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Experts' insights on physical environmental factors impacting the use of urban public open spaces for physical activity

Benjamin Okenwa *, Marga Munar Bauzá

Welsh School of Architecture, Cardiff University, Bute Building, King Edward VII Avenue, Cardiff CF10 3NB, United Kingdom

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ABSTRACT

Studies on physical activity (PA) in urban public open spaces (UPOS) have explored the individual, social, physical, and environmental factors influencing PA engagement. However, there is a lack of focus on identifying the factors that attract users to open spaces for PA. This gap is significant, especially given the declining health patterns among young adults due to insufficient PA and rapid urbanization in the 21st century. Consequently, there is increasing interest in identifying the physical environmental factors that positively impact the use of UPOS for PA. This study aimed to identify the key physical environmental factors influencing the use of publicly accessible urban open spaces for PA. Following a comprehensive literature review, semi-structured online interviews were conducted with experts (n = 18) in architecture, landscape architecture, urban design, and public health between May and September 2023. The transcripts were analyzed in NVivo 14 using thematic analysis to derive categories and subcategories.This study validated broader concepts of physical environmental factors affecting the use of UPOS for PA, highlighting perceived safety as a significant social and physical factor. This research identified both compositional (within) and contextual (outside) attributes as fundamental in attracting users to UPOS for PA. The interview results show that while physical environmental factors such as aesthetic attributes, accessibility, land use mix, proximity, safety, and size contribute to the use of UPOS for PA, they do not operate in isolation. By comparing expert insights with a theoretical framework developed from the existing literature, this study validates the relevance of these factors and highlights some practical nuances.

Introduction

The public health field is increasingly concerned about low levels of physical activity (PA) and rising obesity rates (Center for Disease Control 2023). These issues are linked to various health conditions, including cardiovascular diseases (Khan et al., 2020; Rothenbacher et al., 2003), diabetes (Lamonte et al., 2005), mental health disorders (Landers and Arent, 2007), and certain types of cancer (Bray et al. 2018National Cancer institute 2025), ultimately contributing to lower life expectancies in many developed countries (Warburton et al., 2006). Global surveillance of PA levels by Hallal et al. (2012) indicates that one-third of the world's population approximately 2.2 billion people are overweight, while 10 % (around 712 million people) are classified as obese, another 2024 global surveillance study published in The Lancet Global Health, which analyzed 507 population-based surveys conducted between 2000 and 2022, found that 31.3 % of adults equivalent to approximately 1.8 billion people were not meeting recommended PA levels (Strain et al., 2024). The trend of declining PA levels is particularly prevalent among young adults in urban environments, where increased exposure to sedentary settings (such as workplaces and schools) and passive activities (e.g., television, the Internet, and phone use) contribute to prolonged physical inactivity (O'Loughlin et al., 2022; Leslie et al., 2001). PA includes both recreational and utilitarian types of activity, such as walking, cycling, or sports, each varying in intensity and purpose. In this study, the focus is on PA that occurs in open spaces such as parks, plazas or transient open spaces such as trails which collectively represent key types of urban public open space (UPOS). Despite growing concerns, research suggests that younger adults (persons aged between 25–40 years) have been largely overlooked in research related to the impact of the built environment on their health (Leslie et al., 2001) even though this demographic is experiencing a significant decline in PA participation rates (O'Loughlin et al., 2022).

As a result of globalization and increased urban migration, the urban environment has become both beneficial and detrimental to individual well-being, particularly PA (Oka, 2011). Despite living in compact neighborhoods with connected streets and efficient transit systems,

* Corresponding author.
E-mail addresses: okenwacb@cardiff.ac.uk (B. Okenwa), BauzaMM@cardiff.ac.uk (M.M. Bauzá).

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urban residents report high inactivity rates (Pearce and Maddison, 2011). Studying urban environments and their impact on PA patterns is crucial, given the significant growth in the number and size of cities over the past two centuries (U.S. Census Bureau, 2021). According to the United Nations Department of Economic and Social Affairs (United Nations; Department of Economic and Social Affairs, Population Division, 2018) report, "Urban population growth is expected to continue, such that the urban population of the world will reach 5 billion in 2028 and 6 billion in 2041" (2018, p. 10). Evidence suggests that several physical environmental factors such as higher density, mixed-use neighborhoods, and walkable destinations, are positively associated with residents' engagement in PA (Saelens et al., 2003; Kooshari et al., 2014; Wang and Stevens, 2020). However, urban residents remain more physically inactive than suburban residents (Dawson et al., 2007; Cunningham, 2004). With high population density and increasing rural-to-urban migration, urban areas have become critical for addressing various social, economic, and environmental challenges, especially those that can have a positive impact on health and well-being, such as PA. UPOS serves as a fundamental component of the built environment and offers diverse opportunities for PA, such as walking, cycling, running, and various sports (Babey et al., 2008; Bedimo-Rung et al., 2005; Cutumisu and Spence, 2009; Fathi et. al., 2020; Godbey and Mowen, 2003; McCormack et al., 2010) while reducing exposure to various of chronic diseases (Alfonzo et al., 2008). Thus, identifying the factors influencing the use of UPOS for PA is critical for effective urban planning and for creating environments where people can conveniently engage in PA.

This research aims to question, assess and validate a theoretical framework of physical environmental factors influencing the use of UPOS for PA. The framework was developed from a literature review and further explored and validated through insights from experts to ensure practical relevance and trends. The research starts by examining the relationships between UPOS and PA, building on previous studies that have consistently found positive relationships between the built environment and health (Sallis, Owen, and Fisher, 2015; Wang et al., 2021). While recognizing the influence of other socio-ecological model levels (intrapersonal, interpersonal, organizational, and policy), this study primarily focuses on the physical environmental factors within the built environment, which are key components at the community level (Sallis et al., 1997). Physical environmental factors are the built and natural attributes of UPOS that impact their use for PA. Specifically, "Physical" factors refer to attributes within an open space, while "environmental" factors relate to the surrounding context. Together, they are integral in influencing how UPOS are used for PA. Physical factors such as design attributes (Kaczynski et al., 2008; Kamińska and Mularczyk, 2021; Van Hecke et al., 2018), safety (Owen et al., 2004), and proximity (Bedimo-Rung, Mowen, and Cohen, 2005; Giles-Corti et al., 2005; Kaczynski and Henderson, 2007), as well as environmental factors like accessibility (Giles-Corti and Donovan, 2002; Humpel, Owen, and Leslie, 2002; McCormack et al., 2004), density (Kotharkar and Bahadure, 2012), land use mix (Boer et al., 2007; Cervero and Kockelman, 1997), and spatial distribution (Kaczynski, Potwarka, and Saelens, 2008; Sugiyama et al., 2013), have been found to positively influence PA engagement, thereby promoting health outcomes and longevity (Wang et al., 2021).

