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Sustainable access to sports facilities in an urban context

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ABSTRACT

The location of sports facilities impacts on the possibilities for citizens to join and be active in sports activities; many of the trips that sports activities generate every day use unsustainable modes of transportation. As such, ensuring accessibility to sports and recreation activities presents increasing challenges in relation to both negative climate effects and urban inequalities. This paper studies the location of, and accessibility to, sports facilities, analysing the catchment area of facilities from a socioeconomic perspective in order to advance knowledge on sustainable and equal accessibility.

A set of methods is tested with the aim of increasing our understanding of the relation between access to sports facilities and municipal goals regarding climate and inequality. The results show that the city of Uppsala in Sweden affords unequal accessibility to sports facilities as a result of their location in the urban context and a result of the design of the street network, of public space. The results provide key insights regarding how urban planning and accessibility relate to the possibilities of practicing a sport and potentially reaching sports locations using sustainable modes of transportation. The analysis further illustrates that the conditions for introducing sustainable travel modes vary in relation to different sports, a finding which calls for the development of analytical analyses and adapted strategies that can take local and specific conditions into account, rather than uniform and normative approaches.

KEYWORDS

Accessibility to sports, sustainable transportation, urban planning, urban inequalities, living conditions

1 INTRODUCTION: EQUAL AND SUSTAINABLE ACCESSIBILITY TO SPORTS

Providing access to sports facilities and sports activities in urban areas presents increasing challenges in relation to negative climate effects and urban inequalities. Today, the staging of sports activities and events results in a large carbon footprint—not least as the result of travel to and from activities, which produces greenhouse gas emissions and demands high levels consumption of energy (Hognestad et al. 2022). At the same time, accessibility to sports and recreation is an essential factor in creating opportunities for supporting and promoting increased physical activity among the citizens, which exerts positive effects on public health, especially for children and adolescents (SOU 2023:29). Moreover, engagement in sport associations and sport activities has positive effects from a social perspective, potentially strengthening social networks, bridging social polarisation, and affecting urban segregation patterns. Thus, the location of sports facilities in the urban context becomes crucial and influences the level of access that different neighbourhoods afford. In Sweden, the municipalities—primarily, their Department of Urban Planning and Department of Culture and Leisure—are responsible for locating sports facilities. Because the location and distribution of facilities across the city affects accessibility for citizens, it is related to sustainability goals, both those that address climate issues and those that address urban inequality.

Climate change is affecting possibilities to practice sports. Conversely, sports—and specifically *how* they are practiced—often have a negative effect on the climate, sometimes even aggravating problems (Fredman et al. 2018; Larneby et al. 2022; Svensson et al. 2023; the Research Program Mistra Sports & Outdoor 2020-2024). Interestingly, these negative effects are increasingly being problematized by sports organizations, athletes, supporters, and others interested in aiding the transition to more sustainable habits and norms, including the negative effects of events and the transfer of trips to sustainable modes of transportation (McCullough & Kellison 2018; Moser et al. 2019; Riksidrottsförbundet 2023a; Backman & Svensson 2022; Hognestad et al. 2022; Hautbois & Desbordes, 2023). A similar problematization of outdoor activities has been on the agenda for a longer time (Sandell & Sörlin 1994). In this study, focus is placed on accessibility to sports facilities, the potential to reach them using sustainable travel modes, and how access is closely connected to urban planning and urban design.

In Sweden, the transport sector is responsible for a third of the greenhouse gas emissions (Prop 2020/21:251). There are, however, large differences in these effects across the country. In Uppsala County, the share of emissions caused by transport is as much as 46%, including

domestic transportation (sverigesmiljomal.se)[1]. Sweden has adopted an ambitious goal, aiming to reach zero greenhouse gas emissions by 2045 (Prop. 2020/21:151). The pursuit of this goal will influence society on many levels, including spatial and urban planning, urban design, and infrastructure investment as well as practices and habits. Transport strategies have mainly, up until now, focused on travel that is related to commuting to work and studies, while travel related to leisure and recreational activities has not been prioritized, despite the fact that many such trips use non-sustainable modes of transportation. Besides the goals for transport in Sweden, there are goals addressing access, safety, environment, and health that are equally important to acknowledge when it comes to providing and planning for sports facilities (Prop. 2008/09:93).

Uppsala's transportation goal aims for all trips within the municipality to be carried out using sustainable transportation modes by 2050, according to the 'Program för mobilitet och trafik' (2022). Municipal strategies have been put in place to address the localization of goal points to improve the accessibility of sustainable modes such as walking, cycling, and public transportation, as well as to develop street networks to increase connectivity (Program för mobilitet och trafik, 2022, p.7). The distribution between modes of transportation is currently as follows: 16% walking, 40% cycling, 12% public transportation, and 32% private vehicles (Handlingsplan för mobilitet och trafik, 2021, p.4). The goal for 2030 is to achieve a distribution with 16% walking, 55% cycling, 12% public transportation, and a reduction to 17% for private vehicles.

Uppsala municipality has a special planning program for sports and leisure activities that states that access to an active leisure, which promotes good health, should be balanced across genders, between sports and other leisure activities, and between organized and non-organized activities; it should also be accessible irrespective of socioeconomic background (Idrotts- och fritidspolitiskt program, 2015, p.4). The overarching aim is to provide equal opportunities for citizens. In the program, there are a number of goals relevant to the focus of this study. First, it is stated that access to facilities should be satisfying and easy to reach by foot, bike, or public transportation. Second, the facilities in themselves should be accessible, safe, attractive, and pleasant (Idrotts- och fritidspolitiskt program, 2015, p.5). The non-sustainable travel necessitated by leisure activities has a negative effect on climate, and risks increasing social inequalities within sports since groups with fewer resources and lower access to private cars

[1] https://www.sverigesmiljomal.se/miljomalen/begransad-klimatpaverkan/klimatpaverkande-utslapp/uppsala-lan/#:~:text=Under%20perioden%201990–2021%20har,Uppsala%20saknar%20betydande%20tung%20industri. (Accessed, November, 13, 2023).

may be excluded from activities that are not within easy access from where they live or within easy access using public transportation.

