Smart City Governance and Children's Rights: Perspectives and Findings from Literature on Natural Elements Influencing Children's Activities Within Public Spaces

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Abstract. This paper shows a comprehensive literature review based on a comparative method that investigates a set of 25 papers from different disciplinary fields. The articles are retrieved from the Web of Science and SCOPUS databases and individuated through queries containing the key terms child, play, city, neighbourhood, outdoor space, public space, urban space, mobility. The timeframe considered spans from 2004 to present. The analysis focuses on three related aspects: (i) methodology; (ii) conceptual apparatus describing children's experience of spaces; (iii) green spaces and natural elements incorporated in public space design considered as determinant of children's outdoor activities. This paper provides detailed information on the relationship between the availability of natural settings and elements and children's outdoor practices and activities. Retrieving from previous studies the concept of practicability the authors reflect on significance of natural elements in reinforcing the potential of the built environment to promote children's independent playful practices. This study is instrumental in structuring an analytic methodology for determining a synthetic index of the practicability of public spaces. The relevance of a methodology for assessing practicability relies on its potential to enable a better understanding of conditions conducive to children's independent playful practices and to support governance by assisting the implementation of strategies of urban regeneration within the smart city paradigm.

Keywords: Smart cities governance · Systematic literature review · Children's independent activities · Built environment

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1 Introduction

This paper investigates the potential of natural spaces and elements integrated into the public space to enable children's independent functional, recreational and social activities, through a comprehensive review of the literature concerning the built environment correlates of children's activities within the public space [1].

This study is part of a broader research aimed at developing a synthetic index and an assessment tool for investigating the potential of the built environment to promote children's outdoor independent and playful activities. This potential is encompassed in the concept of practicability. This study aims to address two aspects: (i) the definition of a conceptual apparatus for describing the enabling conditions and developmental effects of children's independent outdoor activities (CIAs); (ii) identifying features of blue/green infrastructures, integrated in the public space, that enable children's outdoor practices and activities.

This paper focuses on children's independent activities (CIAs) as a fundamental actualisation of what Henry Lefebvre calls "the right to the city" [1–3]. Outdoor independent activities include independent mobility and agency and thus incorporate the complex of practices producing the meaningful engagement with the material environment: exploration, occupation and transformation of spaces, intra-active play, structured group activities, imaginative and creative games.

The issue of children's independent activities leads to investigate whether the contemporary city incorporate in its socio-spatial and symbolic structures a "place for children" [4].

The research on children's outdoor activities reflects a shift in the conception of children and the recognition of their right to "a life of their own" [5] and to health - intended as a state of complete physical, mental and social well-being [6]. Studies involving concepts and methodologies from different disciplines, such as urban planning, social sciences, environmental psychology, geography, medicine, consistently relate children's outdoor play, as well as their independent spatial mobility and physical activity to positive effects on their physical well-being, on their emotional, cognitive and social development, on the acquisition of spatial and environmental skills, on the construction of their social and individual identity.

In particular, outdoor activities are related to bodily health, healthier weight and more stable body mass index [7, 8], to better motor coordination and balance and to reducing incidence of obesity and of cardio-vascular diseases [6, 9–12]. Involvement in outdoor practices is also associated to positive effects in sense of ownership, emotion regulation, intellectual and creative development, socialisation, development of language and collaborative competences, sensitivity and sympathy towards other species, independence, autonomy, sense of confidence and of self-esteem and in supporting the development of tactics [13–17].

In general terms, positive effects of outdoor activities on children's health can be re-conceptualised through the capability approach, as effects on children's fundamental capability to develop. This, in turn, incorporates ten central capabilities: life; bodily health; bodily integrity; affiliation; practical reason; play; senses, imagination, and thought; emotions; connection to nature and other species; control over one's environment [6, 18, 19].

Therefore, the questions of childhood and of its place within the contemporary city [4] emerge as a central issue within the global processes of growing urbanization: the construction of a built environment that ensures children's right to the city involves both the conceptualization of children as political becomings [17] – whose tactics and agency have future salience, being mobilized and informing adult practices – and the awareness of children's right to the city as a component of their right to well-being and as a pre-condition of their integral development. Moreover, an accessible and usable public space can determine better conditions of access to public spaces and urban opportunities for all city-users. Thus, children can be regarded as city-users whose well-being, independence and satisfactory engagement with urban spaces are an indicator of the sustainability and inclusivity of the contemporary city [20].

