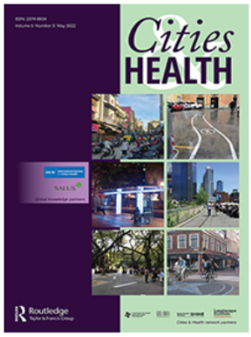

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Creating active urban environments: insights from expert interviews

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ABSTRACT

Urban planning and design offer opportunities to nudge people towards more active behavior. This is a popular topic among urbanists and health professionals, with several guidelines and best practices already developed. However, a gap exists between theory and practice and the complex realization process of such active environments is rarely documented. In this study, we investigated the process of designing, implementing, and evaluating active urban environments through semi-structured interviews with 11 European practitioner experts in the field of active environment design and development. We additionally analyzed 51 examples of active environments they provided. We discuss definitions of active environments and their added value to encourage active behavior and provide an overview of the spectrum of design strategies, elements and boundaries used to create them. We also describe typical steps in the design and realization process, including types of stakeholders, main gaps, and points of friction in this practice.

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Active environments; urban design; physical activity; design- and realization process

Introduction

Frequent physical activity is a well-known and key part of maintaining a healthy lifestyle (Owen *et al.* 2010, Buettner and Skemp 2016, WHO 2018). However, it still proves difficult for many people to embed this in their lives (Blair 2009, Kohl *et al.* 2012). Finding effective ways to encourage people to be more active and helping them to maintain a healthy lifestyle by promoting physical activity is thus a critical endeavor to increase public health (Kohl *et al.* 2012, Ekelund *et al.* 2016, WHO 2018, 2019).

For people to change their behavior, contextual characteristics play an important role next to individual ones. This encompasses both the social and physical context. Regarding the latter, a growing body of research shows that the design of urban environments can contribute significantly to increased physical activity levels (Sallis *et al.* 2016, Smith *et al.* 2017, Kärmeniemi *et al.* 2018, Boldina *et al.* 2021), as living environments strongly impact people's routines and therefore public health. Creating healthy living environments is thus increasingly prioritized by governing bodies, institutions and practitioners (Krefis *et al.* 2018).

Healthy placemaking

'Health' is a multidimensional concept (de Leeuw and Simos 2017). The WHO describes it as a state of complete physical, mental and social well-being (WHO 2022), which encompasses a vast collection of determinants of both internal and external origin. A healthy environment, in the broad sense, should provide optimal conditions to improve and maintain external factors. Next to the design of the physical environment, this entails matters such as good air quality, clean water, sanitation, and a wholesome socio-economic and political climate (de Leeuw and Simos 2017).

There are multiple advantages to intervening at the environment level to increase public health. Though people's living environments are multi-faceted and complex, the physical environment remains a constant, integral part. The way places are designed can therefore strongly influence behavior (Kahn *et al.* 2002, Wang *et al.* 2016, Krefis *et al.* 2018). Making chances in the public domain ensures the accessibility and context aware decision-making needed for a population-based approach (Forberger *et al.* 2019). Additionally, well-designed public spaces can stimulate social interaction and provide a sense of security (London 2020).

To do this effectively, knowledge about people who use the public space – how they use it, perceive it, and their desires for improvements – is essential. This asks for an approach that values and uses these insights to create public places of everyday life, also known as *placemaking* (Thomas 2016). When adopted well, such an approach can be transformative in affecting how people live, leading to a better, more livable

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public realm (Madden 2011). This makes *healthy* placemaking, where the urban space is reshaped to improve people's quality of life (London 2020, Bicquelet-Lock 2021), an important practice.

The multifaceted nature of 'health' requires a holistic approach towards creating such places. In this research, however, we narrow our scope to focus on *active living*, defined by Edwards and Tsouros (2008) as a way of life that integrates physical activity into daily routines.

Although many forms of physical activity can improve overall health, integrating physical activity of at least a moderate intensity into daily routines is found to be most effective (Edwards and Tsouros 2008). From an urbanism perspective, this means that while dedicated sport- and recreation facilities remain important, the focus should be on shaping *daily urban systems* (DUS), in such a way that they support and encourage more active routines.

The practice of active environment design is gaining traction in the urbanism field, keeping pace with growing awareness of their influence and the urgency of the public health issue. As such, it is becoming an integral part of healthy placemaking practices and providing a growing body of research (Edwards and Tsouros 2008, McCormack and Shiell 2011, Kostrzewska 2017, Salvo *et al.* 2018, Forberger *et al.* 2019).

Since physical inactivity is a public health issue with a large part of the population as the target group, population-based approaches are often preferable over ones focusing on an individual-level (Kahn *et al.* 2002, Reis *et al.* 2016, Forberger *et al.* 2019). However, in their scoping review, Forberger *et al.* (2019) note that most interventions aiming to increase physical activity only target specific population groups and/or focus on certain settings, specific technology, or particular disease prevention. Additionally, all interventions they reviewed targeted the micro-level, with mostly point-of-choice prompts targeting the individual (Forberger *et al.* 2019).

Healthy active placemaking

The concept of active environments, also referred to as 'activity-friendly environments' (Sugiyama *et al.* 2014, Koohsari *et al.* 2018), 'activity-friendly neighborhoods' (Sallis *et al.* 2016, Kärmeniemi *et al.* 2018), 'activity-promoting environments' (Solomon *et al.* 2009, Le Gouais *et al.* 2020) or 'active living infrastructure' (Le Gouais *et al.* 2020), defines physical places, typically in an urban context, that through their function and design increase physical activity levels of their users. The goal is to increase public health on a population level, and to improve quality of life, making it closely related to – and a main part of – healthy city and healthy urban planning initiatives (Barton *et al.* 2003, Edwards and Tsouros 2008, London 2020). The urban context brings with it an emphasis on active living, with *active transport* (walking and cycling) as a core element (Giles-Corti *et al.* 2015, Buettner and Skemp 2016, Kostrzewska 2017, Smith *et al.* 2017). This includes not only proper sidewalks, bike lanes and crosswalks but also street connectivity and access to public transport and facilities, leading to a preference for *mixed-use areas* and higher population density (Edwards and Tsouros 2008, Kostrzewska 2017, Smith *et al.* 2017, Kärmeniemi *et al.* 2018). In addition to increased *accessibility*, the presence of parks, green and playgrounds is often mentioned as an important and influential factor regarding physical activity (Edwards and Tsouros 2008, Adkins *et al.* 2012, Koohsari *et al.* 2015, Smith *et al.* 2017). Next to these physical properties, it is also important how the environment is *experienced* (Deelen *et al.* 2019). This is why a higher sense of *aesthetics* (experienced beauty) (Lee and Vernez Moudon 2008, Adkins *et al.* 2012, Kostrzewska 2017, Salvo *et al.* 2018) and perceived *safety* are important factors (Lee and Vernez Moudon 2008, Kärmeniemi *et al.* 2018, Salvo *et al.* 2018).