This paper is organized into three remaining sections. The data and research methods section discusses study participants, data collection, and analysis. The results section presents the physical environmental factors identified in the study, examining each factor. The final section addresses the implications of the findings and suggests areas for future research.

Data and research method

Methods

This study employed a two-part methodological design: Part 1 included a literature review, and Part 2 involved expert interviews. The first part began with a comprehensive review of literature, including peer-reviewed journals, academic books, and relevant reports retrieved using keyword combinations related to "urban public open spaces," "physical activity," "built environment," and "health" through academic databases such as Scopus, Web of Science, and Google Scholar. Studies were selected based on their empirical relevance to the physical environmental factors affecting PA in UPOS. The literature review formed the foundation for developing a theoretical framework that consists of six physical environmental factors influencing the use of UPOS for PA. Each factor was further divided into sub-factors to highlight specific attributes, see Table 1.

Following the literature review, Part 2 involved collecting qualitative data through semi-structured interviews with experts to validate and refine the framework. A purposive sample of participants was selected to explore their perspectives and experiences related to the physical environmental factors influencing the use of UPOS for PA. Institutional approval was obtained from the authors' institution's Research Ethics Committee prior to data collection to ensure compliance with ethical and procedural guidelines. The findings from both parts are presented together in an integrated framework (see Table 1).

Participants

Eligible participants included a cross-disciplinary group of experts from academia and industry, selected for their demonstrated contributions to research, policy, or practice related to active urban environments. For this study, an "expert" was defined as someone with graduate-level training in fields such as public health, population health, urban design, planning, landscape architecture, architecture, or community design. Participants were identified through purposive sampling based on their publication records, positions in relevant organizations, or work in built environments. Recruitment was conducted systematically, beginning with a targeted list of authors of peer-reviewed papers and books reviewed during this study, supplemented by the professional networks of the authors.

After identifying potential participants, invitations were sent via email to 125 experts, starting in May 2023, with follow-ups occurring several times between May and September 2023. Invitations were extended globally without geographic restrictions, resulting in a diverse set of participants. Each invitee received a brief description of the study and a link to schedule an interview if interested in participating. Eighteen experts participated in the study. The 18 experts represented a diverse range of professional sectors, including academia (8), private firms (4), public-sector agencies (3), and non-profit organizations (3), with some overlapping roles. Their disciplinary backgrounds include urban planning, architecture, landscape design, public health, and environmental psychology. Geographically, the participants were based in North America, Europe, and Australia, offering cross-regional perspectives relevant to UPOS and PA.

Data collection

Semi-structured interviews were conducted, allowing guided and open-ended responses (Creswell and Creswell, 2017), and participants had the flexibility to share their unique insights and nuances that may not have been captured otherwise. This strategy supported a rich, in-depth analysis that validates, broadens and interrogates the significance of the findings from the literature review. The interviews were conducted virtually with the participants on a recorded Zoom call. The informal nature of the sessions allowed for open and candid discussions

Table 1
Framework of Factors Influencing Urban Public Open Space use for Physical Activity Based on Findings from Previous Studies and Insights from Expert Interviews.

Factor	Sub-Factor(s)	Findings from Previous Studies (Selected Citations)	Insights from Expert Interviews
Aesthetic Attributes	Amenities Building Variety Coherence Comfort Enclosure (Presence of buildings) Human Scale Maintenance Materiality Morphology Pedestrian Shed Place making elements Relationship with buildings Sense of Place Sidewalks Street Art Street Furniture Trees and vegetation Views/vista Visual Attractiveness	Studies consistently highlight the aesthetic attributes of an UPOS as a significant factor in attracting users for various social and PAS. Aesthetic attributes in UPOS creates attractive environments that positively influence visitations and support a stronger sense of place, improving both psychological well-being and PA engagement. Jacobs, 1994; Gehl, 2013; Sugiyama and Thompson, 2008; Humpel et al., 2002; Sugiyama et al, 2010; Baek et al., 2015; Zhai and Baran, 2017; Giles-Corti and Donovan, 2002; Saelens et al., 2003;	Experts agreed on the role of design elements such as street furniture, sidewalks, and vegetation. However, they further included maintenance and cleanliness as critical aspects that influence how users perceive attractiveness, noting that upkeep strongly influences how welcoming a space feels and creates a sense of safety. experts also highlighted the benefits of having aesthetic attributes that improve convenience such as benches, water fountains and toilets.
Accessibility Attributes	Active Travel Infrastructure Block Size Connectivity Parking Availability Physical Access Public Transit Option Topography/ Terrain Universal Design	Accessibility to UPOS is shaped by the presence of active travel infrastructure (sidewalks, cycleways, and transit options), connectivity, block size, parking availability, and terrain. Research shows that UPOS located within well-connected networks strongly correlate with both active travel, recreational and physical activity. Natural features, such as topography or terrain, also affect the ease of movement and overall accessibility. Saelens et al., 2003; Roe et al., 2016; Kriken et al., 2010, pg 136; Jacobs, 1994, pg 178; Giles-Corti and Donovan, 2002; Sugiyama and Thompson, 2008; Coombes et al., 2013; Weber, 2006; Handy and Niemeier, 1997	Experts confirmed the significance of distance and connectivity as found in the literature, but they expanded the scope to include usability for all users (inclusivity) and access that incorporates universal design principles, rather than just ease of travel. Experts also discussed accessibility within an UPOS to include universal design principles for all ages.
Land Use Mix Attributes	Density Destinations Mix of Functions Multi-Purpose Space Vertical Grain	Higher population density and a diverse land-use mix, including primary destinations within walking distance, provide vibrancy and enhance the use of UPOS. Scholars have also linked such functional diversity to a stronger sense of community, which fosters engagement in PA. Greenwald and Boarnet, 2001; Saelens et al., 2003; King et al., 2003; Gehl, 2013; Jacobs, 1994; Kriken et al., 2010, pg 89.	Experts confirmed the benefits of mixed land use to promote engagement in PA in UPOS, but broadened the scope to include social and cultural dimensions, such as sense of community, cultural use, and vibrancy. They noted that a social environment often drives repeated use of UPOS for various activities and can also promote active living.
Proximity Attribute	Walkable Distance	Proximity, typically defined as a walkable distance to UPOS or destinations, is one of the most consistent predictors of PA. Multiple studies have shown that people living closer to parks or other types of UPOS are more likely to use them and engage in recreational walking. Perceptions of proximity are often as influential as objective measures of proximity. Kaczynsky et al., 2014; Roe et al., 2016; ; Giles-Corti et al., 2005; Hurvitz et al., 2014;Koohsari et al., 2013; Sugiyama et al., 2010; King et al., 2003;.Kaczynski et al., 2014	Experts simplified proximity to walkable distance to UPOS, suggesting that perceptions of proximity matter more than actual proximity in the everyday use of an UPOS for PA. This validates findings from literature.
Safety Attributes	Large expanse of parking Lighting Perceived Safety Visibility	Existing literature highlights that perceived safety from crime, traffic and disorder significantly influence routine visits to an UPOS for both social and physical activities especially amongst groups such as older adults, women and children. Baek et al, 2015; Boer et al., 2007; Saelens et al., 2003; Kaczynski et al., 2014; Zhai and Baran, 2017; Wang et al., 2020.	While experts acknowledged the importance of visibility and lighting, they placed greater emphasis on perceived safety, noting the roles of user experience and design features that support natural surveillance.
Size Attributes	Accommodate More Activities Balance of Distribution	Studies suggest that larger UPOS offer more opportunities for diverse activities	The literature highlights the benefits of having a larger UPOS more