In order to achieve the goal of equal access, as well as ensuring that sports facilities can be reached using sustainable modes of transportation, an urban planning practice is needed that provides for sports and recreation in proximity to where people live, or in proximity to sustainable modes of transport—e.g., sports facilities that are accessible by means of active transportation (including walking and cycling) or public transportation. The design and organization of cities impacts greatly on the potential to reach sports facilities. This paper presents a study of Uppsala, exploring how this impact may be analysed and described. Through the study, firstly, an analysis of accessibility to sports facilities was performed, which, when connected to a socioeconomic index, identified possible inequalities. Secondly, the catchment areas for two different sports and their facilities—football fields and ice rinks—were analysed using a method taking urban form into account. Finally, an in-depth study focusing on the local catchment areas of ice rinks, and their distance from the homes of members of three different ice associations, was performed. The paper presents approaches and methods for capturing opportunities for sport, considering inequality aspects as well as sustainable transportation aspects; the results increase our understanding of the present situation and elucidate potentials for transitioning to a situation of equal and sustainable travel to sports facilities.

2 THEORY AND LITERATURE

According to a national travel habits survey, leisure-related trips make up 22% of the total amount of all domestic trips in Sweden (Trafikanalys 2023). Of these, as much as 62% are carried out by car, 8.2% are performed using public transportation, while the share of trip made by means of walking and cycling constitute 25%. When comparing municipalities, large differences exist regarding the modes of transportation used. One travel survey undertaken in the City of Uppsala showed that the share of cycling (35%) was higher than the national share, while walking comprised 14%, public transportation 13%, and cars 36% (Uppsala kommun, 2015, p.16)[2]. The survey further included information about leisure trips, which shows that the use of cars was higher than average, namely 42%, while public transportation was lower, only 10%, cycling comprised 28% and walking 15% (ibid., p.23). The Uppsala travel survey reveals that for trips with distances up to five kilometres, cycling was a frequently used transportation mode and the share of transportation by car increased for trips longer than three kilometres. Walking

[2]Uppsala municipality: Travel Survey. (2015). https://www.uppsala.se/contentassets/0f67ce2bd3ce47169ceae0d716547ba8/resvaneundersokning-2015.pdf (Accessed 20 January, 2024).

was generally used for distances up to two kilometres, after which its share dropped and was replaced by other modes of transportation (ibid., p.28).

On the national level, the Swedish Environmental Protection Agency states that transportation via car needs to be reduced and that this requires interventions into the built environment—in general, urban planning needs to plan to minimize the need for transportation (Naturvårds-verket 2023). Strategies for public transportation in Sweden mainly focus on trips to work and studies, i.e., commuting. Trips for leisure activities have more or less been ignored. As new goals for decreasing the greenhouse gas emissions of the transport sector are becoming increasingly stricter, interest in reducing trips for recreation activities is growing. A trend exists whereby low daily amounts of travel (primarily related to work) tend to be offset by more extensive leisure mobility (Naess 2006). Recent studies based on mobile phone data have found increased activity among high-income groups compared to low-income groups, and comparing weekdays and weekends; results suggest the existence of significant social inequalities in leisure-related trips (Toger et al. 2023).

The 'Program för mobilitet och trafik' in Uppsala (2022), emphasizes the importance of achieving 100% sustainable traveling (e.g., walking, cycling, or fossil-free transportation) while reducing the need for traveling. An urban planning practice able to takes such aims into account is needed: one capable of designing a city that is accessible, where amenities and resources are located in proximity to where people live, work, or study, which can be reached using public transportation. Furthermore, the program emphasizes *equal access* to sports facilities for different societal groups—a perspective included in this investigation.

The location of sports facilities in different parts of the city influences the level of access they are afforded. This study investigates the accessibility enjoyed by different socioeconomic groups, with the aim of describing the potential to reach these locations using sustainable modes of transportation. Uppsala municipality's policy for sports and leisure (2015) describes sport as a key to welfare and increased quality of life, going on to state that conditions and opportunities to participate in sports and recreation should be equal for all inhabitants, independent of their socioeconomic background (Idrotts- och fritidspolitiskt program, 2015, p.3). The aim is to achieve adequate access to facilities for sports and recreation and ensure that such locations and facilities should be easy to reach by walking, cycling, or using public transportation. There is a special plan for the development of sports facilities (Lokalförsörjnings-plan för idrotts- och fritidsanläggningar 2021), where the current situation is described

highlighting if there is a need/demand for facilities and it identifies where new investment and development is needed.

Working within the research programme Mistra Sport & Outdoors, under the theme focusing on sustainable transportation, a co-creation process was initiated with the engaged actors. The group discussed hindrances and opportunities in relation to decreasing unnecessary transport and moving from unsustainable transport modes, primarily cars, to other more sustainable modes, i.e., walking, cycling, and using public transportation (Larsson et al. 2022). Clearly, and as highlighted by actors involved in the project, different sports do not have the same potential to change practices and habits (Larsson et al. 2022), as different practices, norms, and behaviours apply (Laxdal et al. 2022; Lagrell 2024). One factor at play, in which urban planning plays a significant role, is the location of facilities and their distribution in the urban fabric. Some typical examples of distribution were tested in this study. Sports that tend to have local catchment areas include, for example, football, basketball, and gymnastics (during athletes' first years, not at an elite level). Such sports have their facilities distributed throughout the city, while others, like ice sports and swimming sports, often depend on highly specialized facilities that are very few. For children and adolescents, this means that they are likely to have long distances to travel to practice, and limited opportunities to walk or cycle.