The number of healthy-active placemaking initiatives, together with numerous guidelines provided in the literature on how best to do this, shows that this is a timely topic in practice and research. However, both appear focused on providing directions or listing components needed to establish these places, highlighting the key design elements mentioned above (Edwards and Tsouros 2008, Hasselback *et al.* 2017, Kostrzewska 2017, Urhahn 2017). Details about the process and its impact remain largely overlooked.

Challenges to address

Despite the abundance of such guidelines for designing active environments, Frumkin (2003) points out that critical questions such as '*Says who?*', '*Does this actually make people happier or healthier?*' or '*How would success be measured?*' often remain unanswered due to a lack of solid validation. This is remarkable, because implementation should be followed by evaluating the process, sharing results and reviewing the plan (Edwards and Tsouros 2008, Foroughmand Araabi 2018). Similarly, O'Neill and Simard (2006) outlined the constantly reappearing dilemmas causing this gap in five questions about the *why*, *what*, *who* and *how* of these evaluations. They stressed the need for such evaluations, rejecting uniform approaches and advocating tailored evaluation for each project (O'Neill and Simard 2006). Still, in the literature, project evaluation often happens long after completion by comparing characteristics between several 'successful' locations as done by Kostrzewska (2017) and Sallis *et al.* (2016). In practice, evaluation appears rare. Scheepers *et al.* (2014) did find and reviewed eight

evaluation studies of environment adjustments to promote active transport. They also noted a large gap between the number of implemented interventions and those tested for effectiveness (Scheepers *et al.* 2014). The absence of structural impact evaluation thus remains (O'Neill and Simard 2006, McCormack and Shiell 2011, Salvo *et al.* 2018, Forberger *et al.* 2019), leaving opportunities to learn from past success and failures unused.

An opportunity can be seen here to use 'smart city' technologies to collect additional before and after data. This is a growing body of increasingly embedded ICT technologies that constantly gather city data to advance performance (Harrison *et al.* 2010, Angelidou *et al.* 2017), learn and address the challenges following urbanization and population increase (Gabrys 2014, Nathali Silva *et al.* 2018), and increase and maintain quality of life (Kondepudi 2014, Nathali Silva *et al.* 2018). 'Smart Cities' are characterized by being inclusive as well as their ability to adapt to their inhabitants' behavior (Pérez-Delhoyo *et al.* 2018, Caird and Hallett 2019). For this, people have become an important resource (Gabrys 2014, Balaban and Tuncer 2016, Resch *et al.* 2016, Pérez-Delhoyo *et al.* 2018). Through visiting 'smart' areas and crowd dynamics, sharing self-reported data or joining participatory design practices, citizens themselves provide valuable input for governments and urban architects (Aschwanden *et al.* 2008, Pérez-Delhoyo *et al.* 2018, Galič 2019). These data unveil patterns that can inform decisions regarding new policies or spatial designs (Thi Nguyen and Boundy 2017, Thakuriah *et al.* 2017). The easy access to more data would suggest easier, better, and more evaluations. Unfortunately, this is not (yet) the case. Caird and Hallett (2019) even found 'strikingly little research' on evaluation of smart city interventions themselves.

Adding a digital context brings opportunities to capitalize on the potential of urban design to encourage physical activity. Simultaneously, it expands complexity in this challenge as it increasingly creates new venues for interventions, such as augmented reality or IoT solutions. Regarding the environment, this progress entails a shift from human-computer interaction to human-environment interaction or human-building interaction (Streitz 2007, Alavi *et al.* 2019). Here, environments become truly smart as their interactions become more human-centric, having not just sensors but more interactive technologies embedded in them (van Renswouw *et al.* 2021). This development asks for a more holistic and multidisciplinary design approach (Stephanidis *et al.* 2019), that next to urban planning, design and public health, also includes experts on behavior change strategies and digital technologies.

Designing for public spaces encompasses a mixture of functions for a large, versatile and constantly changing userbase, making it a challenging endeavor (Mast *et al.* 2021). Healthy-active placemaking processes are therefore highly complex (Scheepers *et al.* 2014, London 2020). With many stakeholders and uncontrollable variables to consider, it requires comprehensive and interdisciplinary approaches (Corburn 2004, Sallis *et al.* 2016, Salvo *et al.* 2018) that are not always available (Krefis *et al.* 2018). The context-dependent nature also makes it hard to define generic measurable evaluation parameters (O'Neill and Simard 2006). Gaining more understanding of the workings of this process as a whole – the timeline, parties involved, steps taken, and barriers encountered – is therefore an important first step to determining and implementing evaluation methods and improving the creation process and post-occupancy effects of healthy active places.

In this paper, we combine this knowledge from theory with that of practice (Giles-Corti *et al.* 2015, Pineo *et al.* 2020). By analyzing active environment examples and 11 expert interviews, we explore practitioners' definitions of active environments and their project experiences. We present an overview of main design strategies and elements used to shape active environments and provide insights into the process of creating them. We conclude with a description of typical steps in the design and realization process as well as main gaps and points of friction in this practice.

Method

Participants

We interviewed 11 experts (four females, seven males), between 30 and 60 years old. Participants were recruited from the authors' professional networks and additional snowball sampling, based on their experience in working on active environment projects. They were involved in projects located in north-west Europe and Portugal, with a majority in the Netherlands. This aligns with their main places of residence. Participants represented different roles in the design and realization process. Our sample includes experienced practitioners and researchers from the fields of industrial design, data design, urban design and planning, policy making and physical activity innovations. Some participants had multiple areas of expertise. For an overview of participants, see Appendix A. All participants had experience with the hands-on, practical side of creating active environments, which was the focus of these interviews. Several participants had additionally been involved in academic research, resulting in (co-)authored publications describing design principles and guidelines for creating active environments.