(continued on next page)

Table 1 (*continued*)

Factor	Sub-Factor(s)	Findings from Previous Studies (Selected Citations)	Insights from Expert Interviews
		and sustained engagement. Particularly, when size is combined with accessibility and attractiveness, it is associated with increased frequency and intensity of PA. Koosari et al., 2014; Flink and Searns, 1993; Giles-Corti et al., 2005; Sugiyama et al., 2010; Bedimo-Rung et al., 2005; Coombes et al., 2013.	strongly than experts; however, experts viewed size as supportive but secondary to other physical environmental factors, such as safety, aesthetics and accessibility, suggesting that usability matters more than absolute scale.

that lasted between 14 and 37 minutes (average 21 minutes), depending on the depth of conversation, richness of the participant's responses, and time availability for both the interviewer and participant. At the beginning of each interview, the researcher asked the participants three questions: (1) Do you agree or disagree that physical environmental factors impact the use of UPOS for engagement in different types of PA? This first question was mostly answered with a binary response, and the researcher then followed up with a probing question (2) Can you explain how physical environmental factors may impact the use of UPOS for engagement in different types of PA? Participants anecdotally elaborated on their initial responses by delving deeper and providing additional information that has shaped their perspectives. (3) What physical environmental factors do you consider to significantly impact UPOS use for PA among young adults? Here, participants identify the specific factors they consider most important in influencing young adults' use of UPOS for PA, often referring to initial comments from the second question. Young adults were referenced not as the central focus of the study but as a baseline group assumed to have full physical ability and minimal support needs. This framing enabled a clearer examination of how standard environmental factors affect open-space use for PA, avoiding confounding influences tied to age, disability, or gender-specific needs.

Data analysis

All recorded interviews were transcribed, coded, and analyzed using NVivo 14. The analysis method was adapted from Braun and Clarke's (2016) thematic analysis approach, supplemented with a matrix-based analytical framework to map coded data onto an initially developed theoretical framework developed from the literature, and then refined through an iterative review of transcripts to ensure consistency. This approach allowed us to validate, adjust, or expand the original framework based on expert insights, thereby developing both deductive and inductive themes. Here, themes represent recurring physical environmental factors that participants identified influencing engagement in PA in UPOS. To provide transparency and highlight the relative importance of themes, the authors counted how many participants mentioned each attribute and displayed these frequencies as percentages of the total sample (n = 18). This approach is consistent with qualitative thematic analysis guidance (Creswell and Poth, 2016). The identified factors were further categorized into subfactors. The data analysis in this study included making notes during interviews, reviewing recorded transcripts, and deriving codes from the recordings. It follows the five stages of thematic analysis: getting familiar with the data, generating codes from the transcripts related to the research and possible emergent themes, comparing codes between interviews and recoding, developing preliminary themes, and iterating them using a framework that suits the research aim, defining themes, and synthesizing data into charts (Creswell and Poth, 2016).

One primary coder conducted the thematic coding process, supported by a second coder, who reviewed a sample (25 %) of the transcripts to ensure intercoder reliability. Discrepancies were discussed until consensus was reached, enhancing analytical rigor. The analysis resulted in 40 emergent themes categorized into six groups. Following the structure of the theoretical framework developed from the literature, these themes and categories are presented as physical environmental factors and subfactors (see Table 1). To ensure validity and reliability, the interview protocols were carefully designed, pilot-tested, and followed by accurate transcription, coding, and documentation. While the analysis was qualitative, counts of how many participants referenced each theme were recorded within the thematic matrix to illustrate the consistency of certain factors across diverse expert views.

This study combined a review of existing literature with expert interviews to provide both a theoretical foundation and practical validation. The literature informed the initial framework, which was then refined and validated through expert input to ensure its alignment with real-world applications. The process followed established qualitative research guidance on integrating theoretical insights with empirical data to develop frameworks that are both rigorous and practically relevant (Creswell and Creswell, 2017; Braun et al., 2016)

Results and discussion

First, we define an UPOS as a public space within an urban environment designated for outdoor recreational activities and social interactions (Madanipour, 2003; Wooley, 2003). These spaces can take many forms, including parks (Chiesura, 2004; Newman, 1973), squares (Miller, 2007), plazas (Miller, 2007), playgrounds (Woolley, 2003), gardens (Newman, 1973), and other types of green or natural areas (Little, 1995). In this study, "factors" refer to the broader categories of physical or environmental influence (e.g., accessibility), while "sub--factors" are specific components or attributes within each factor (e.g., connectivity, pathway continuity). There was consensus among participants when asked if physical environmental factors impacted the use of UPOS for PA. Subsequently, each participant was asked to describe the physical environmental factors that positively influence this use. Table 1 summarizes the interview data, organized into main physical environmental factors and sub-factors. The third column provides a concise synthesis of findings from the literature review, and the fourth column presents insights from the expert interviews.

Factors influencing urban public open space use for physical activity

Aesthetic attributes

Researchers in built environment and psychology have found that aesthetic attributes attract users and promote socially sustainable activities that enhance PA (Ahmad Nia and Atun, 2016). Lynch, (1984) discovered a positive link between well-being in urban spaces and the desire for a visual order. He analyzed physical elements that enhance urban life, aligning with Jacobs' (1994) argument that aesthetics, functionality, and social dynamics are inextricably linked in creating "successful" urban spaces. Recent studies have examined perceptions of environmental aesthetics (Weber et al., 2008), gathering data through surveys, interviews, and natural observations of open spaces (Ahmad Nia &Atun, 2016; Burton and Mitchell, 2006; Webber et al., 2008) and streets (Kamińska and Mularczyk, 2021). They concluded that aesthetic attributes influence people's preferences (Ahmad Nia and Atun, 2016) and cognition, directly impacting individual engagement with their surroundings. In the context of UPOS use for PA, which often overlaps with other recreational purposes, Kaczynski (2008) examined aesthetic attributes based on the visual qualities that attract people to engage in

PA in parks and found that specific features such as paths, unpaved trails, playgrounds, wooded areas, and water features strongly correlated with the increased use of open spaces and neighborhood streets for PA. Other studies assessing the impact of aesthetics attributes on UPOS for PA examined features and amenities, noting a positive correlation between the presence of certain features and enhanced PA (Alfonzo et al., 2008; Kaczynski et al., 2008; Van Hecke et al., 2018).

