and
  - enable a high recycling rate with low machine-based outlay;
- in order to promote climate adaptation:
  - can store precipitation above the ground and underground in the event of heavy rain,
  - dissipate high surface temperatures and enable these to be utilized, and
  - use irrigation systems that conserve water. (Katthage, 2022)

According to Katthage (2022), further research and development work is required for the supplementary areas. To help protect the climate and the environment, it is necessary for the supplementary areas of outdoor sports facilities to be developed in an ecologically valuable way so as to increase the biodiversity of flora and fauna in these areas.

Other existing types of sports facilities, such as sports halls and both indoor and outdoor swimming pools, should additionally be investigated in terms of their effects on human well-being. Solutions for sports halls and swimming pools are also required in a local sustainability strategy and sports development plan so as to promote the social benefits of sports facilities on a holistic basis.

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6.1 List of references

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6.2 List of figures

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6.4 Glossary

S&B Agenda
Based on the United Nations Agenda 2030 (Martens & Obenland, 2017, p. 10), the *S&B Agenda* developed by Katthage (2022) formulates goals for the sustainable development of existing outdoor sports facilities in the form of an action and management framework for decision-makers. The forward-looking action goals of the *S&B Agenda* take the form of prioritized indicators for assessing, promoting and improving the sustainability and social benefits of existing outdoor sports facilities.

Type of land utilization in the land-use plan (LUP type)
A status analysis parameter indicating the primary type of land utilization in the land-use plan for the area that borders on the outdoor sports facilities (based on: Budinger, 2012; Meinen et al., 2016).

Requirements planning
A method geared towards the population's actual requirements and sports activities (BISp, 2000, p. 8). The key question in terms of requirements planning in the context of sports complex development planning is as follows: Which sports facilities and sports amenities are to be provided for the population, in what quantity, in what configuration in terms of sports function and construction, with what equipment and in which locations, now and in the future (BISp, 2000, p. 12)?

Existing outdoor sports facility
An outdoor sports facility that has been constructed and approved following an acceptance inspection and may be in use. Its utilization is a "can" requirement, while its existence is a "must" requirement, as outdoor sports facilities that are not being used for sports can still benefit society – as a producer of fresh air or as a neighborhood meeting point, for instance.

Type of operator
A status analysis parameter indicating the type of organization that is operating the outdoor sports facility. The types of operators covered by this work are municipalities, universities, clubs and the German Federal Government.

Exercise areas
Exercise areas are sports areas equipped with a sports surface. Unlike sports areas, the size and/or marking lines of exercise areas cannot be assigned to one or more sports (e.g. synthetic surfaces for gymnastics and strength sports).

Checklist (in the assessment system)
A qualitative assessment method for the characteristics in the status analysis. The assessment is carried out by adding together the individual checklist points (Löhnert, 2011, p. 10).

Clusters
A concept based on Weigand (2019, p. 103), according to which characteristics within a particular cluster should be as similar as possible (Weigand, 2019, p. 103) so that groupings become apparent. The aim is thus to achieve homogeneity within the clusters and heterogeneity between the clusters (Weigand, 2019, p. 103). The "supply", "common good" and "climate and environment" clusters defined by Katthage (2022) combine several characteristics groups made up of individual characteristics, in line with the attributes used by existing assessment systems (Richter et al., 2018, p. 10).

Surface drainage
The removal of precipitation water – in the case of water-impermeable surface coatings, by routing it into drains connected to a receiving water and, in the case of water-permeable coatings, by means of infiltration and surface runoff (DIN 18035-3:2006-09, p. 5).

Elastic layer
A layer consisting of elastic materials that is installed in situ or made up of factory-prefabricated products. It ensures the planarity and shock-absorbing properties of synthetic turf (DIN 18035-7:2019-12, p. 9).

Supplementary area
An area within a site that cannot be used directly for sports purposes but is additionally required for the functioning of the sports area. Examples

include circulation areas, areas for spectator facilities, building areas, commercial areas, vegetation areas that cannot be used for sports purposes, areas for emission control and areas for non-sports leisure activities (e.g. play areas, barbecue areas, groups of seats, areas for recreational games) (DIN 18035-1:2018-09, p. 7).

Bound elastic base layer
A layer consisting of natural aggregates, elastic granules and elastic binders (DIN 18035-7:2019-12, p. 9).

Filled synthetic turf
Synthetic turf with a pile layer containing fillers (DIN 18035-7:2019-12, p. 10).