Procedure

We conducted semi-structured interviews that were held online via videoconference because of COVID-19 measures at the time of data collection. Based on our literature study and defined research scope, an interview guide was prepared in a session between the authors. The guide, provided in Appendix B, entailed four main themes: (1) *Active Environments*: Participants were asked to provide examples and their definition of what entails an 'active environment'. These were discussed, together with their important elements and potential perceived challenges, gaps, and opportunities; (2) *Collecting and Making Sense of Data*: Here, we discussed the types of data collected during such projects, how they are interpreted and used, and if this use includes monitoring or evaluation. We also discussed unavailable data that could have been helpful and views on using data in the design process; (3) *Illustrative Example*: Participants anecdotally described one active environment process they were involved in. The example included a timeline, stakeholders, decision-making, challenges and problem-solving. This helped to fill in gaps and offer more details about their definition of 'active environments', the process of making and monitoring them, and data collection and handling; (4) *Towards interActive Environments*: Here, participants explain how they regard developments towards more interactive or even 'smart' environments in the context of active environments.

As preparation for the interview, participants were asked to come up with three examples of what they considered active environments, without additional indication of what types of environments we were looking for. This did not need to be projects they had been involved in themselves. We discussed these examples during the interview to gain insight into their perspectives on and definitions of active environments.

The interviews were recorded and lasted between 50 and 105 minutes (average 75 min).

Data analysis

All interviews were transcribed verbatim, then coded and analyzed with MaxQDA Plus 2020 using a thematic analysis approach. We conducted two coding rounds, both with a main and secondary coder. We first used open coding to code participant statements following the main interview themes. These led to a set of codes that were analyzed by the coders and grouped into themes, which were used for a second round of more deductive coding to further refine our results. The created codes were then collaboratively analyzed and discussed to extract definitions, key elements, opportunities, main challenges, and insights into the process of designing active environments. Quotes in this paper were translated to English.

Results

In this section, we present our results following the findings and structure of our open coding strategy. First, we discuss definitions of active environments, their added value when aiming to increase physical activity in a population and main design strategies and elements to create them. We then focus on the process of realizing such environments, describing main challenges and desires of several people involved. Finally, we discuss the role of data in these processes and designs, the opportunities data provide to address current issues, and views, and expectations and concerns interviewed experts have on this with regard to more interactive environment solutions.

Active environments

What are active environments?

Invited to define 'Active Environments', our interviewees started with broad descriptors about the purpose of such places. For instance, an active environment 'challenges you to move' (P2) or 'invites and facilitates to become active or to get moving' (P3). Participants stated that active environments aim 'to challenge users' (P2, P5, and P8), some preferred to use terms such as 'invite or encourage' (P3, P4, P10, and P11) or even 'seduce' (P8 and P9). Others adopted a stronger view, stating that active environments 'provoke the desired behavior' (P9) or 'ensure that you get more active' (P6). P9 notes additionally that technically one should use the term '*activating* environment'. Being easily accessible or close by was mentioned by several participants (P1, P5, and P7). Several participants associated active environments with the 'outdoors' (P1, P6, P7, and P8). To define an active environment, P11 states that the 'daily living environment should be structured in such a way that it strongly encourages you to exercise enough every day'.

From the preparation exercise, we collected 51 examples of active environments (Appendix C), ranging from specific elements or equipment to entire districts, and included both general examples and specific places or installations.

We can divide the examples into aspects of DUS, aimed at integrating (more) physical activity into daily routines, e.g. active transport (n = 26) and more dedicated physical activities such as sports and play, often with a recreational purpose (n = 23). Two examples were classified as both: campsites and a suburban walking route network. The campsite is

a recreational area that simultaneously represents an alternative daily living environment, requiring and inspiring much more physical activity than typical DUS. The walking route network is created for recreational purposes, but by providing attractive walking routes between destinations it also encourages active transport and provides green areas. Participants agree that to some extent, this applies to most parks in urban areas: when destinations lie on both sides, the attractive connection through a park is likely to inspire active transport between those destinations. This effect becomes stronger when dedicated transportation routes (straight, direct routes with a suitable surface and proper width to accommodate the flow of foot- or bicycle traffic) are a part of the design.

Comparing them to the key aspects of active environments found in the literature, we can categorize 13 examples as places for – or aspects of – active transport, 16 describe green or park settings and 19 examples represent mixed use and multifunctionality. Five examples were categorized as both supporting active transport and providing park or green areas. Eight examples represented places or equipment dedicated to specific recreational use.

Added value of active environments to encourage active behavior

According to our interviewees, the added value of intervening in the physical environment to encourage more active behavior can be seen at several levels.

At a very basic level, the environment provides boundary conditions through the extent to which it facilitates active behavior (P4, P7, and P9). Using the public outdoor space for these facilities ensures accessibility for a wide range of users. It can provide these facilities in an *'inviting and free'* (P4) manner, allowing people to decide for themselves if and how they use the provided space (P10). This element of 'freedom' to make autonomous decisions about active behavior is also mentioned by several experts as an important advantage of interventions in the public space. Experts highlight the distinct difference between 'active behavior' and 'sports' (P4, P7, P10, and P11), stressing that an active lifestyle only requires the first, not necessarily the latter. Focusing on creating more active daily routines therefore strengthens the potential of the environment to specifically also target and include the group that has (sub)consciously decided not to practice sports.

> I think [the added value of intervening in the physical environment] is substantial. [. . .] The living environment of people, you can achieve much more there than through stimulating sports *(P10)*

> I believe you can trigger and challenge – or facilitate – people more through a certain design. *(P8)*

Interviewees also describe a certain inevitability of having to enter that environment, stating that *'using the space and therefore that space itself, is part of our identity'* (P11). Since people exist in context, the way their living environment is shaped largely determines their routines (P1). By designing and planning these places to make that desired behavior (such as walking or biking) easier or more attractive, the urban environment creates supportive daily urban systems (P1, P3, P8, and P9). These can be strong enablers to break bad routines and to create new, more active ones (P1). Especially for people in deprived areas, this support to be active in the direct living environment is mentioned as very important (P7 and P10).

Creating active environments

Strategies. From our interviews, we can distinguish several strategies to evoke active behavior through environment design (Figure 1). Ranging from open and unobtrusive to increasingly more forced, these strategies can be placed on a continuum:

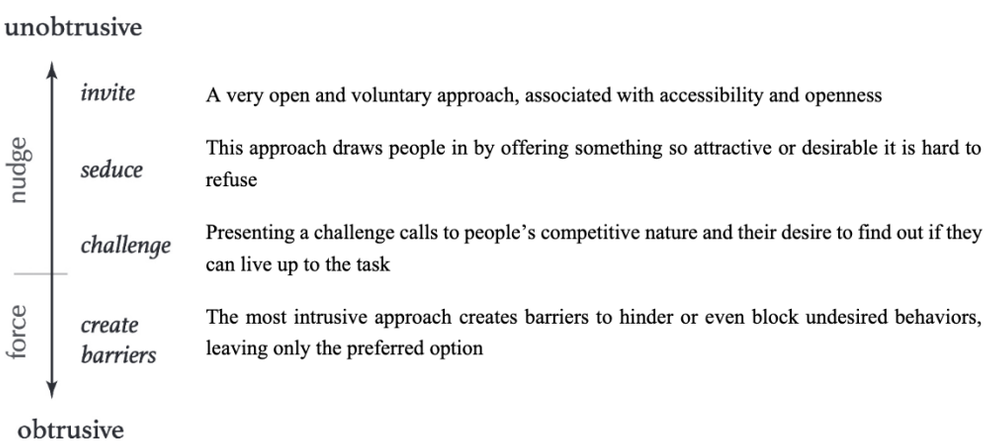

Figure 1. Design strategies to evoke active behavior.