The findings from the interviews align with existing research on the aesthetic attributes influencing the use of UPOS for PA, but in a more practical sense. Experts consistently mentioned various aesthetic attributes relevant to the use of an UPOS for PA. Within the broader category of aesthetic attributes, 19 subfactors were identified (Fig. 1). Among these sub-factors, the presence of trees and vegetation, comfort, amenities, and visual attractiveness were the most frequently cited factors that positively influence the use of UPOS for PA.

They highlighted that well-maintained UPOS are attractive for walking and recreational use, whereas poorly maintained spaces deter visits. As one participant noted, "So, maintenance is kind of, I will say it's kind of an aesthetic, there's an aesthetic dimension, right to being sure that shrubs are trimmed, or the lawn is trimmed, or we don't have a bench that's falling apart, right?" (P#: 2308250).

This reflects a broader view that cleanliness and upkeep are as important as design quality in encouraging regular usage. The presence of trees and vegetation was also stressed as an essential feature that shapes user experience. Several experts explained that the presence of trees and varied plant materials creates both comfort and attractiveness, thereby sustaining engagement in PA. For example, one expert stated, "I think providing shady areas, and if you send out older people that are compromised, physically providing areas where you can exercise and then pause us about to place in a shaded area, and then walk some more and then pause again, setting rest spaces" (P#: 2306160). Corroborating another expert who said, "Landscape that helps provide shade in the summer and wind protection in the winter or winter city here" (P#: 2308080). This suggests that having trees and other forms of greenery not only improves appeal but also provides pedestrian shade to relax and improves thermal comfort during extreme weather conditions. Having continuous sidewalks and street lighting was also highlighted as enabling the use of UPOS for PA, as one participant said, "Stimulation in a way that is both consistent and encouraging for people to walk, right? So great sidewalks that are consistent in width and length. Street lighting that is consistent. That doesn't create those, you know, shadows at night" (P#: 2308080). Attributes such as human scale, enclosure, and how they relate to buildings were also mentioned. An expert said, "I think scale and walkability is something that is very, very important. And so, the scale of blocks, the scale of streets" (P#: 2308092). Another expert discussed the importance of UPOS aesthetic attributes in promoting or sustaining a sense of place. "So again, I think it's about understanding the place that you're in, and the kind of people who may be using that space. And then addressing their needs" (P#: 2308110).

Some aesthetic attributes also overlapped with safety attributes, as participants emphasized the importance of maintenance, linking it to safety, and suggesting that a lack of maintenance implies negligence, which may deter the use of an UPOS making it more threatening to users. Participants also identified street furniture, such as drinking fountains, street art, trash bins, lighting, and water features, as elements that enhance the usability and convenience of the UPOS, provide comfort and rest areas, and contribute to the overall aesthetic appeal. Amenities such as sports courts, restrooms, and playgrounds have been suggested to support various activities and provide essential conveniences, thereby enhancing the overall user experience and encouraging more extended stays.

Accessibility attributes

Accessibility refers to the ease of reaching a destination within the context of the built environment (El-Geneidy and Levinson, 2006). Scholars have defined it as the degree to which destinations can be reached (Handy and Niemeier, 1997; Wang et al., 2013). This is an essential factor affecting the use of UPOS. In addition to the ease with which an UPOS can be reached, accessibility also includes the quality, quantity, and type of activities offered within a space (Weber, 2006; Wang et al., 2013). Several studies have examined the relationship between access to public open and green spaces and participation in PA, consistently showing that greater accessibility is associated with higher levels of engagement in PA (Giles-Corti and Donovan, 2002; McCormack et al., 2004; Owen et al., 2004; Giles-Corti et al., 2005; Kaczynski and

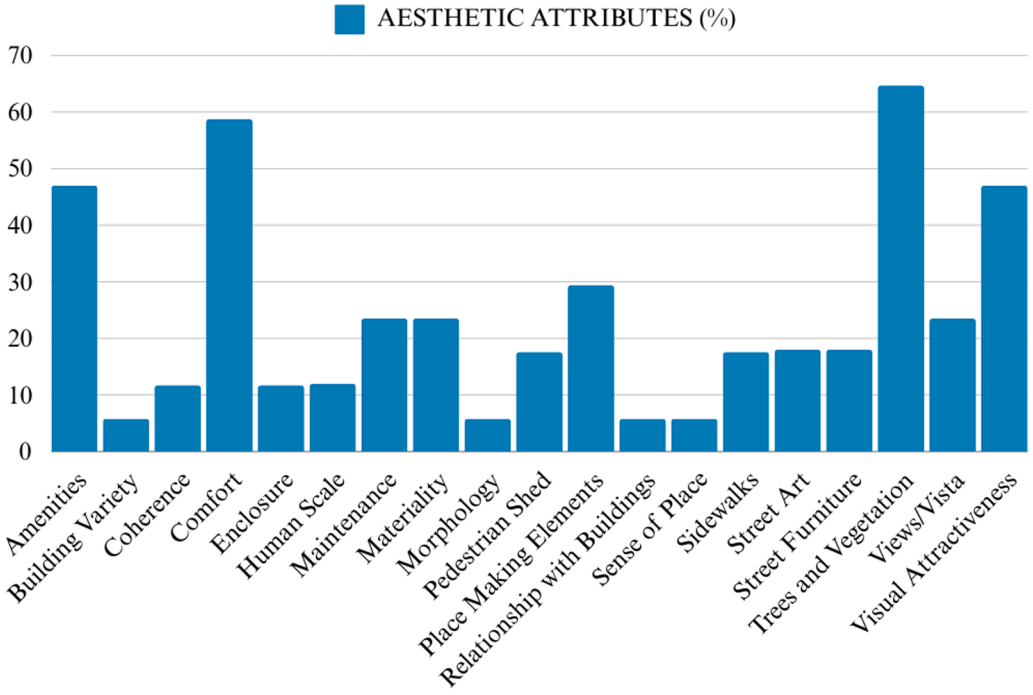

Fig. 1. Bar Chart of Aesthetic Attributes and Corresponding Themes with Participant Mentions (n = 18).