So, what conditions in the environment are important for walkability and for creating walking-friendly cities? Cervero & Radisch (1996) argue that some land-use distributions and characters of local environments—e.g., pedestrian-orientated development and compact, mixed-use environments—are more conducive to walking. The importance of the immediate conditions of a street—e.g., the design of the sidewalk, street frontages of the bottom floor, or dimensions—is also often highlighted (Ewing et al. 2006; Ewing & Handy 2009; Gehl 2013). In addition, a well-connected and spatially coherent urban structure benefits from increased footfall as well as dwelling time (Carmona 2015). However, to understand pedestrian movement in an urban context, where we find overlapping trajectories from longer and shorter trips, it is necessary to acknowledge the street network in itself, including aspects of centrality and connectivity. Space syntax theory has found correspondences between the configurative properties of public space (the street network) and walking, including the distribution of movement flows (Hillier et al. 1993; Hillier & Penn 1996; Hillier & Iida 2005; Hillier 1996). Two useful measures are *integration* and *betweenness*: integration captures how accessible each street line is from all other parts of the network (measured as topological distance) and betweenness identifies the shortest path between all possible locations of origins and destinations. The 'shortest path' may either be described as the metric distance or the fewest directional changes, measuring the angle. A so-

called ‘axial map’ (or segment map) that represents the street network is used for analysing properties that are relevant from a walking perspective (Hillier 1996; Karimi 2012) capturing the spatial relations with implications for movement flows and social processes (Hillier & Hanson 1984). Spatial integration—measured as topological or angular distance between open spaces and revealing the most well-connected spaces (streets/paths) to all other spaces within a system—has been proven to correspond to the distribution of pedestrian flows, and hence, may predict pedestrian movement (Hillier et al. 2012). It is also shown that density plays a role, measured in a way that captures the density found in a certain catchment area, also called ‘accessible density’, i.e., the density found within a certain distance threshold (Legeby 2010a, p.159; Berghauser et al. 2019, p.45-46). Moudon et al. (2007) have identified several attributes in the walking environment that are associated with walking where distance turns out to be a key factor besides the presence of daily utilitarian destinations, land-use mix, and population density, which all play a role as well (Lee & Moudon et al. 2005; Lee & Moudon 2006; Moudon et al. 2007). Similarly, conditions encouraging walking are often beneficial for cycling and according to Handy (2020) principles like proximity, land-use mix, high densities of streets and intersections (connectivity), and perceived distances are all important factors. Cervero and Kockelman (1997) emphasize the importance of density, diversity, and design (the so-called ‘three Ds’), arguing that compact, diverse, and pedestrian-oriented cities can influence travel behaviour by reducing trip rates and encouraging non-auto traveling.

Access to goal points—in this case, the sports facilities in themselves—is key for understanding the potential for enabling walking and cycling. It is argued that it is important to gain a clear picture of the conditions to increase the understanding of what kind of interventions will be relevant and adequate. This paper builds on an earlier study which analysed access to key societal resources in Uppsala (Legeby & Chen 2022b). The study showed that access to urban opportunities differed greatly in different parts of the city, and that reduced opportunities in many cases affected underprivileged groups. This paper develops the inequality perspective in relation to sports facilities and investigates how these locations are distributed in the urban fabric and how access is provided, by comparing groups having different socioeconomic profiles. This opens for a discussion about urban inequality as it relates to sports activities, acknowledging the negative effects of sports-related unsustainable transportation and strong car dependency.

Turning to the trips that are generated by sport and recreation activities, it is argued that these trips have not been prioritized in transport planning nor seen as an important aspect when localizing sport facilities. It is possible to see that sports movement and sports associations in

many countries are increasingly mobilising to work strategically with sustainability issues (Millington et al. 2022). In Sweden, the increased awareness of sustainability issues related to sport activities is evident, for example, in strategies formulated by the Swedish Sports Confederation (Riksidrottsförbundet 2023c). This paper investigates the intersection between sustainable mobility for trips generated by sports activities, seeing the sports movement as a potential contributor to sustainable development and urban planning processes for locating sports facilities, in line with efforts to achieve social sustainability goals by means of enabling equal access for different social groups.

A common determinant factor when planning for sport facilities from a municipal perspective is the availability of land (for the municipality or for the sports actor)—land, in other words, that is ready to be developed from a short-term perspective. Unfortunately, issues of accessibility by walking and cycling, questions of how sports facilities reproduce or combat patterns of inequality, and the design ambitions and attractiveness of these facilities are all often considered secondary in municipalities' approaches. The architectural requirements of the design of buildings are not prioritized, which often results in environments that are perceived as unsafe and solutions that are large in scale and have not been adapted for children and adolescents who spend a lot of their leisure time at, and in the proximity of, these facilities.

So how extensive is the organized sports movement and what are the trips generated on the occasions that sport is practised? Swedish Sports Confederation (RF) organise approximately 19,000 sport associations and have in total 3.3 million members (Riksidrottsförbundet, 2023b). The Confederation estimates that there are as many as 150,000 organized sport activities carried out every day in Sweden (RF 2023c), besides which, there are also competitions, tournaments, and events. The scale of these activities demands that greater attention be paid to trips generated by sports activities and suggests that great potential exists for interventions with positive effects for climate, public health, and equality. Lately, the Swedish Sports Confederation has started to pay attention to trips related to sports activities, nominating this as one of its highest priorities and highlighting the so-called 'double impact' effect in reducing emissions *and* increasing accessibility within sport (Riksidrottsförbundet, 2023c). Among other things, the Confederation has initiated a campaign to encourage sustainable travel habits with the goal of decreasing emissions and improving public health. Furthermore, it is suggested that improved accessibility by walking (and cycling) has a direct positive effect on social groups with limited resources—as such, access is also an issue for social inequality. Earlier studies have shown that low-income families often lack access to a car or driver's license, and that public

transportation is perceived as expensive and fewer people have access to bikes or adopt cycling habits within this group (Henriksson et al. 2024).

Uppsala has a population of 234,000 inhabitants and approximately 260 sports facilities, including outdoor and indoor (Lokalförsörjningsplan 2021). In addition to this, some sports associations run facilities that are not owned by the municipality. A travel habit survey of children (2021) reveals that 37-44% walk, cycle, or use public transportation to reach leisure activities including sports. Hence, as high as 56-64% get to their activities by car and it is estimated that half of the children are given lifts to their leisure activities (most often by parents). As many as 28% of the informants argued that getting there by car is the only possible alternative for them. This means that families with poor access to sports facilities where they live, in combination with low access to private cars, are especially disadvantaged. To explore this, I studied accessibility in relation to different sports facilities, superimposing the results on a range of socioeconomic indicators.