Common good
There is no conclusive definition of the term "common good". Its precise meaning depends on local cultural and social factors. What is certain, however, is that an open town or city for the many that is geared towards the common good is committed to values such as solidarity, community, self-efficacy and participation. The key question is how the well-being of each and every individual within a community can be ensured. This requires a process of ongoing negotiation that highlights various perspectives and gives a hearing to different interests, including conflicting ones. The stakeholders work together on redistributing resources, power and the right to have a say (Bruns et al., 2020, p. 70). In the case of outdoor sports facilities, besides cooperation between stakeholders, the focus is also on promoting health and quality of life by providing sports areas for exercise, recreation and the enhancement of social aspects such as interaction and cohesion (based on: Fabian Dosch et al., Official Journal).

Large sports areas
Large pitches (as specified in Table A.1 of DIN 18035-1:2018-09, p. 21) and other sports areas of a comparable size (e.g. riding arenas) that are not covered by the definition in DIN 18035-1:2018-09.

Large pitch
Standard-compliant pitch dimensions (as specified in Table A.1 of DIN 18035-1:2018-09, p. 21).

Types of area
Outdoor sports facilities normally comprise two types of areas – sports areas and supplementary areas. Sports areas are split into size-related categories based on DIN 18035-1:2018-09 – large sports areas, small sports areas and athletics areas.

Filler
A mineral, synthetically produced a natural elastic building material that is normally incorporated into the pile layer of the synthetic turf for technical, protective and sports-function-related reasons (DIN 18035-7:2019-12).

Action levels
Action levels are groupings of indicators based on the benefit categories (Staub et al. 2011) of ecosystem services and also on the three pillars of sustainability. This does not constitute a hierarchical classification, but rather a grouping of aspects with similar benefits in one unit based on an area-related context. Katthage (2022) defines three action levels relating to the social benefits of existing outdoor sports facilities – "economic efficiency", "health" and "safety and biodiversity".

Main types of sports
A status analysis parameter indicating which types of sports are primarily played in the sports areas.

Indicators
Indicators are a kind of pointer. In specific terms, they describe the forward-looking sustainability goals for specific issues, such as multifunctional sports surfaces or public accessibility. Indicators are a content-based combination of sustainability aspects and social benefits. In accordance with DIN EN 16309, an indicator is therefore defined from the perspective of the "assessment of social performance" (DIN EN 16309:2014-12, p. 5). The distinctive feature of this assessment is that it requires both a quantitative and a descriptive approach (DIN EN 16309:2014-12, p. 5). The checklists and quality (performance) levels for the characteristics are used to make the descriptive approach quantifiable. The goal of the assessment is to achieve the category "Strengths, green".

The indicators do not specify rigid limit values, but are to be adapted to the specific conditions of the location in consultation with the stakeholders, for example using multifunctional sports surfaces or ensuring public accessibility. To apply this in practice, they have been prioritized into "must", "should" and "can" indicators based on an analysis of strengths and weaknesses.

Maintenance
All technical and administrative measures as well as measures by the management team during the life cycle of a property that are aimed at preserving or restoring its operational condition so that it can serve the required function (DIN 31051:2019-06, p. 4).

Maintenance goals
Definition of the required appearance and functionality based on owner goals and geared towards the public, customers, users, staff or costs during a specified period (FLL, 2019, p. 12). This includes a maintenance schedule for carrying out maintenance services.

Maintenance services
Operational services associated with completion and follow-up care that serve to preserve or restore the operational state of outdoor sports facilities (FLL, 2019, p. 12).

Maintenance planning
Administrative planning tasks to prepare, coordinate and monitor maintenance services.

Small sports areas
Small pitches (as specified in Table A.2 of DIN 18035-1:2018-09, p. 21) and other sports areas of a comparable size (e.g. skateparks) that are not covered by DIN 18035-1:2018-09.

Small pitch
Standard-compliant pitch dimensions (as specified in Table A.2 of DIN 18035-1:2018-09, p. 21).

Consumptive/non-consumptive value
Relating to consumption (Duden, 2020).

Criteria
Criteria of existing assessment systems are normally explained in criteria profiles and include the objective, the positive direction of action and the assessment methodology (Richter et al., 2018, p. 11).

Synthetic coating
Elastic single-layer or multilayer, water-permeable or water-impermeable structure of a synthetic surface on which the properties relating to its sports and protective function depend. This normally consists of aggregates (rubber elastic granules and/or fibers), binders (synthetic organic polymers) and solid or liquid additives (e.g. activators, moisture absorbers, stabilizers or thixotropic agents) (DIN 18035-6:2014-12, p. 7).

Synthetic surface
Water-permeable or water-impermeable, multilayer, permanently installed structure comprising a synthetic upper layer, asphalt layer(s) and a base layer without binders (DIN 18035-6:2014-12, p. 6).