Elements. Next to strategies, certain elements were mentioned that are important to establish active environments. These include design elements, but mostly focus on use of the space and creating a certain experience. Alhough divided into categories, many of these elements are closely related to each other through causality or overlapping effects, e.g. when the peaceful feeling of a green space is enhanced by its openness or quietness.

Multifunctional & adaptable. Most examples of active environments mentioned and many of the named elements are related to multifunctional or adaptable spaces. To serve a variety of people, diverse facilities are desired. These can be separate facilities, such as dedicated sports accommodations, but more effective are places that can serve multiple purposes, either at the same time or through varied use over time. This also helps to serve a variety in demographics and so broaden the target audience. Some examples of this include close indoor-outdoor relations, with large opening doors or other transitions enabling indoor and outdoor spaces to merge on occasion. Finally, to ensure long-term use, it is also important that the space anticipates user behavior, changing users and unknown factors, develops over time, or offers something worth coming back for.

Mobility & active transport. Frequently recurring throughout our interviews is an emphasis on active transport, as most physical activity comes not from deliberate exercise but from simply moving from place to place in an active manner (P11). Therefore, stimulating taking stairs instead of elevators, biking instead of driving, and designing places suitable for walking are likely to be most productive. This relates to mixed use areas on an urban scale, as different amenities must be distributed over a walkable or cyclable area.

> A central lunch area in the middle of campus creates a goal to walk towards. So, it's also: creating distance between the goals or destinations that people have. If you put everything next to each other, people will not cover much ground. *(P4)*

Stimulating active transport through design can be done in several ways, but specifically cars appear to have a special status for users and therefore in urban designs. The comfort of easy transportation over well connected, wide roads with good traffic flow, and parking close to home is often perceived as essential. *'Often, cars have a kind of negative impact on the public space. And cars relatively take up a lot of space; many streets have turned into traffic spaces instead of living areas'*. (P9). Several interviewed experts question this status quo (P5, P7, P9, and P11), wondering if, when focusing on healthier lifestyles and better environments, the car's prominent role should be reconsidered. Hidden parking, dead-end streets or 'bike streets', can remove cars from view and encourages traveling short distances by foot or bike. However, more progressive plans that, for instance, leave cars at the neighborhood edge, meet a lot of resistance from residents.

> We presented a fantastic mission about a healthy and movement friendly neighborhood, safe and pleasant for children, but the residents just wanted – they wanted all of that but not at the expense of their car. *(P5)*

Attractive. Interviewed experts agree that attractiveness is an important factor. This is explained on the one hand as an aesthetically pleasing environment, with green or natural elements, things to see, sunken parking and enough space as frequently mentioned examples. On the other hand, it is also described as well programmed and conveniently located, with respect to infrastructure, orientation, and nearby facilities. This attractiveness can be used to invite or even seduce people to enter the environment and encourage active behavior.

> Many people walk and bike here because the street is so well designed, and it is just a pleasant place to be. *(P9)*

Green, blue & outdoor. For some, a synonym for 'attractive', outdoor, nature, green space and water are often mentioned elements. We see a link here to the desired experience of freedom and open space.

> It is appealing to walk a longer route back instead of the shortest option, just because it's a nice area where you walk through nature; there is a pond to walk around and all kinds of nice things to see. *(P4)*

Social and lively. Next physical aspects, the importance of the social context of active environments are mentioned by all interviewed experts. Liveliness and activity are also frequently discussed. Strengthened by multifunctionality and an important enabler for social attractiveness, liveliness is often mentioned as a key element of the desired experience. The provided social safety, social cohesion, and social contacts can help to attract people to a place or even to participate in certain activities, with social contacts and sporting or being active together as important motivators for physical activity. Additionally, seeing and therefore normalizing active behavior stimulates that same behavior in the spectator (P7).

> Seeing and being seen is very important. If you don't see it, you don't know it … While seeing [people being active], that also stimulates. *(P11)*

Next to the strategy of creating *inviting* environments, social components can also be used to establish or enhance *challenge*, when people encourage and challenge each other to increase their performance. Finally, creating a sense of ownership of the public space will increase social safety and the feeling of being 'allowed

to use' the space (P1 and P10). This can for instance be done by involving future users in the design process, a practice used by all interviewed experts.

Experiences. Although difficult to translate to direct design suggestions, a considerable number of statements about active environments contained feelings that such places should evoke. Especially joy, pleasure and happiness are frequently mentioned, along with freedom and space. Closely related to *attractive*, these statements stress the importance of creating amenity value, not just adding elements but also creating an experience.

Boundaries & thresholds. Within the scope of mentioned elements, we categorized some as threshold or boundary conditions. We regarded elements as such either when they are essential; without these, the place does not work.

Enable. Interviewed experts state that active behavior can be supported through either specific installations or a space that allows open use for several purposes. The environment provides the enablers to be active, so it is important that facilities address existing needs in the surrounding area. Especially opportunities to combine several recreation or transport facilities for different population groups in one place are deemed very effective. This is of course closely related to social, lively and multifunctionality elements, as multifunctional places bring groups together and so create a lively and well-used environment.

Accessibility. For practical reasons, accessibility is directly related to the effectiveness of active environments. Subdivided into reachability (access points and routes) and proximity, accessibility is an important enabler for use in general. Interviewees note that special attention could, and should, be paid to ensure accessibility for more vulnerable groups such as minorities, people with disabilities or low incomes. Additionally, proximity and visibility can enhance the see-and-be-seen aspect by enabling chance encounters with active behavior and environments.

> I like mountain biking, so then a forest path is very nice. But to get there I need to travel, often by train, so that always is something of a barrier for me. *(P7)*

Safety. A sense of safety is necessary for any place to be considered pleasant or attractive, making this a clear boundary condition. Safety includes both social and physical safety, such as a suitable traffic situation, proper maintenance, lights after dark, and safe installations.