Henderson, 2007). Carmona (2021) asserts that frequent visits to a UPOS are a well-accepted indicator of the success of that space, corroborating the findings of Whythe (2000). A study in Australia reported that access to an attractive public open space was associated with increased use for recreational walking (Giles-Corti et al., 2005). This study confirms that attractiveness alone may not be sufficient to attract users to open spaces if they are not easily accessible. Another study found that the options of open space facilities, but not their distance from participants' homes, were positively associated with the use of PA (Humpel et al., 2002). As a critical factor in evaluating spaces within the built environment, accessibility is typically assessed using both objective and subjective (perceived) approaches (Hoehner et al., 2005; McCormack et al., 2008). Objective approaches consist of physical features, such as transit options, distance, terrain (Weber, 2006), distribution of open spaces or potential destinations (Handy and Niemeier, 1997; Weber, 2006), connectivity, and permeability (Weber, 2006). The subjective or perceived approach to measuring accessibility refers to the perception of distance, attitudes, norms, and the travel time (Hoehner et al., 2005; Wang et al., 2013). Researchers have argued that people's perception of accessibility informs their intent to use an UPOS, ultimately resulting in diminished or increased use of the space (Penchansky and Thomas, 1981), and that perceived accessibility serves as a significant predictor of actual use. While Penchansky and Thomas primarily focused on healthcare issues in their research, the applicability of their findings to open space accessibility for PA may be somewhat limited. The multidimensional nature of accessibility poses challenges when translating it into performance measures for evaluation. Accessibility can be measured in both spatial and non-spatial terms (Handy &Niemeier, 1997; Weber, 2006) as well as perceived or objective measures (Hoehner et al., 2005; McCormack et al., 2008). Despite numerous studies attempting to address these dimensions of accessibility, many have struggled to find conclusive solutions (Handy and Niemeier, 1997).

Like the literature, experts interviewed identified accessibility to UPOS as a significant factor influencing use for PA, highlighting specific key attributes of accessibility (Fig. 2) in this context. 83.3 % of participants mentioned that access to UPOS influences its use of PA. Within the category of accessibility, 60 % of the experts referred to connectivity, whereas 33 % mentioned universal design principles as key aspects of accessibility. These were the most frequently identified subfactors of accessibility by the participants. Participants framed accessibility to include both ease of connectivity and user experience, stating that small barriers can be decisive: "All it takes is one stressful moment, one lack of connection, and people will just, you know, give up and go somewhere else" (P#: 2306200). Ease of travel was also highlighted as very important, as participants emphasized that the directness of routes from one point to another was crucial for increased accessibility, including the availability of parking for drivers. "If a person doesn't have a way to get to that place, then they're not going to go. And so, we're talking about accessibility, either driving and being able to find parking or being able to walk, and that you probably know" (P#: 2308162).

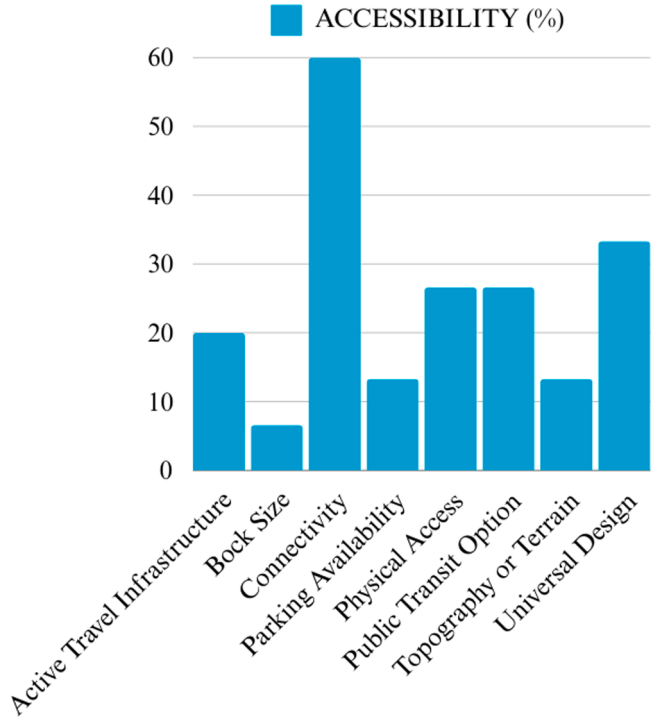

Fig. 2. Bar Chart of Accessibility and Corresponding Themes with Participant Mentions (n = 18).

Additionally, participants also mentioned good transport links and the choice of different modes of transport; one expert stated, "If it is a larger destination park, you want to be getting good transport links. And you know, that's not just car dependency, is there some of that can be built along the existing public transport network, is their metro lines can be extended, or additional stops to be included in there in terms of accessibility, and within the bike itself, as well, you know, but think about the different uses as well" (P#: 2306270). Participants also pointed to physical access, such as hours of operation, as a deterrent to open space use for PA. Another participant stated, "Sometimes there's nice green spaces, but they'll be closed off a lot of the time, they're not accessible. And we'll break the habit of going there when they might be open" (P#: 2306160).

One social aspect of accessibility discussed during the interviews was the need for equitable access to UPOS. In addition, one participant highlighted smaller block sizes as a relevant aspect of the built environment that influences accessibility. Discussions on the impact of accessibility to UPOS and PA confirm that well-connected spaces, particularly those linked to active travel infrastructure such as greenways, trails, and public transit, are more frequently used for PA. Participants also underscored the significance of micro-scale accessibility within an open space, emphasizing that circulation within a public open space designed with universal accessibility in mind caters better to diverse user groups. While most aspects of accessibility identified in this study are related to physical accessibility, social accessibility was not wholly excluded.

Land use mix attributes

The Dictionary of Urbanism defines land use mix (LUM) as a mix of complementary uses within a building, site, or geographical area (Cowan, 2005). Other researchers have broadly defined LUM as the composition of uses within a geographic area (Frank and Pivo, 1994; Saelens, Sallis and Frank, 2003). LUM can range from a small-scale mix in buildings (vertical grain) to a large-scale mix across a neighborhoods or blocks (horizontal grain), integrating a sustainable mix of functions across scales (Greenwald and Boarnet, 2001; Leslie et al., 2007; Saelens et al., 2003; Gehl, 2013). Within built environment and health research, LUM emerged following 20th-century global concerns about sedentary living due to reliance on automobiles and less engagement in walking, biking or transit. The emergence of LUM presented an essential component of urban design that aims to integrate diverse land uses, promote active transportation, social interaction, and create healthier, more livable urban environments that encourage residents to lead active lives (Saelens et al., 2003; Frank et al., 2003). A study in Atlanta found that mixing land uses was positively associated with increased PA among adults (Frank et al., 2006), which has been corroborated by numerous other studies that identified a positive correlation between LUM and engagement in PA. A comprehensive study investigating the impact of new urbanism design guidelines on walking in ten US cities found that higher levels of business diversity (four or more business types) in an area were associated with more walking (Boer et al., 2007).

Another study found that walking, the most common type of PA, is higher in areas with higher residential and employment densities and a variety of destinations (Cervero and Kockelman, 1997). Numerous studies conducted by Robert Cervero, a transportation and land-use planner since the 1990s, found that residents living in areas with high LUM diversity have higher levels of walking for transportation but lower levels of leisure walking (Cervero, 1996; Cervero and Kockelman, 1997).