Synthetic turf/pile layer
The synthetic turf layer consists of synthetic fibers (synthetic filaments/ribbons), a carrier fabric and a backing (DIN 18035-7:2019-12, p. 10).

Synthetic turf area
A sports surface in the form of a tufted, machine-knitted or woven carpet that has a pile resembling natural grass (DIN 18035-7:2019-12, p. 10).

Synthetic turf system
All components of synthetic turf that influence its performance or biomechanical properties, including the synthetic turf layer, filler and elastic layer, and all base layers that contribute to the sports surface's performance (DIN 18035-7:2019-12, p. 8).

Athletics areas
Standard-compliant areas for running, jumping, throwing and shot-put disciplines (DIN 18035-1:2018-09, p. 6).

Life cycle
A number of phases that a property passes through, starting with conceptual design and ending with disposal (DIN EN 13306:2018-02, p. 23).

Life cycle costs
The total costs incurred during the life cycle of a sports facility – production, utilization and end-of-life costs (Eßig et al., 2015, p. 319).

Multi-use sports surfaces
The marking lines, sports and protective functions, and technical properties of these sports surfaces enable them to be used for multiple sports (based on: Ott, 2012b, p. 105).

Characteristics
In line with the criteria of existing assessment systems, characteristics constitute the third level of detail in the assessment system of Katthage (2022). Unlike the criteria, they 1.) can be made up of subcriteria of the criteria profiles, 2.) have, in some cases, been newly combined from criteria of several assessment systems or 3.) have been newly formed based on the literature analysis.

Characteristics groups
Based on the groups of criteria of existing assessment systems, characteristics groups constitute the second level of detail in the assessment system of Katthage (2022). The "maintenance and dismantling", "location", "utilization", "vegetation" and "water" groups combine several characteristics into one thematic unit.

Modernization
The modification or improvement of a property, taking into account technological progress, in order to meet new or changed requirements (DIN EN 13306:2018-02, p. 37) and resulting, for example, from a change in the demand for sports surfaces or sports areas due to new types of sports.

Multicoded sports areas
Sports areas with appropriate overlapping and linking of various functions such as climate adaptation, rainwater management and cooling, along with opportunities for spending time and recreation (F. Dosch et al., 2017, p. 49). The focus is on the functions of the sports areas and the structural adaptation of sports surfaces.

Multifunctional sports areas
Besides their suitability for sports use, sports areas with appropriately structurally modified sports surfaces can also be used for non-sports purposes, for example by kindergartens or for events (based on: Haury et al., 2021, p. 20).

Benefits
In microeconomics, benefits are defined as economic value or the ability of goods to meet a specific need of the consumer household (Suchanek et al., 2018). An ethical aspect is also defined, whereby benefits are understood as a good feeling, social respect and individual identity (Suchanek et al., 2018). Katthage (2022) uses the term "social benefits" in the same way as Marzelli et al. (2012, p. 10), understanding them as services that deliver economic, material, health and psychological benefits for people.

Expected lifespan
The period up until the expected end of use of a sports surface. This can be determined by the wear of sports surfaces, or by a change in the utilization goal of the operator or user. It results in the sports surfaces being dismantled or reconstructed (FLL, 2018, p. 14).

Intensity of use
The maximum possible usage period of sports surfaces in hours per week or year based on optimal maintenance (FLL, 2014, p. 19).

Utilization capacity
Hours of use/play that are possible on sports surfaces without damage in the form of premature wear that reduces the expected lifespan.

Hours of use
A parameter indicating sports surfaces' intensity of use, with hours serving as the unit of measurement. A distinction is made between actual and theoretical hours of use (Itten et al., 2020, p. 18).

Topsoil pitch
Sports turf area without a technical structure incorporating a drainage layer, as specified by DIN 18035-4:2018-12.

Parameters
Katthage (2022) defines the following parameters for her analysis: type of operator, main type of sport, age of sports facility / sports area, type of sports facility and type of land utilization in the land-use plan (LUP type). These parameters are the framework for assessing and improving sustainability, and also influencing factors for achieving sustainability goals.

Planning levels
Planning levels are specialist disciplines involved in planning outdoor sports facilities. Katthage (2022) makes a distinction between property planning in the sense of landscape architecture, sports planning in the sense of sports complex development planning, and urban planning.

Quality levels
A qualitative assessment method for the characteristics in the status analysis. All the requirements for a particular quality level must be met in order to achieve a higher rating (Löhnert, 2011, p. 10).

Renovation
Restoration of a property, taking into account technological progress, to ensure the functionality of sports surfaces for the types of sports played to date (based on: DIN EN 13306:2018-02, p. 44).