3 METHODS AND DATA

The study used data provided by Uppsala municipality, including outdoor and indoor sports facilities, data on residential locations, and socioeconomic indicators based on data from Statistics Sweden for 2018. The street network was represented by an urban model of Uppsala city developed in earlier research projects (Legeby, Koch, Miranda 2019; Legeby & Chen 2022a), and for analysis of the municipality at large I used a model produced for the Mistra Sport & Outdoors research program[3]. Accessibility was, in this study, measured in terms of metric and topological distances through the street network, mirroring the network for walking and cycling. 'Metric reach' was used to determine the catchment area for pedestrians and cyclists and metric reach from sport facilities was analysed (Peponis et al. 2008; Legeby 2010b). The spatial and accessibility analysis employed Place Syntax Tool (Stavroulaki et al., 2019). Specifically, we conducted an analysis of overall access to sports facilities using the full data set of indoor and outdoor facilities provided by the municipality of Uppsala (for details, see Legeby & Chen 2022a), further analysing the number of facilities within a certain walking distance from residential home addresses[4]. The resulting matrix shows the accessibility of facilities alongside the level of income in different neighbourhoods.

[3] Urban model of the municipality developed by Jorge Gil, 2023.
[4] Analysing the so-called 'attraction reach' using the Place Syntax Tool.

To illustrate and compare how accessible the facilities for different sports are, an analysis of the covering ratio of the facilities was developed. To do this, I measured the distance from each street segment to the goal points and hence the coverage ratio of the urban fabric. For this analysis, the study used football fields and ice rinks, as these are highlighted as rather different sports, drawing from interviews with representatives from the municipality and the district sports association (RF-SISU). Football is described as a sport with a local catchment area and facilities that are distributed across the city, while ice rinks are fewer and are clustered in one specific location (as a result of a municipal strategy).

Skating is a rather common and popular activity, especially during the winter season. In studying the 'mix' (the diversity) of the population within the catchment areas of the ice facilities in the city, the analysis addressed facilities used by both public and organized sports associations. The number of residents within a two-kilometre radius—potentially within walking-cycling distance—was measured. According to the municipal travel survey, walking/cycling were common modes of transportation at distances up to two kilometres. Data from the socioeconomic index provided by the municipality, an index that combines the three variables of income, education level, and employment rate, was then added to the analysis. The data of the residents was aggregated at the level of administrative small geographical units[5] and residents living within these units were accorded a specific value.

Turning to the situation for organized activities on ice, including ice hockey and figure skating, I analysed the distance travelled by members of three associations, from their home locations to the cluster of ice rinks located in Gränby, which is the main centre for organized ice activities in Uppsala. The dataset included in total of 3,823 members from three associations.[6] According to the municipality, a third (1,160 people) are members who practice ice hockey or figure skating (here defined as 'the athletes'). It is noteworthy that there is no available data on the home addresses of those who are actively practicing sports in Sweden, neither at the municipality nor at the Confederation (RF/SISU) level. Such data is kept by the associations and sport clubs, but there is no municipal/region/national register. The RF/SISU data includes all members, and thus was used in this study. The lack of available data is a limitation for these kinds of studies.[7]

[5] The administrative and geographical areas used here are the so-called NYKO 5.
[6] Data provided by RF/SISU, County of Uppland. The hockey association has 2,495 members, and the two figure skating associations have 1,328 members in total.
[7] The municipality has less access to data regarding where the athletes/members live than RF/SISU but is still the actor responsible for the planning and operation of sport facilities.

In addition to the above, a selection of policy documents, plans, and programs from the municipality relating to planning and development of municipal sports facilities as well as relating to transportation were reviewed. Semi-structured interviews were also carried out with officials and representatives for the sports associations, which influenced the design of this study.[8]

4 RESULTS

The public facilities in the municipality of Uppsala are used both for school activities and by sports associations and their organized activities. According to the municipal program for sport and leisure (2015), facilities should be located to enable a mixed constitution of social groups that contributes to decreasing polarisation. The approach advanced in this paper was designed to address municipal intentions regarding achieving adequate and equal accessibility and enabling the use of sustainable transportation, and to take into account socioeconomic aspects: by analysing the current situation, a better understanding can be developed regarding adequate strategies and investments for the future.

Our analysis of access to indoor and outdoor facilities from home locations in the city of Uppsala linked that access to a socioeconomic index, also considering differences in accessibility to different sports. The focus was primarily placed on the possibility to reach facilities by means of walking and cycling, i.e., active transportation, which is especially important for groups with fewer resources and children and adolescents. The analyses are divided into four sections, presented below.

4.1 Unequal access to sports facilities

The first analysis explored the accessibility from each residential address in the city to all sports facilities, focusing on possible inequalities. This captured the facilities that are provided locally and thus possible to reach using sustainable transportation means, which are argued to be favourable both for climate and from a public health perspective; in this, it also captured a number of important aspects of urban inequality.

Uppsala municipality provides data on all of its sports facilities as well as a socioeconomic index regarding its residents. Accessibility from each residential address in the city (Euclidian distance) to each outdoor and indoor sports facility was analysed. Residents were divided into three

[8] The interviews have been guiding the design of the study but will not be described in detail in this paper.

groups according to their income levels. The results show that both low-income *and* high-income neighbourhoods can afford poor access to sports facilities. However, from a social sustainability perspective, it is especially problematic when low-income neighbourhoods are disadvantaged by inadequate access to sports amenities, as residents have fewer mobility opportunities. This means that the idea of equal access the municipality aims for is not mirrored in the current situation. Neighbourhoods in the southern part of the city in particular stand out, e.g., Ultuna, Nyby, and Ulleråker, as well as Eriksberg and Nyby in the north.