> If it's not safe – physically safe, socially safe – it can be the most beautiful and challenging place, but it will still not be used. *(P8)*

Additional challenges

We also asked participants about barriers and challenges regarding the use of the public space to increase physical activity. Part of the mentioned barriers are related to the active environment elements described above, such as the complexity of the venture, negative impact of unsafe places, physical barriers, or distance to facilities. We noted several additional challenges.

Participants agree that active environments depend on a delicate balance. *'With the physical environment alone, it will never work. To break routines, you need a hybrid, integrated strategy'* (P1). Even if most components seem ideal, *'when one of the other elements points the other way it can completely negate the rest'* (P8). Failing to provide the right socio-cultural context can weaken the effect of the physical conditions (P8). *'Presence of a bike lane does not automatically mean people will use it. You need to stimulate it and communicate'* (P3). It is important that the entire DUS is regarded, *'not just one piece of the puzzle'* (P9). The balance of active environments also depends on local and temporal factors, with changing variables for each place (P10) and over time (P9 and P11).

Another important question is how to prevent conflict of interest between different uses or users? For instance, when playing, children use the same space cars use to 'kiss and ride' (P5) or when a growing population and increased recreational use of the quay forces rowers out of their training zone (P11). Such situations are ideally recognized early in the design process so that a suitable compromise can be found. A popular strategy to address as many relevant elements as possible is including user input in the design process, often through a form of co-design. All participants agree this is effective and have used such methods in the past. However, *'when users are involved they will quickly start to serve their own interests, which do not always align with an active living environment'* (P5).

While the presence of green space is often mentioned as an enabler of physical activity, there are also some critical notes. Green is also a *'distance-creator'* (P10). This does not always align with the desired accessibility or liveliness of destinations that also encourage physical activity. It can even decrease perceived safety. Additionally, *'more green space does not lead to more physical activity, there is no relation. There is, however, for* attractive *green'* (P11). Another potential disadvantage of more green space is that as it creates distance, it also creates more space to park cars, which in turn leads to increased car use (P10).

Related to the social aspect, when creating active environments, it is important to consider whether the activity in question is socially accepted for people to feel comfortable doing it (P4, P5, and P11).

Finally, P4 points out that it is difficult to measure effects in a robust way, because when using sensors or

tracking there should be consent or an opt-out for participants.

Process

The process of creating active environments is described as a complex and often long-term process by our interviewees and in the literature (Carmichael *et al.* 2020, Pineo and Moore 2021). Based on experiences and descriptions of interviewed experts, we provide insight into two main factors responsible for this complexity – the timeline and multiple stakeholders– what this means for monitoring and evaluation, and other related challenges that project teams experience.

Timeline

Although there is ample variation, largely based on scale, active environment projects are essentially urban design projects and therefore typically measured in years, sometimes decades. Related to the scale and public nature, the large number of involved stakeholders also results in a slower process.

The discussed example projects ranged from six months for a public beach volleyball field (from the moment 'the right people were involved' (P3)), in which design, management and construction were realized, to over fifteen years for an urban redesign, subdivided into five years of research, strategy development and a first version urban plan; five years of user participation and iterative redesign; and five years from urban plan to construction plans. This still excludes the actual construction phase.

A longer run time leads to more complexity because over time, team members, vision, demands, and policies can change, often leading to reassessment and adjustments. Regarding this timeframe, the design will be built largely on foresight and predictions of future users, which require more research and advanced strategies. Additions to or interventions in an 'existing' environment are much smaller, with a more straightforward and faster process than a complete area redesign.

> "The more large-scale, the more complex and long-term". (P1)

We note that with their varying positions and roles in the process of creating active environments, the interviewed experts do not all define the same 'starting point' of that process when they discussed timeframes. This was mostly related to their own involvement. Some defined the 'start' as the moment an idea was defined, and for others, it started when the money was made available or when the project team was assembled.

Stakeholders

Complexity also comes from the number of stakeholders in active environment projects. While again increasing with project scale, even for a small project, there are many to consider. With varying stakes, concerns, opinions, and degrees of influence for all involved, who all need to come to an agreement, more stakeholders inevitably lead to a more complex process. We have defined six types of stakeholders that are involved in all active environment projects:

- *Client and investors:* often (local) government or project developer, occasionally company or private party
- *Property owners:* government, housing association, company, or private party
- *Creators:* designers (urban planners, architects, landscape designers), developers, builders, and contractors
- *Rules and regulations:* government (a.o. spatial planning, public health), spatial management, security
- *Research and information:* research partners & institutions, data analysts, knowledge institutions, municipal health service, consultants
- *Users and involved parties:* residents; local entrepreneurs, schools, or institutions; housing and community associations

Monitoring & evaluation

Though it concerns expensive and long-lasting projects, all interviewed experts agreed that there is very little monitoring or evaluation of projects after realization and post-occupancy. While often aiming for a 'better' or 'more active' living environment in general, the defined project goals do not reflect measurable standards to determine whether the project has succeeded in reaching this goal. Though they all acknowledge the desire for this validation and the knowledge it would bring, interviewees also list many reasons explaining its absence.

Very pragmatically, it is often 'no-one's job' to do this research, leading to the question of who should. Designers leave the project once construction starts, moving on to the next project. The same goes for builders after construction. Adding research time is not part of their contract. Since validating post-occupancy success is not required, there is also little incentive for investors to fund this.

Another much cited issue with post-occupancy validation is the large number of variables involved, causing an ever-changing context with accompanying challenges of measurable goal setting. What goals can be set that represent a 'better' or 'more active' living environment and can at the same time be expressed in measurable aspects? To what degree can you compare pre- and post-intervention situations if there are different people, different weather, different activities or other variables that cannot be controlled? *'This dependency on uncontrollables makes it so hard to define proper validation criteria that it is only rarely tried'*

(P5). These comparison issues only get worse when more time passes between the pre- and post-measurements.

Related to this, it is also debatable to which extent success or failure features at one location will be the same for another. Different contexts with many uncontrollable variables make comparing two places a challenging endeavor. This in turn increases doubt about the value of such research.

> If you design and organize the suburbs of Amsterdam the same way as the city center, the first thing that will happen is that the residents will leave. Because that is not their environment. *(P10)*

An obvious counter to that doubt would be for general research purposes, at least. After all, if enough data of enough projects are collected, general statements and truths can be derived on an abstract level that apply to most, if not all, projects. This would require a critical mass of studied interventions before producing useful insights, but for research institutions, such large-scale and long-term studies are far from unheard of.