A total of 83.3 % of participants identified mixed land use as a significant contributor to UPOS use for PA. Among these, 53.3 % highlighted that functional diversity around an open space helps activate an area, ensuring continuous activity throughout the day and influencing the overall perception of safety. A participant said, "If it's at the center of lots of things, it becomes a different type of use throughout the day" (P#: 2308080). Participants also noted that land-use patterns surrounding an open space should also mirror the internal mix of activities that occur in the space to become a multipurpose space as another participant noted "Certainly, the mixed use neighborhoods so that almost everybody has a school, a grocery store or pharmacy, everything they need within their daily lives within a 10 to 15 minute bicycle" (P#: 2306200). Expanding on this, another participant described how neighborhood-level land-use mix, whether in the form of vertical grain or horizontal grain, enhances urban vitality. "For example, is there a place where you can put some retail at the ground level if there is like a very important public space, is that where you're going to put more density? Maybe that's where you're going to put apartments and multifamily with some mix of uses so that there's more. There's just a bit more of a dynamic environment that is being created along that space, and that can be a huge contributor to the success or the failure of a place" (P#: 2308092).

Sense of vitality was consistently linked to the increased use of UPOS, as higher density and multifunctionality tend to attract more foot traffic and spontaneous social and physical activity. Another participant stated, "I suppose it's nice to have particular routes through and maybe a destination. So sometimes people will go to a cafe or, you know, that's a common culture in an urban setting, there are particular locations within the scheme that they might then choose to go in that direction towards. So, we put a lot of emphasis in our city on having maybe a destination cafe or a destination, something within the park in order for people to passively go and enjoy that" (P#: 2308020). Participants also suggested other sub-factors related to mixing land uses, such as having destinations around an open space and proximity to commercial establishments, schools, and residential areas, all of which contribute to making UPOS a seamless part of daily routines. These land-use synergies support a more integrated urban fabric, where PA becomes a byproduct of everyday movement in layered, multifunctional environments (Fig. 3). Among the participants who mentioned LUM, population density, and land-use mix were seen as interconnected in promoting active environments, each enhancing the effectiveness and sustainability of the other. Overall, a balanced, functional mix around open spaces improve user experience and supports engagement in PA.

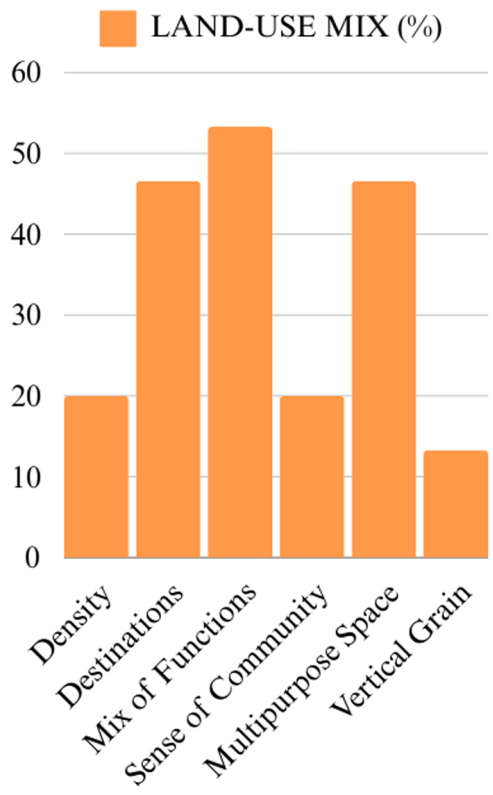

Fig. 3. Bar Chart of Land Use Mix and Corresponding Themes with Participant Mentions (n = 18).

Proximity attributes

In urban design and planning, proximity refers to the closeness of various locations, amenities, or services to one another or specific points of interest, such as residences, workplaces, schools, transportation hubs, and stores. Within urban design guidelines, proximity to UPOS has been frequently cited as a key ingredient that offers numerous benefits such as enhancing mental health (Giles-Corti et al., 2005; Kaczynski and Henderson, 2007), encouraging social interaction (Baek et al., 2015), improving quality of life (Bedimo-rung et al., 2005; Kaczynski and Henderson, 2007; Payne et al., 2005), and engagement in PA (Bedimo-rung et al., 2005; Payne et al., 2005; McCormack et al., 2010; Baek et al., 2015). Previous studies have extensively examined the influence of proximity to UPOS on PA engagement, both as an independent factor (Payne et al., 2005) and in combination with other physical environmental factors (Giles-Corti et al., 2005; Kaczynski et al., 2008) which has produced inconsistent results with some studies arguing that proximity to UPOS does not necessarily influence people's engagement in PA (Kaczynski et al., 2008; Kaczynski et al., 2014). However, other studies have found compelling evidence that living closer to UPOS such as parks is generally related to increased PA levels (Giles-Corti and Donovan, 2002; Kaczynski and Henderson, 2007; Sugiyama et al., 2010). The study by Sugiyama (2010), conducted among adults in Perth, Australia, found that shorter distances to open spaces with aesthetic attributes were positively associated with more leisure walking. According to this study, although proximity is important, its significance is closely tied to the quality of the park. This finding is also consistent with a previous study conducted in the same location (Giles-Corti et al., 2005).

In this study, 50 % of the experts interviewed highlighted proximity as a critical determinant of UPOS use for PA, noting that when spaces are located within a walkable distance, individuals are far more likely to integrate them into their daily routines. As one participant explained, "Parks have to be somewhere people can walk" (P# 2306270). Others noted that while driving to green spaces is possible, people are more likely to use UPOS located within a walkable distance regularly because of the minimal effort and time required to access them. "Proximity is important. Although I do know that people will drive to green spaces if they don't have one close by, you know, that goes with a relative degree of privilege of being able to take the time to do that. But so, when things are closer, people are more likely to use them" (P#: 2308250). Locating UPOS near users also encourages active transportation modes such as walking, jogging, and cycling. One expert noted that proximity to a UPOS may influence the social characteristics of how well the space is used, not only for PA but also for fostering social interactions and community engagement.

Additionally, experts highlighted that distance to an UPOS can act as a barrier to its use, especially for certain populations such as older adults, children, or individuals with disabilities. The experts did not specify whether proximity should be measured subjectively or

objectively, which is significant given the ongoing debates in existing research about whether subjective or objective measures are superior and how well this different measurement approaches align when examining proximity objectively (Lackey and Kaczynski, 2009). The interviews revealed that proximal UPOS, such as neighborhood parks, are more inclusive as they reduce physical and psychological barriers. In analyzing recordings from the interviews, no themes were coded under proximity as it appeared to be straightforward, walkable distances.