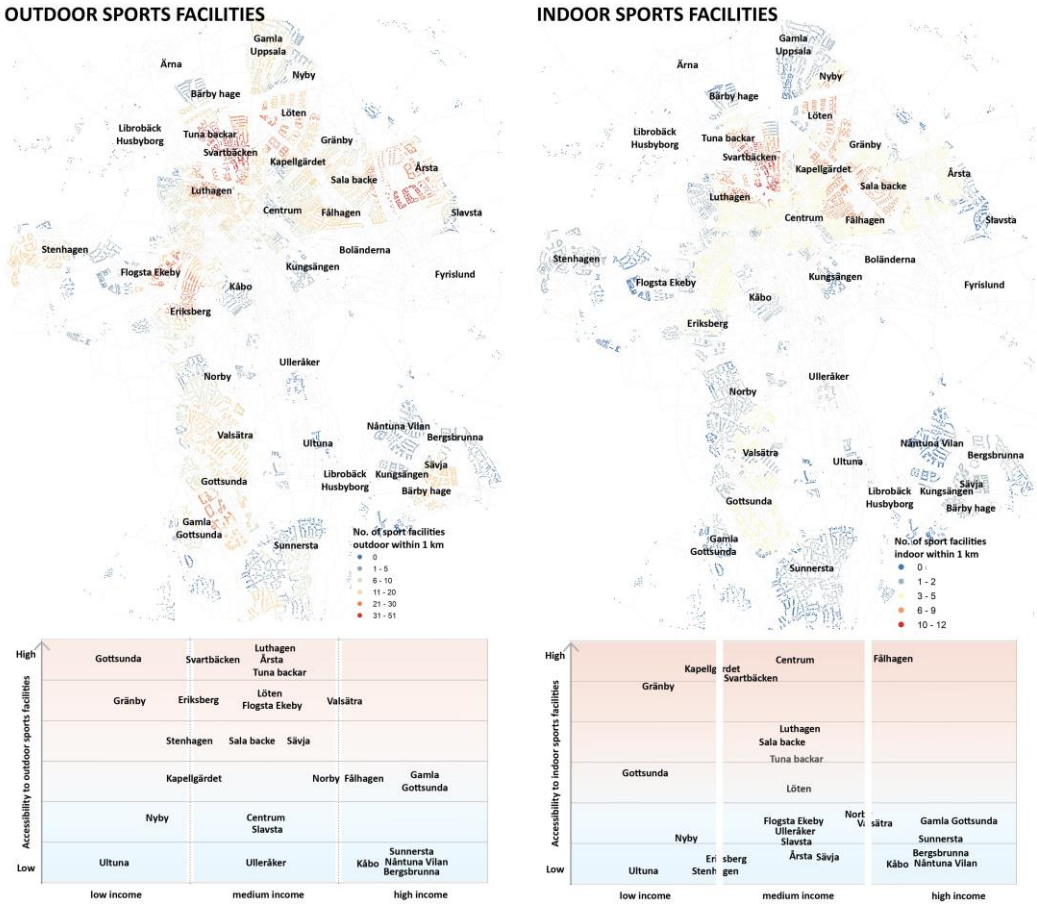

Figure 1: Accessibility to sports facilities, outdoor (left) and indoor (right). In the matrix, high levels of access is shown in warm/red colours and low access in blue colours. The income level of the neighbourhoods is presented along the horizontal access (source for maps: Legeby & Chen 2022a).

4.2 Coverage ratio: football fields and ice rinks

Significant differences exist in the potential to use sustainable modes of transportation to access particular sports. For some sports and associations, walking and cycling already constitute the main modes of transportation while others are more dependent on private cars. Not only practices and norms but also the location of facilities differ; the latter is the result of

planning and urban design practice, demonstrating that planning plays an important role in the possibility to walk, cycle, or use public transportation.

To illustrate how conditions differ for different sports, I proposed a method for comparing two sports by means of an analysis of coverage ratio. We selected one sport that was well-distributed in the urban area (football) and one that was dependent on very few facilities (ice sports) based on information from the interview respondents. According to the informants in the interviews, football associations operate on a neighbourhood level (at least for children and early teens) while ice sports like ice hockey and figure skating have one main location for practice, in Gränby. In this analysis, however, all ice rinks were included, including those that are open for the public (and non-organized activities), as well as one pond in a central park that the municipality prepares during the winter when the weather allows. An axial map was used to model the catchment area of these sports facilities, wherein the darker red line indicates the distance up to three axial steps, acknowledging the presence of the facilities in the urban setting (Legeby et al. 2019) and how easy it is to orientate to reach them (rather than only measuring metric distance).

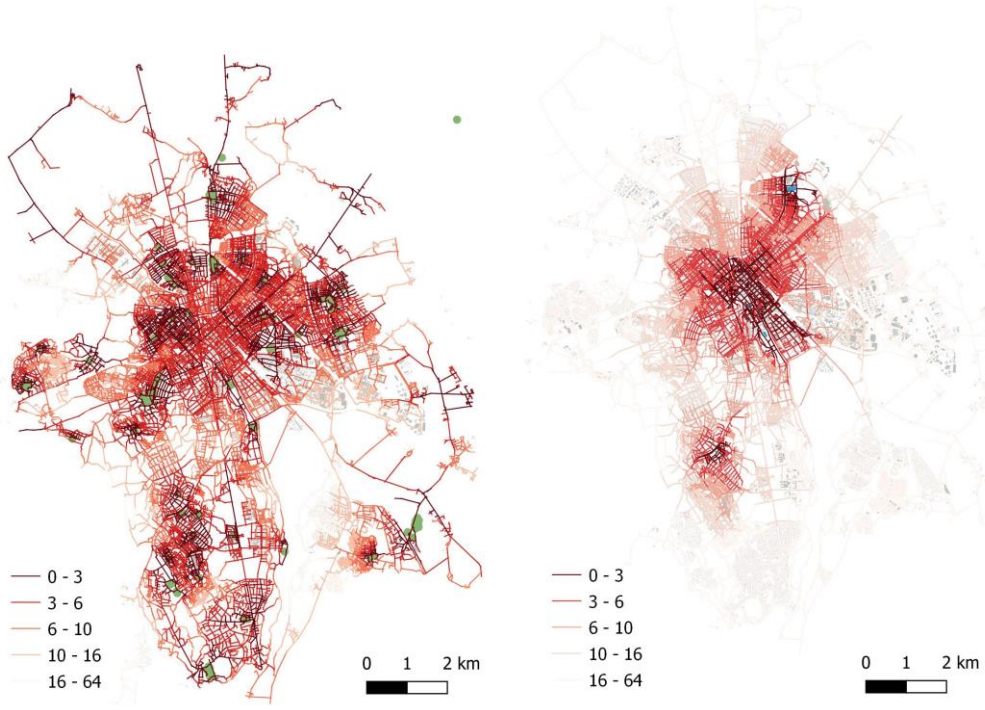

Figure 2: The spatial reach from football fields (left) and spatial reach from the four ice rinks/facilities (right) in the city of Uppsala measured in axial steps, i.e., the distance measured as the number of turns when moving through the street network. The coverage ratio is significantly larger for football fields than for ice sports facilities.