However, current research projects related to healthy and active environments are often validated based on valuable lessons learned, publications or clear process descriptions, regardless of the effectivity of the designed space itself (P1). Again, this decreases incentive for that validation.

Data

Data in the current process

For most interviewed experts, the role of data is limited to mapping pre-intervention situations and, sporadically, evaluating the new, post-intervention one. To get a comprehensive view of the 'current' (pre-intervention) situation, data are collected on a wide range of contextual and user-specific topics. Often, a combination of qualitative and quantitative methods is used, including surveys, interviews, diaries, counting, tracking devices, and focus groups. The most frequently mentioned collected data types are demographics, socioeconomics, neighborhood and behavior data, long-term statistics, and health parameters.

Within the context of creating healthy active places, these data mostly provide information about behavior, health and well-being of the local population and the current state of the environment (including green and traffic infrastructures, facilities, and programming).

Important to note is that not all these data are collected by the project team. Especially, generic, large-scale and long-term data typically come from local or national databases built from routine population screening. For these data, the project team is dependent on available data, which is often less copious for smaller and sparsely populated areas (P9 and P10).

Several experts (n = 5) also include a (local) needs assessment in their sum-up of collected data, which was used to finalize problem definition and design directions. For others, this was already established by other parties or before they were involved in the process.

For long-term processes, such as urban redesign, additional input from users and other stakeholders was collected at certain stages in the process to realign or adjust course if needed.

Data desires

When rounding up the illustrative example, we asked participants what could have improved the process or what they desire for future projects.

All experts expressed a desire for more data for better monitoring and evaluation (P1, P5, and P7), learning behavior patterns and motivation (P1, 2, 3, 4, and 9), problem definition or hotspot finding (P3), walking routes (P4), information about future users (P5), crime rates (P7) and more and longitudinal post-occupancy data collection (P1). P7 further specified a need for better ways to predict user behavior and deal with changing needs over time. Some participants also preferred clearer instructions to interpret the accessible data (P11 and P8) and visualizations instead of 'numbers' to provide data insights in a comprehensive and instinctive manner (P6, P8).

There is a clear desire to bring together and combine knowledge that exists in different places (P2, P5, P8, P9, and P11), which requires a more integral approach with experts in different fields (P9 and P11) and a back and forth between them during the process, instead of one waiting for the other to finish and then take over (P11).

In line with the need for more data and more knowledge about data-handling, several participants desired a stronger collaboration between knowledge or research institutions and practice (P1, P5, P8, and P11), for instance, for monitoring of effectivity (P5), or shared use of resources (P8).

Finally, P1 expresses a desire for comprehensive modelling to create a 'digital twin' of the design before realization to test scenarios. This would create a feedback loop in the design process, making it more iterative.

> Ideally, data is in the full cycle of analysis, scenario development and optimization, definite plan, monitoring impact after realization, assessing, and optimizing for redevelopment of the environment. Perhaps the first is happening – although I am pretty sure not systematically and comprehensively – the rest is not. *(P1)*

Interactivity and creative use of data

We also asked participants about their expectations regarding application of more interactive technologies

to create active environments. We divide their answers into two categories: concerns expressed and possibilities seen.

Barriers & concerns. We note that besides the data designers, participants have some difficulty in imagining what such technology could add, because they find it hard to envision suitable application examples. They associate the terms 'data', 'technology' and especially 'interaction' with collecting data (P1, P4, and P11), commercialization of the public space (P5), fun-for-once gadgets (P9) or interactive play installations for children (P8). This may be nice for some fine tuning (P9 and P10), but it is not essential to improve active environments (P9, 10, and 11).

> Multifunctionality in the physical sense, I totally get that. [It can have different functions at different times, based on] the physical appearance. But a digital layer, how that can contribute – I'm still unsure what that would be exactly. But exciting. *(P9)*

When discussing personalization, experts expressed concerns about privacy (P4, P5, and P6), and whether thorough personalization could be perceived as 'scary' (P6). They also worry about feasibility and desirability of personalization of the public space (P1 and P2); the added complexity and necessity to use an accompanying smartphone app (P8). Some experts also feel that interaction or personalization often remains too shallow (P4, P6, and P9), making it cheesy (P6), boring (P9) or patronizing (P4). P1 additionally wonders if it is desirable from a social perspective, since one of the goals of the public space is to bring people together. People should therefore not only use it in a personalized way, but together.

Finally, some practical concerns are raised, such as costs and maintenance, durability (P8 and P9), sustainability (P9) and who is responsible, both for maintenance and for data collection and security.

Data opportunities. All participants saw potential for smart solutions to improve measuring, monitoring and knowledge acquisition. Some further specified this as large-scale data collection to learn about real behavior patterns over time and gain more in-depth understanding (P1 and P2). Participants also mentioned opportunities for combining data (P5 and P6), creating predictive models (P6), and providing overview to help deal with complexity (P7 and P8) and to improve problem definition (P3, P9, and P10).

When thinking of actual interactive applications, some imagine hybrid solutions with a digital layer placed over the physical world (P8), creating a deeper connection between the physical and virtual world (P9), which enables different use of the physical space (P9). Participants see use for such technology to reach higher levels of personalization (P3, P6, and P7) based on certain personal preferences (P7), depending on life phase or age (P6), or even establish several layers ranging from the individual to a larger whole (P4). They also see opportunities to increase efficiency, e.g., smart transport systems (P10) or energy use (P7) and encouraging active transport through smart green light solutions for bikers and pedestrians (P3); automatization of processes (P4); and improving sustainability (P5), safety (P7) or health-related parameters (P10).

Discussion

In this study, we investigated the process of designing and implementing active urban environments through semi-structured interviews with 11 experts in this field. When selecting participants, we aimed for diversity and multiple perspectives. Views or methods that seem field-specific may therefore be influenced by personal vision. Though outside the scope of this paper, it would be interesting to regard different perspectives between disciplines on a larger scale. Future studies could also include experts from other regions of the world next to Europe to refine the global vision and further expand applicability of their findings.

We identified several aspects of active environments: associations and definitions, design process and guidelines, impact on user behavior, and the process of realizing such environments in the public space.

Regarding active environment examples provided by interviewees, we note some professional bias, as larger area examples come from urbanists and digital installations are mostly named by participants with an industrial design background. Several examples concerned projects that participants had worked on themselves. Despite this, the sample still provides insights into what professionals perceive as active environments. The diversity of examples indicates variance in definitions or participants' associations with such places. This ambiguity aligns with different terminology used throughout the literature, suggesting lack of a universal definition of active environments, their scale and/or context. Combining definitions provided in the literature with those given by participants, we define active environments as physical places, typically in an urban context, that through their function and design increase physical activity levels of their users.