Protective function
A sports surface property that serves to relieve the strain on the user's locomotor and musculoskeletal system when running, jumping and playing ball games, and is also designed to reduce the risk of injury (DIN 18035-7:2019-12, p. 10).

Sponge city principle
The cooling effect of ground surfaces and vegetation areas is an aspect that is growing in importance in towns and cities in terms of both heat-related precautions and rainwater management in harmony with nature. Green spaces adequately supplied with water are natural urban "refrigerators". This cooling effect can be enhanced by storing rainwater, implementing soil-improving measures and continuously supplying vegetation with water. Promoting the "sponge city principle" and developing sustainable storage and irrigation systems are therefore key future tasks for climate-adapted towns and cities (Becker et al., 2015, p. 10).

Age of sports facility
A status analysis parameter indicating the period when the outdoor sports facility was completed.

Sports facility types
A status analysis parameter. Based on DIN 18035-1:2018-09, Katthage (2022) distinguishes between the following types of sports facilities: sports park, competition facilities, large pitch.

Sports surfaces
Sports surfaces are systems developed specifically for sports. They provide a sports and protective function and the necessary technical properties (DIN 18035-7:2019-12, p. 10).

Sports surface offering
The sports surface offering is defined, in particular, based on usability – for example, monofunctional or multi-use sports surfaces and multifunctional or multicoded sports areas. This also affects maintenance and the intensity of use.

Sports development planning
A targeted, systematic and practical planning process for designing sports premises and specifying these in an overall concept (Göring et al., 2018, p. 2f.).

Pitch
An area for sports use with marking lines to indicate the boundaries (DIN 18035-1:2018-09, p. 6). Also referred to as a "playing field" in some English-speaking countries.

Sports area
An area constructed and equipped in a way that makes it suitable for competitive sport and also for informal types of sports activities, physical exercise and leisure activities (DIN 18035-1:2018-09, p. 6)

Age of sports area
A status analysis parameter indicating the period when the sports area was built, renovated or modernized.

Demand for sports areas
The demand of people actively participating in sports for sports areas with appropriate sports surfaces for the relevant types of sports.

Sports function
Property of a sports surface that serves to ensure the best possible application of the various techniques of individual sports, while also preventing excessive risks relating to stress on the locomotor system and fatigue due to excessive expending of energy (DIN 18035-7:2019-12, p. 10)

Sports park
An outdoor sports facility consisting of several large pitches, small pitches and athletics areas, as specified in Annex C of DIN 18035-1:2018-09, including spectator facilities.

Sports turf area
A sports area with ground cover consisting of grass that comprises an upper turf layer, a base layer and, if appropriate, a drainage layer and a structural foundation (DIN 18035-4:2018-12, p. 6).

Sports complex development planning
A planning method to determine the requirements for sports facilities using data about a specific population's sports activities (BISp, 2000,p. 7f.) for a defined period.

Statements
Based on the results of the literature analysis and the status analysis, Katthage (2022) derived statements to be rated by specialists in terms of their relevance and practicability.

Technical function
Property of a sports surface that serves to maintain the sports and protective functions on a sustainable basis. The technical function is geared, in particular, towards wear and ageing behaviour, water permeability and dimensional stability (DIN 18035-7:2019-12, p. 10).

Tamped surface
The uppermost layer of a tamped area, the properties of which determine the sports and protective functions for users. Single-layer surfaces are used for pitches and athletics facilities, and single-layer or multilayer surfaces for tennis courts (DIN 18035-5:2021-03, p. 8).

Tamped area
A water-permeable, multilayer sports area made up of building material combinations (mixtures of aggregates) without binders, comprising a tamped surface, a dynamic layer and an unbound base layer that together form the upper structure (DIN 18035-5:2021-03, p. 6).

Environmental compatibility
Assessment of the effects of elastifying layers and synthetic turf with or without elastic fillers on soil and groundwater, which are natural resources to be protected (DIN 18035-7:2019-12, p. 10).

Supply
The original German term used for this cluster ("Versorgung") means providing something, but also looking after something (Duden, 2020). Accordingly, besides covering the provision of resources such as building materials, personnel and funding, the "supply" cluster also includes measures related to maintenance and the optimization of the intensity of use (Katthage, 2022).

Receiving water
An existing body of water, drainage network or infiltration system (DIN 18035-3:2006-09, p. 6).

Competition facility
An outdoor sports facility consisting of a large pitch with athletics areas, as specified in Annex C of DIN 18035-1:2018-09. Further sports areas, normally small pitches, may also be present.

Additive
A material or substance to improve technical vegetation properties (DIN 18035-4:2018-12, p. 8) and/or properties relating to sports, protection or other technical functions.

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