The analysis illustrates that football fields are much more present in general in the city than ice facilities. The coverage ratio is significantly higher, leaving very few neighbourhoods without access to a football field. The opposite situation appears for ice sports. With only four facilities, the catchment areas cover a limited part of the city. The central part of the city is found to have high access, together with a node in the north and one node in the south. Hence, large areas and many neighbourhoods are left with limited or poor access to ice sport facilities. Hence, such facilities are less present in the urban landscape. As a result, football players have more favourable conditions for increasing the share of walking and cycling compared with children engaged in ice hockey, figure skating, or non-organized skating. This illustrates the considerable variation in strategies for implementing sustainable travel patterns for different sports and the need for such strategies to be adjusted for specific conditions. In contributing to a detailed mapping of the current situation, spatial analysis makes it is possible to identify which neighbourhoods afford poor access to opportunities (here exemplified only for two sports but the method is possible to apply to test other sports).

4.3 Catchment area of ice facilities

In the next analysis, I introduced a converse approach, nominating the ice rinks as the point of origin and from that identifying the catchment area accessible by walking or cycling, and, within that catchment area also analysing the socioeconomic profile of residents. Following the goal formulated by the municipality in its plan for providing sports facilities (2018), facilities should be located to enable a mix of social groups. The first step was to define the catchment area; a distance of two kilometres was used to reflect the possibility of walking or cycling to the location. The distance was measured through the street network to take into account urban form and physical barriers. The second step was to look more closely at the population, determining how many people live in the catchment area and superimposing the socioeconomic index to assess the mix of different social groups. The results show that the number of people within the catchment area of each facility varies from about 19,000 people to almost 46,000 people. The catchment area of the Studenternas facility takes in the central part of the city and has a rather low population density. Within this catchment area, there is a mix of people according to the socioeconomic index, with a low socioeconomic group in the minority group (about 20%). Svandammen is an artificial pond in a central public park but as it gets cold during winter the municipality prepares it and opens it to the public for ice skating. Svandammen is shown to be well-integrated into the inner city and has the highest number of people living within a two-kilometre walking distance. The share of population belonging to the ‘high’ socioeconomic index category (54%) is the highest of the four ice facilities; the lowest socio-economic index category applied to only 12% of the population. As a result of the structure of

the urban grid (the street network is characterized by a distributed centrality), Svandammen had the largest catchment area of the facilities. Gränby is further out, located in the north of the city, but still in a rather densely populated area. The income levels are generally low among the 35,061 people living here compared to the city as a whole. At 11%, those characterized by a high socioeconomic index are underrepresented in comparison to the two other groups. Half of the residents within the catchment area have a low socioeconomic index status. The catchment area of Valsätra, which is located on the outskirts of the southern part of the city in a lower-density area (compared to the inner city), comprised of about 19,000 residents. Here, low socio-economic status dominated (50% of residents), with 22% in the middle group and about a third (28%) in the high category. From this analysis it is possible to conclude that the location of a facility has a very direct impact on who will benefit from it as an urban investment. In Valsätra, the share of households with access to a car is comparatively low, which means that many families are dependent on reaching urban amenities by walking, cycling, or using public transportation.

This kind of analysis is possible to use to assess the consequences of decisions regarding the location of sports facilities and investments in existing infrastructure, or investments in new facilities to come. From a social sustainability perspective, the ice rink in the south, Valsätra, reaches much fewer people—less than half compared to Svandammen in total number—but reaches almost twice as many people from the group characterised by a low socioeconomic index (9,479 residents), a group that has less potential to travel longer distances. The ice rink Gränby reaches as many as 17,417 residents with a low socioeconomic index.