We compared 51 active environment examples provided by interviewees to determinants of the built environment associated with physical activity found in the literature. We see a clear overlap in important themes between the literature and these associations. However, where the literature focuses on active transport as the main determinant (Edwards and Tsouros 2008, London 2020), these examples show stronger

affinity with green places, multifunctional and mixed-use environments. While proximity to different destinations increases walkability and therefore also supports active transport, these diverging points of focus suggest a disparate emphasis in research and practice. Whether this difference stems indeed from vintage point or rather from more practical considerations – such as active transport being easier to measure and therefore research than for instance the impact of mixed-use or multifunctional spaces – is not clear.

To compare the practitioners' lens to theory from the literature, we discussed definitions and important elements of active environments in our interviews. We combined and organized these into five themes, desired experiences and three boundary conditions. Especially, the design elements mentioned here are in line with goals and guidelines for active environment design found in the literature (London 2020).

Though we see a lot of overlapping and complementing elements indicated as important for active environments, there are also some noticeable differences. For instance, interviewed experts describe both green, open, and quiet places and lively, multifunctional urban hubs as typical examples of active environments. This underlines the varying activities, experiences, and desires they associate with 'being active'. Based on these interviews, physical activity can be perceived as a mindful experience, focusing on bodily tasks and attractive surroundings. However, it also has the potential to bring people together, creating a lively environment and thus become a catalyst for social structures and cohesion. People are attracted to such social hubs for companionship and sense of belonging. The social component of active behavior is a strong motivator for physical activity and therefore of great value for active environments. When brought together through active behavior, people are simultaneously motivated to join the action through normalization, invitation, challenge, or positive peer pressure. Sense of belonging and 'see and be seen' are main motivators for people in general and thus also for active behavior. It is important for active environment designers to address all these purposes of and motivations for physical activity.

Creating active environments is a complex process, as it is often long-term and concerns multiple stakeholders. Despite the added complexity, involving all stakeholders in this process yields key goals and principles that help shape successful active environments. This includes consulting future users, a popular strategy that is both used and recommended by all interviewed experts. As there are many approaches to this, often depending on project specifics, details about user participation in practice are outside the scope of this paper.

To improve the design and/or creation process of active environments, participants agreed that studies of design processes combined with evaluations of long-term use and impact of realized projects would be valuable. However, since these projects are typically initiated and executed by local governments and developers, evaluation is simply not a priority. Even if developed by or with a research team – e.g., in cooperation with a university – there still rarely are studies of eventual impact or effectivity (Scheepers *et al.* 2014, Salvo *et al.* 2018). This is a big gap and a missed opportunity to learn from both good and bad previous work.

The existence of this gap was already addressed by Frumkin in 2003 and O'Neill and Simard in 2006. Sadly, little seems to have changed in the following fifteen years, as experts still list mostly the same issues described by them; *What should be evaluated? Evaluate for who? Who should undertake the evaluation? How should the evaluation be performed?* (O'Neill and Simard 2006). All these topics were addressed during our interviews, stressing the need for a better framework to perform this evaluation, or perhaps more rigorously to discard the desire for a 'checklist' and develop a method suitable for this complex, long-term process.

We see potential for this in new data applications and smart city technologies. When asked what could help improve the process or designs of active environments, participants all agreed that more knowledge – coming from more data – would be helpful in a variety of ways. Using embedded sensors or other smart technology, many previously unattainable data are now within reach and should be used to their full potential. To capitalize on the opportunities provided, participants argue for stronger collaboration between knowledge institutions and practice as well as for adding data experts to the project team.

Advanced data analytics methods can help track and understand behavior longitudinally and on a large scale. Embedding more technology into the environment makes it less static, perhaps even interactive (Streitz 2007). A digital layer allows for easier adjustments, increasing multifunctionality, a main element of active environments mentioned in these interviews. Such environments can also be more easily altered – or updated – once they are realized. This allows for a more iterative urban design process, where the data collected by an environment actually feed back into the design loop to improve that very environment. We thus conclude that data can be used for more than collecting information about use and performance. It can become a creative material for designing engaging interactions and intelligent ecosystems (van Kollenburg and Bogers 2019). When regarded as such, data may become an integral part of a new generation of

interactive environments (van Renswouw *et al.* 2021). Although we are excited by the opportunities this presents, further research is needed to explore the potential of interactive solutions for active environment design.

Smart city and human-environment interaction developments underline the value of expanding the multidisciplinarity of design teams to increase insights gained from available data. We see an opportunity to include not only data analysts but also data designers in these teams.

Conclusion

In this paper, we discussed definitions of Active Environments and their added value in the public space when aiming to increase physical activity of a population. We first presented an overview of the strategies and elements used to create them. We then provided insights into the complex process of realizing such environments by describing the two main factors responsible for this complexity: the timeline and multiple stakeholders. We reviewed the challenges that occur, paying special attention to monitoring and evaluation. Finally, we discussed the role of data in these designs and processes, and opportunities it provides for both researchers and practitioners. With this work, we contribute to closing the gap between theory and practice by bringing together insights from both. By outlining key elements of the design and realization process of active environments together with issues, desires and potential identified by experts, we provide valuable insights and inspiration for professionals on both sides.

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Appendix A - Participants overview

Table A1. Describes participants' demographics.

ID	Gender	Age	Main Discipline	Context
P1	M	59	Urban Design and Planning	Industry & Academic
P2	V	32	Industrial Design	Academic
P3	V	38	Physical Activity Innovations & Society	Industry
P4	M	37	Industrial & Data Design	Industry
P5	V	32	Urban Strategy and Development	Local Government
P6	M	38	Industrial & Data Design	Industry
P7	V	33	Physical Activity Innovations & Society	Industry & Academic
P8	M	45	Physical Activity Innovations & Society	Industry
P9	M	51	Urban Design and Planning	Industry
P10	M	52	Public Health and the Environment	National Government
P11	M	46	Urban Design and Planning	Industry

Appendix B - Semi-structured interview guide

Semi-structured interviews were conducted in Dutch and translated to English

About you

Who are you? What is your job title and job description?
What is your professional and educational background? Work experience?
How does your job relate to Active Environments?

Photo Elicitation - Examples of Active Environments

Preparation task: In preparation of this interview, could you please come up with 3 examples (you can of course bring more!) of what you would consider as an Active Environment. It does not have to be a project you have been involved in, but just a good illustration of the topic.
During the interview: Let's look at the examples you have been providing. Can you tell me what these are and why they are considered Active Environments? What is the strategy they use to trigger people?