Safety attributes

Neighborhood safety is a critical factor influencing the use of UPOS for PA. Studies have found that residents who consider their neighborhood safe, are more likely to engage in outdoor and recreational activities (Miles and Panton, 2006; Miles, 2008). The aspects of safety that have received attention in built environment and health research include dog attacks, crime, traffic, pedestrian-related safety, and infrastructure conditions (Owen et al., 2004; Painter, 1996; Okenwa and Nassar, 2021). Safety in the built environment is studied as a combination of social and physical factors, as it includes aspects that influence individual perceptions and actual conditions (Miles, 2008). Studies have also shown that the social aspects of safety (especially crime) are more complex and, therefore, subjective to measure (Foster and Giles-Corti, 2008). Literature examining safety and engagement in PA remains mixed as studies have reported inverse associations between perceptions of danger and less PA within neighborhoods or open spaces (Bracy et al., 2014; Foster and Giles-Corti, 2008). Furthermore, research has consistently shown that specific sociodemographic groups, such as women, older adults, and children, often report higher levels of fear of crime than others (Hale, 1996; Miles and Panton, 2006), highlighting the subjective nature of safety perceptions.

Participants overwhelmingly indicated that the feeling of safety was the most relevant factor influencing decisions to use UPOS for PA, with nearly 90 % identifying it as central. One participant stated, “People don’t have spaces that are safe and attractive and healthful, then they’re not going to be able to, to be out and about in those environments” (P#: 2308110). Several safety aspects were highlighted as directly influencing willingness to use UPOS regularly. As shown in Fig. 4, among the participants who mentioned safety, 87.5 % identified perceived safety as integral. One participant state, “No? Well, I guess I’m gonna go back to the, to the perception of safety question, because I feel like that almost is the is the key to getting people to use these spaces” (P#: 2308250). Although the perception of safety was frequently discussed, the participants’ descriptions of safety concerns were broad. Another participant stated, “And so, one of the first things is safety. In a public space, people tend to steer clear when it is not safe or does not feel safe. Sometimes a perception is enough to keep someone from being away, or to keep someone away. And if a place feels safe, maybe it’s not, but if it feels safe, that’s someplace that people will want to go” (P#: 2308162).

Other participants identified vehicular traffic and social safety as the most prominent aspects. “It has to be safe, both in terms of well, the threat of motor traffic, but also social safety, so that we don’t feel like there’s a threat of being attacked in that space” (P#: 2306200). Participants also suggested that feelings of insecurity could be addressed by designing more spaces with passive surveillance, as another participant noted, “I think we adopt sort of a common view that if there is vitality, and there is surveillance of an area, then there’s more like a bit of, you know, a bit of coming and going and a place is more likely to be or feel safe” (P#: 2308020). This suggests that increasing visibility within an UPOS and its surroundings, and eliminating hiding places tends to make UPOS users feel vulnerable and anxious. “So visibility, designing the landscape so that you know, you’re not in areas where you might be alone, for example, and I would say, that applies not just to the outside of a green space, but as you pass through the green space that you’re flanked by areas that might be observed by other people” (P#: 2306160).

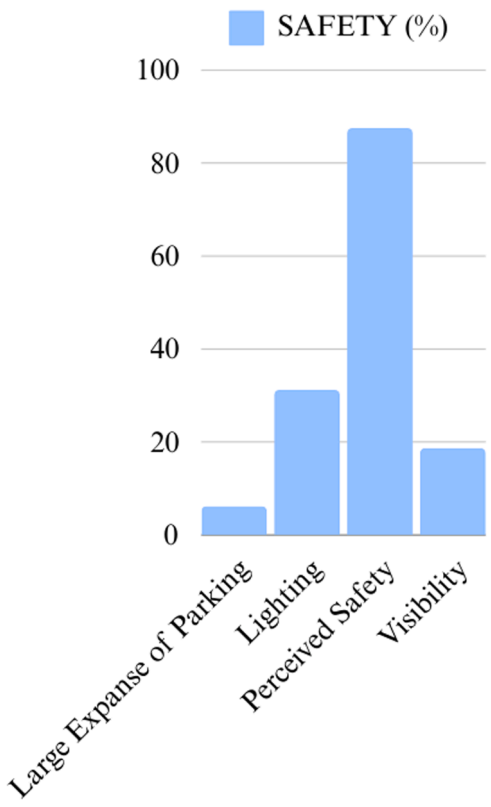

Fig. 4. Bar Chart of Safety and Corresponding Themes with Participant Mentions (n = 18).

The interview participants’ responses indicated that the perception of safety was a critical factor influenced by various elements, such as the physical design of the space, the presence of other people, and the overall maintenance of the area. For instance, a well-maintained, clean, and well-lit space is perceived as safer than a neglected or poorly lit space. Integrating these safety elements into the design and location of an UPOS can significantly enhance its attractiveness and usability for the community at large.

Size attributes

While both small and large open spaces can support PA, research indicates that the size of an open space may be significant in determining its use for PA (Kaczynski et al., 2008; Wang et al., 2019). Research shows that open space size is a contingent physical environmental factor (Giles-Corti et al., 2005). This is because it is typically examined along with other physical environmental factors, such as accessibility, amenities, and aesthetics (Kaczynski et al., 2008; Sugiyama et al., 2013). The integrated approach used by most studies in examining open space size suggests that, while size is important, its impact on PA may be contingent upon the presence and quality of other physical environmental factors. However, findings have consistently shown that larger open spaces provide numerous benefits that enhance their use for PA participation (Giles-Corti et al., 2005; Kaczynski et al., 2008; Sugiyama et al., 2013; Van Hecke et al., 2018; Wang et al., 2019). In addition, larger open spaces are often better equipped to accommodate a variety of activities, such as sports fields, walking trails, and playgrounds, which attract more users and support diverse forms of PA (Coombes et al., 2013).

Although less frequently mentioned in the interviews, 22.2 % of participants considered size to be a significant influence on the use of UPOS for PA (see Fig. 5). Larger open spaces were discussed as versatile, allowing multiple activity zones to coexist, from sports and play to

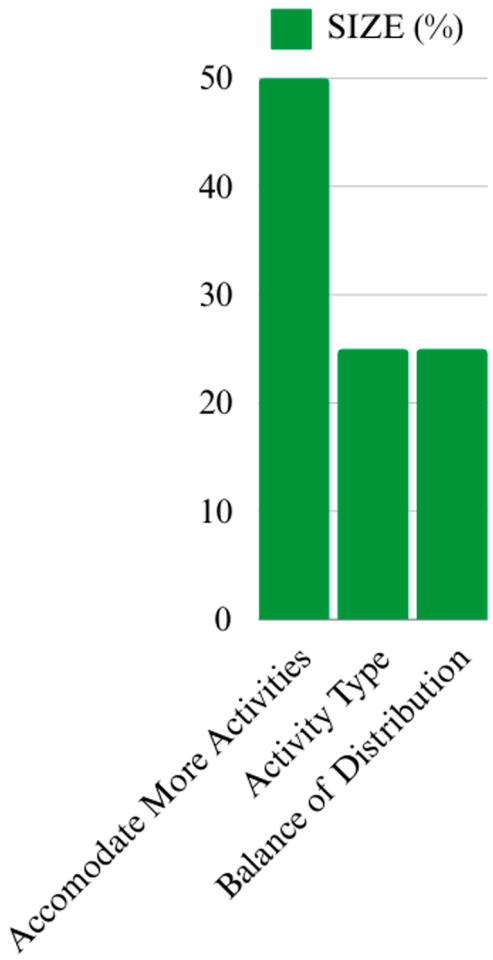

Fig. 5. Bar Chart of Size and Corresponding Themes with Participant Mentions (n = 18).

relaxation and social activities. One participant described this role, noting that larger areas create flexibility for diverse users and functions: This diversity is essential for attracting a broader demographic and promoting sustained engagement within the space throughout the day as seen in large neighborhood parks such as Central Park in New York and Golden Gate Park in San Francisco.