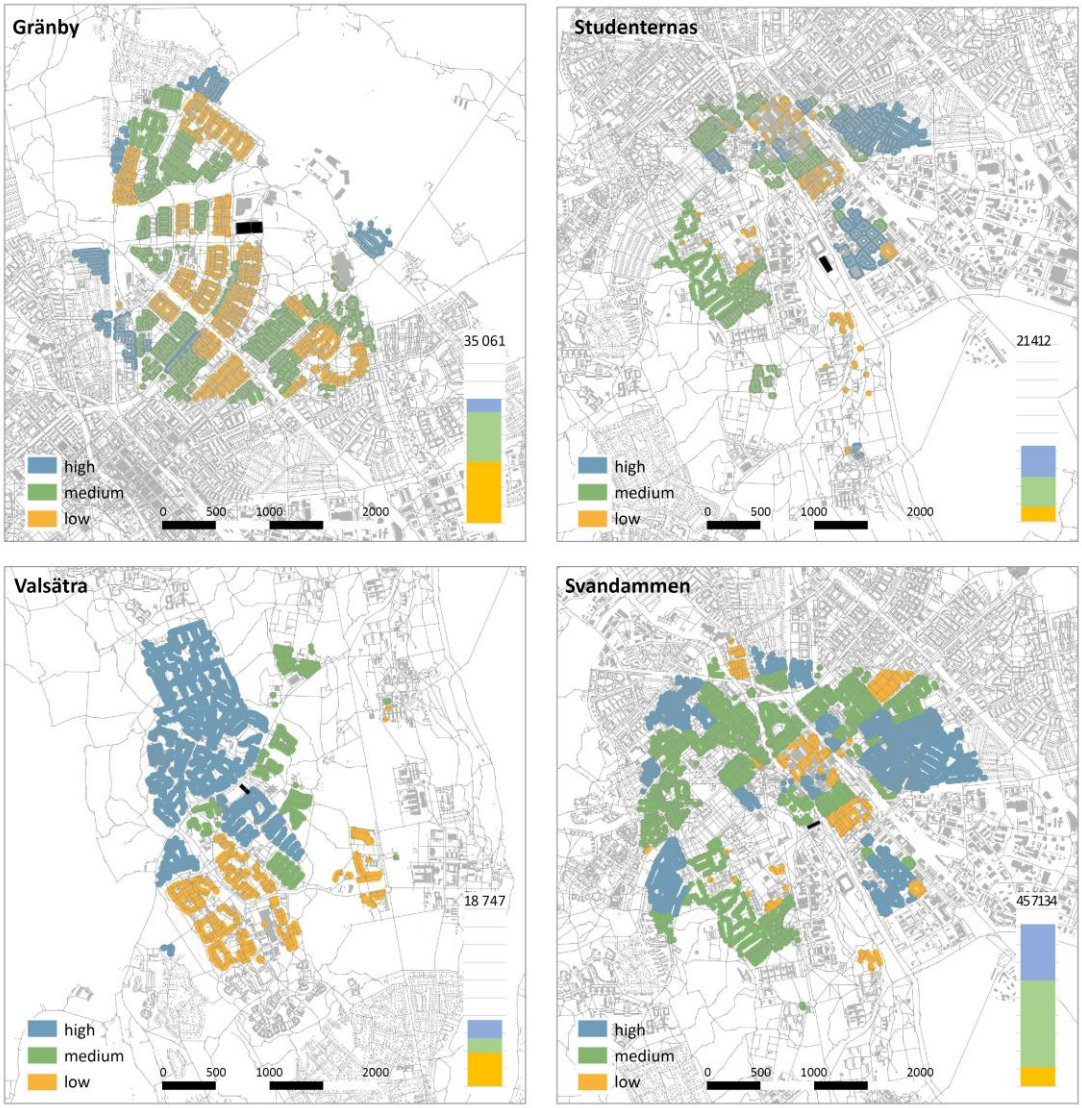

Figure 3: The catchment area of the four ice rinks in Uppsala showing the total number living in proximity to the facility and the mix of residents according to a socioeconomic index.

To understand how the location of facilities relate to the important routes for moving in the city (especially walking and cycling), I compared these locations with the pattern of spatial centrality, that is, how close the facilities are to the so-called 'foreground network' and when consistent through scales described as pervasive centrality by Hillier (Hillier 2001; Hillier 2009; Hillier et al. 2012). The analysis can reveal whether facilities are placed on the most central streets or deeper in the system—and thus less accessible and less visible from the main movement paths (Legeby et al. 2019). Two different radii were used to capture 'betweenness' at 2,000-metre and 5,000-metre distances (which are relevant for pedestrian and cycling flows), with results showing that that the ice rink used only during winter, Svandammen, is located in direct contact with the foreground network at both scale levels. In contrast, Valsätra in the

south is shown to be located on a street that is part of the foreground network at the 5,000-metre scale but not at the 2,000-meter scale. In the area around Gränby, centrality patterns at the two scales do not match, meaning that Gränby is next to streets with high betweenness values at the 2,000-metre scale but disconnected from the foreground network at the 5,000-metre scale. The facility called Studenternas, located in the south next to the city core, has direct access from the foreground network at both of the two scales; as a result one can argue that it is placed in proximity to but beside the most important routes for walking and cycling.

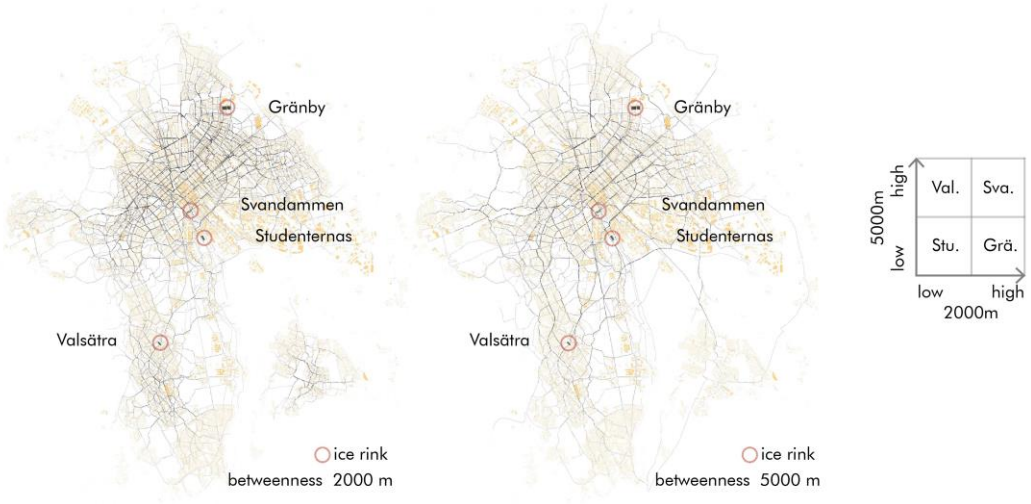

Figure 4: Betweenness analysis, radius 2,000 metres (left) and 5,000 metres (right) revealing which of the facilities have direct contact with streets with high centrality values, the so-called foreground network, and which are disconnected. The matrix diagram illustrated the four facilities in relation to betweenness values at the different scales.

4.4 Distance to location for practising ice sports

Finally, I conducted an in-depth analysis of the distance between the homes of members of three ice associations to where the sport is practiced through the street network. The results provide an indication of the potential to transfer trips from private cars to other modes of transportation within a sport that has its facilities concentrated in one (or few) locations in the city.

The results of the analysis of Gränby show that the mean distance for the members from home to the facility is as much as 10,000 metres. Traveling back and forth for each practice potentially generates a lot of emissions, energy consumption, and negative climate effects. There is no data on how often each member practices, but for most young people it may be 2-4 times per week. Maps showing the closest path from residents to Gränby reveal that the members are distributed in many directions. Nevertheless, it seems like some clusters of members exist along

a number of routes, from 6-7 to up to 15 routes, which indicates that there may be a potential for ride-sharing or the coordination of the trips to some extent.