Active Environments

How do you define Active Environments? (what does this mean to you?)
What is the objective of AE according to you?
What do you see as main triggers for people to be active?
How does it translate into the process or solution you would implement?
What is the added value of acting at the environment level to trigger people into being active?

Collecting and Making Sense of Data

What type of data is usually collected to conduct projects on AE? (this could be anything you defined as data/source of information)
Why?/What kind of questions did you/the team (hope to) answer with these data?
How do you make sense of the collected data? (summaries, visuals, analysis, . . .)
What are you using the data for? (can be not to improve but to satisfy client/marketing, . . .)
How do you monitor or evaluate the success of the project? (again data)
→ after how long/length of intervals between measurements if applicable

Designing with data and in real life

How did you use data in the design/decision process?
Access to what data would (have) improve(d) the design?
What type of data do you wish you would have but is typically missing?

Illustrative Example

During this interview, you mentioned a couple of examples of AE. Let's focus on one specifically.

- Can you describe an example of an AE project you have been involved in? Ideally, walking us through the project from the start to the implementation? (steps and general timespan)
  a. Follow-up: What happened next? Who was involved at this stage? What was your role? Why? Can you give me more details?
  b. What were the criteria of success and (if so) how were they assessed?
  c. In this project what kind of data did you collect? (before, but if applicable also during and after the study)
- If the existing design is an interactive solution:
  a. what kind of data is collected by the design?
  b. is this only used for interactivity or also for evaluation/research?
  c. how is it processed?/how 'smart' is the design?
  d. How do you handle GDPR and privacy issues?

Towards interactive environments

The increase of digital technologies and applications enables a new generation of more interactive or even smart environments. How do you see this development in the context of active environments?
How do you see the opportunities, pros and cons of using such technologies to create more personalized environments?
Why would personalization/gamification be effective in the design of AE?
How can one concretely design for it (or approach it)?

Appendix C - Examples of active environments

Table C1. Describes examples of active environments provided by participants.

Participant	Example of active environment	Additional description (if provided)
P1	Expansion District in Almere (NL)	The complete recreative, active program 'reaches into the back yard'
	Bicycle streets and low-traffic residential areas	Space for pedestrians and bikers, who have preference here over cars
P2	Gymnasium	Environment that triggers activity for children as well as adults
	Natural outdoor swimming facility (with some play equipment)	I experience [and therefore associate] free time and leisure facilities with much more activity than a workplace
P3	Grass field in park	
	Playground	
	Bike lane	
	Calisthenics equipment	
	Benches	To make elderly people move, you need to place benches.
P4	Twinkeltegels	Interactive light tiles in sidewalk or play area
	Eckart Smart Exercise Route (NL)	Path with interactive tiles that light up sequentially with a pre-set pace
	High Tech Campus Eindhoven (NL)	Attractive outdoor areas, combined with one central lunch location. Invites people to walk there and lowers barriers to extend that walk
	Social Stairs (NL)	Interactive staircase that invites to take the stairs instead of elevator
	Workwalk (NL)	Route that facilitates walking meetings
P5	Roombeek area, Enschede ('streets to play') (NL)	Streets that are opened and closed for cars at certain times and jumping stones in pond
	Smartcity Living Lab Scheveningen (NL)	Smart sensors collect a variety of data, primarily for sustainability, but public health and vitality solutions are also considered
P6	Camping site	A kind of pleasurable troublemaking by giving up comfort and so creating circumstances where you need to move much more to do what needs to be done (like shopping, cooking, using the – often centrally located – facilities, but also play and entertainment)
	Theme park	People there walk considerable distances and spend a lot less time sitting down than on other days
P7	Skatepark, Steigereiland IJburg – Amsterdam (NL)	A busy area, attracting different age groups. Facilitates skating but also social bonding and walking routes
	Parcours	Training facility (for biking)
P8	Bike route, 'beautiful and free' (separate from car road)	
	(Inflatable) assault course	
	Schoolyard with 'challenging' playground equipment	
	Park 'n Play by JAJA Architects Copenhagen (DK)	
	Kwiek exercise route (NL)	Suggests exercises using objects already present in the area
	Geulberg area (NL)	Mountain bike trail and golf court on/around artificial hill (former dump site)
	Cruyffcourts	Public small soccer fields in residential areas
	Forest	In itself already a space for play and physical activity
P9	van Beuningenplein Amsterdam – by Carve (NL)	Multifunctional neighborhood area with pavilions and sport facilities
	Bicycle street	Street where bikes have preference
	Sport-axis Amsterdam (NL)	Bike and walking route
	Genneper Parken Eindhoven (NL)	
	Park Somerlust Amsterdam (NL)	Transition between urban and green area, both a transport and park place with attractive routes

(*Continued*)

Table C1. (Continued).

Participant	Example of active environment	Additional description (if provided)
	Gardens of Zandweerd in Deventer (NL) (under construction)	Cars stay at the edge of the neighborhood and streets have become garden paths
	Building where you see the stairs first and then the elevator	
P10	'Speeldernis' Rotterdam (NL)	Nature play areas
	Beweegtuinen e.g. Muiderwaard Alkmaar (NL)	Area with public fitness equipment, targeting senior citizens
	Passage Rijksmuseum (NL)	Infrastructure primarily for pedestrians and bikers
	Beuningenplein Amsterdam (NL)	
	Cruyffcourt	Especially when combined with neighborhood sport coach
	'Oegstgeester Ommetjes' (Strolls of Oegsteest) (NL)	Short walk routes with nature elements in residential area
	'Kindlint' ('Child-ribbon')	Dedicated child-safe low-traffic routes to important locations (e.g. school, playground, sport club)
	'Play streets' Roombeek Enschede (NL)	
	FIT happens (app)	App for active use of the public space (Rotterdam)
P11	Martikel no.8 – Copenhagen (DK)	
	Dynamic streets – example in Berada (PT)	The street is about facilitating mobility. What kind of mobility, and how we get from place to place is an important part of how physically active we are
	Multi sports installation – example in Matosinhos (PT)	
	Temporary use, multiple use; e.g. weekly rhythm & events – example: Art event in Zaragoza (ES)	
	Waterside (busy, lively) - example in Hoi An (VN)	
	Miera Street – Riga by Fine young urbanists (LV)	Street designed with priority for bikers and pedestrians, with shops and cafes, but with tram and car traffic in mind
	Areas for street play – example in Siena (IT)	