Another critical aspect of UPOS size, as described by participants, was how large open spaces could be integrated across neighborhoods, enhancing permeability by promoting balanced distribution and ensuring that the benefits of open spaces are accessible to a broader range of residents. While the size of an UPOS emerged as a secondary factor compared with other physical environmental attributes such as safety and accessibility, these insights suggest that it plays a foundational role in shaping the potential of a UPOS, particularly when the goal is to support diverse PA at the neighborhood scale.

Expert insights confirmed that the literature was sufficiently comprehensive to establish a robust theoretical framework while refining specific subfactors. The alignment between expert perspectives and prior studies highlights the practical relevance of the framework and its potential to guide urban planning and design strategies for future UPOS, where people can conveniently engage in PA.

Conclusion

This study contributes to the existing literature on the relationship between the built environment and health, mainly focusing on how specific physical environmental factors influence the use of UPOS for PA. By comparing expert insights with a theoretical framework developed from the existing literature (Table 1), this study validates the relevance of the identified physical environmental factors and reveals practical nuances. The factors identified by experts largely confirmed previous findings that demonstrated significant relationships (Babey et al., 2008; Cutumisu and Spence, 2009; Fathi et al., 2020; McCormack et al., 2010). At the same time, the alignment and few divergences between the literature and expert perspectives enhance the credibility of the framework, ensuring that it is both evidence-informed and practical. Based on the interview results, we found that although physical environmental factors such as aesthetic attributes, accessibility, land use mix, proximity, safety, and size specifically contribute to the use of UPOS for PA, they do not operate in isolation. Instead, these factors interact with and reinforce each other, creating a more holistic and convenient environment. The unique contribution of this study lies in its holistic assessment of the physical environmental factors influencing the use of UPOS for PA. Whereas most previous research has assessed these factors individually or in limited combinations, this study integrates them into a comprehensive framework, offering a more complete understanding of how UPOS can better support PA. Although this study focused on the physical environmental factors only, participants occasionally noted how social factors also intersect with the built environment. For instance, perceived safety has a strong social dimension, as its impact varies across demographic groups (Miles and Panton, 2006). These differences highlight that safety is not only a function of the physical environment but is also shaped by social experiences and vulnerabilities. Other social factors include economic barriers, such as transport costs, and limited access for low-income groups despite open spaces being available and free (Pearce and Maddison, 2011). These social factors create access disparities that cannot be addressed solely by improvements to the physical environmental factors. Future research should explore these intersections to better understand inequities in access and use among diverse populations.

Nearly all participants (94.4 %) identified aesthetic attributes, particularly the presence of trees and vegetation, amenities, and comfort as central to attracting users to UPOS for PA. They noted that these features not only enhance visual appeal but also create environments that support different types and intensities of PA. For example, shaded plazas with seating areas are conducive for light activities, such as strolling or exercise mostly among older adults. On the other hand, trails, courts, and open fields are associated with more vigorous activities. Participants also stressed the importance of management, noting that poorly maintained UPOS quickly lose their attractiveness and discourage use. This aligns with Carmona et al. (2008), whose study of public spaces in London highlights how even well-designed public spaces can deteriorate without regular maintenance and management. Experts also underscored the synergy between maintenance as both an aesthetic and a safety attribute, which also overlaps with the concept of visual coherence.

Notably, experts from different countries identified safety as a critical determinant of UPOS use for PA. Although safety is frequently discussed in relation to UPOS use (Miles, 2008; Okenwa and Nassar, 2021), it was not anticipated that experts from diverse contexts would consistently rank it as a primary factor. This consensus underscores its central role in UPOS use. Social safety, shaped by the presence of other people and opportunities for passive surveillance, was also identified, particularly where it overlaps with land use mix attributes. This reflects Jacobs's (1994) emphasis on vibrant street life and the role of mixing compatible uses ensure constant activity. Similarly, Wang and Stevens (2020) highlighted how "loose spaces" that support diverse informal uses can influence both visibility and perceptions of safety.

Accessibility and land-use mix attributes were consistently identified by experts as central to UPOS use for PA, essentially confirming patterns established in the literature. Well-connected neighborhoods with pedestrian paths, transit links, and active travel infrastructure were seen as enabling easy access, while barriers such as steep terrain could limit use, especially for older adults. Microscale accessibility attributes, such

as universal design, were highlighted as critical to ensuring complete access to and within an UPOS. Similarly, experts reinforced that integrating residential, commercial, and recreational uses around UPOS promotes higher use for both social and physical activity by incorporating opportunities for PA into daily life. The role of land use mix has been framed in the literature as a function of diversifying complementary land uses, however, experts in this study expanded this concept by describing mixed land use as a dynamic social environment that fosters vitality. These perspectives align with established urban design theories, highlighting connectivity and mixed land use as foundations for vibrant, active communities (Jacobs, 1994; Madanipour, 2003; Kriken et al., 2010). While the existing literature highlights the significance of a larger UPOS, experts argue that quality often outweighs sheer size.

These validations and refinements show how industry perspectives add nuance to the theoretical model developed in this study. By linking long-standing literature with recent industry trends, this study strengthens confidence in applying existing evidence to contemporary urban planning. The framework will support planners, designers, and policymakers in planning new UPOS and assessing existing ones to better promote PA in urban contexts. Although this study provides valuable insights into the role of physical environmental factors in shaping the use of UPOS for PA, certain limitations should be acknowledged in this regard. Future research should engage experts from specific sectors of the built environment and public health to identify sector-specific trends and reduce reliance on more general perspectives. In addition, while expert views highlight complex issues and emerging industry directions, they should be complemented by user feedback to capture lived experiences and needs. A mixed-method approach that integrates expert perspectives with user evaluations, particularly from underrepresented non-Western contexts, would further strengthen the framework's applicability across diverse settings. Overall, this study underscores the importance of validating theoretical frameworks with industry knowledge in design research.

Ethics statement

Ethical approval for this research was granted by the Welsh School of Architecture Research Ethics Committee. All participants provided written informed consent to participate and gave verbal consent prior to audio recording of the interviews. Data were collected, stored, and analyzed with strict adherence to confidentiality and institutional ethical standards.

CRediT authorship contribution statement

Benjamin Okenwa: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Marga Munar Bauzá:** Writing – review & editing, Supervision, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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