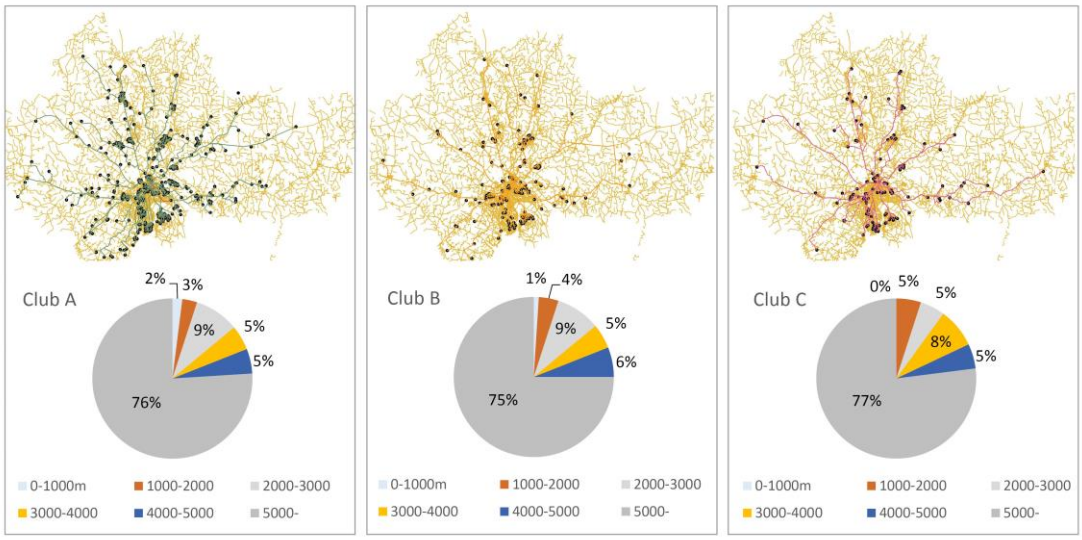

Figure 5: The distances from the member's home location to Gränby Sport Centre. The number of routes that people are clustered along differs as the three associations are compared.

Very few of the athletes live in the immediate proximity of the ice rinks: 5% live within 2 kilometres and 23-25% within 5 kilometres of the facility. Given that hockey players have a lot of gear that is difficult to transport, the potential to transfer trips with private cars to sustainable modes is limited given the available alternatives. Moreover, the majority of association members live in areas with high access to cars within the household, while public transportation services have limited coverage further out from the city of Uppsala. Very few of the members live in areas characterized by a low socioeconomic index categorization; most live in areas associated with a high socioeconomic index status. According to Hägerstrand (1970), travel patterns and behaviour are linked to capability constraints, coupling constraints, and authority/steering constraints, which are arguably at play here. In this case, this is exemplified by the rather long distances that the members have from their home location to Gränby, the generally high access to cars in the household, the lack of adequate public transportation, and the need to be on time to practice.

5 DISCUSSION AND CONCLUSIONS

Trips generated by sports activities constitute a considerable share of all transport kilometres carried out in a city. The sports community has identified a potential to increase the awareness about sustainability aspects through the sport movement in Sweden and introduce new habits and practices. At the same time, there is a clear connection to goals about achieving equal living conditions, since groups with fewer resources are today already more or less excluded from

participating in some sports and recreation activities unless they are located in proximity to where people live, or possible to reach with public transportation. The Swedish Sports Confederation emphasizes the so-called double impact effect of reducing emissions while increasing accessibility and positively affecting the health of citizens.

The city of Uppsala has formulated goals addressing a transition whereby on the one hand the share of sustainable trips increases and dependence on private cars decreases, and on the other hand, inequality is counteracted when it comes to the accessibility of sports facilities for different social groups. The analysis performed in this study demonstrates a method for assessing which neighbourhoods are disadvantaged in terms of urban opportunities—in this case, specifically, accessibility to sports facilities. Such an analysis, when superimposed on information about the socioeconomic profile of residents, opens up for the identification of underprivileged groups and urban neighbourhoods affording poor access.

The results from the spatial and accessibility analysis—including an analysis of catchment areas—show that equal accessibility is dependent on two factors: first, the location of a sports facility in the city, and second, the street network and its configurative properties (i.e., the distribution of centrality, which enables accessibility).[9] To address the inequality aspect, it is essential to compare accessibility rates to the socioeconomic profile of the residents within the catchment areas of facilities.

The approach tested in this study, it is argued, contributes to the production of nuanced descriptions of the current situation; it also makes possible comparisons between neighbourhoods. Moreover, the resulting descriptions have the potential to guide urban planning and urban design practices when it comes to planning for sports and recreation in a way that also encourages walking and cycling in the city. A well-founded description and understanding of the current situation opens up for a more precise distribution of resources and an allocation of investment that not only focuses on a single goal (such as providing the city with adequate number of sports facilities) but also takes other sustainability goals into account (e.g., sustainable mobility, and urban design for equal living conditions). Through this paper, I argue that decisions regarding the location of sports facilities have a very direct impact on the local living conditions that emerge in different parts of the city. Spatial analyses such as the one performed here provide a way to avoid inequalities and support sustainable modes of

[9] It needs to be acknowledged that besides this, the design of public space including the walking and cycling street network and the buildings and their immediate surrounding is crucial but is however not in focus in this paper.

transportation; more accurate planning leads to a better fulfilments of adopted municipal goals, both regarding sustainable mobility and regarding equal access to amenities.

By comparing different sports, the results show that the potential for those active in sports and associations to transition to sustainable travel habits varies considerably. In this study, football fields proved to have a significantly larger cover ratio in the city compared with sports that only have a few facilities; the analysis illustrates in a precise way which parts of the city afford access and which areas afford poor access. Hence, the strategies for approaching the problems the sports movement faces with unsustainable mobility have to be adapted to the specific situation, including the conditions of the location, the conditions for a specific sport, as well as the practices and norms within a certain sport. A 'one size fits all' strategy is unlikely to constitute a productive way forward: rather, adapted strategies are needed.

It is argued that the analytical approach and methods applied in this study have increased and nuanced existing understanding regarding accessibility to sports facilities in urban areas, linking variations in accessibility to several sustainability goals, including the potential for increasing the use of sustainable travel modes as well as equity in living conditions and social sustainability. The analysis of the mix of residents in proximity of ice rink facilities increases knowledge about which groups in society benefit from urban investments, and may support the municipality in their decisions and ability to achieve adopted goals. The results help to better understand pathways for implementing a transition to sustainable travel to sports facilities and reducing dependency on private cars, and provide insights into the consequences of urban design and urban planning. The location of sports facilities, that the study shows here, has a very strong impact on several sustainability goals, directly and indirectly.

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