This study is, in fact, instrumental in structuring the conceptual and theoretical framework of the analytic methodology for assessing the practicability of the public space, in organising the layout of the evaluation tool and in offering a preliminary insight into the built environment aspects relevant for enabling children's practices.

Considering these premises, the paper is organised in four sections: the first section illustrates a summary of the most relevant perspectives informing the research on children's experience and perception of the public space; in the second one the methodology adopted for this study is clarified; then the results are presented and in the fourth one, a discussion of the results is presented. The paper concludes by considering the limitations of the study and by illustrating its relevance for the development of an analytic methodology for assessing the practicability of public spaces.

2 Methodology

A set of 195 papers from different disciplinary fields (Education, Educational Research, Environmental Sciences, Geography, Environmental Studies, Urban Studies, Transportation, Planning Development, Civil Engineering, Environmental Engineering, Architecture) is retrieved from the Web of Science and SCOPUS databases and individuated via queries containing the key terms child, play, city, neighbourhood, outdoor space, public space, urban space, mobility. The time frame considered spans from 1990 to present (see Fig. 1). In a second stage, a sample of 25 journal articles is selected and is investigated via a comparative content analysis.

Fig. 1. Distribution of articles among different disciplinary fields. Results obtained frome the Web of Science database by entering the query [(child AND ("play" OR "mobility") AND ("city" OR "neighbourhood" OR "outdoor space" OR "urban space" OR "public space")]. Timespan: 1990–2019.

The final sample is selected through an analysis of the abstracts. The criteria are: (i) articles considering a sample of children whose age is included, at least partially, within the range 5–13 years: this is the range of age considered by the authors in previous studies on the practicability and inclusivity of the public space [2, 3] (ii) articles considering as dependent variable either children's independent mobility, autonomy or exploration and experimentation and as correlates, or independent variables, built environment spatial and material factors; (iii) a reduced timeframe spanning from 2004 to present. The analysis focuses on 7 related aspects: (i) Area of the study, sample size and methods; (ii) impacts of the discussed research; (iii) the dependent variable, i.e. which aspect of outdoor activities is considered; (iv) developmental effects associated to children's engagement in outdoor activities; (v) Categories for describing children's experience of spaces and elements of the environment related to children's perceptions and practices; (vi) Categories of the public space considered as places of children's practices; (vii) elements of the public space considered as positive or negative related to children's CIAs.

For each functional, material, spatial or social BE factor considered as an independent variable it is specified the direction of the relation, discerning positive, negative and ambiguous relations, and cases in which the direction of the relation is not specified. The content comparative analysis is developed through the utilisation of a matrix, whose layout is derived from the SCOPE tool [3] and from the IAAPE tool [21]. In particular, the correlates of children's activities are organised into 11 categories, reflecting 11 dimensions including the BE spatial, functional, cultural, socio-economic factors and individual socio-demographic characteristics influencing levels and patterns of children's outdoor activities. These dimensions include Connectivity, Convenience, Comfort, Conviviality, Conspicuousness, Coexistence, Commitment, Socio/cultural factors, individual children's factors, individual Parents' factors, Dwelling factors.

Connectivity refers to the integration of a public open space into a continuous network of walkable surfaces and into the arterial network of the collective transportation routes. Convenience refers to the conditions of access to different local destinations, formal and informal sites of play, and of density, intended as opportunities to participate in social activities. Comfort measures the effects of microclimatic and environmental conditions, treatment of surfaces, and geometric and constructive features of pedestrian facilities to increase people's sense of wellbeing, and fulfil the needs of different users related to their abilities and purposes. Conviviality refers to the extent to which the public space promotes interactions with social and material resources, enabling functional, optional, and social activities, and activating self-reinforcing processes. Conspicuousness reflects the extent to which public spaces are imageable, interesting, and inviting, in terms of spatial legibility, complexity, and coherence. Coexistence refers to the impact of traffic on the potential of the public space to accommodate children's independent recreational and social activities. Commitment refers to factors indicative of the engagement, responsibility, and liability of local agencies toward the promotion of children's independent mobility and activities across public spaces.

Socio-economic and cultural factors refer to environmental social and cultural structures and economic conditions determining whether children's independence is regarded as a goal, a necessity, or a condition to be prevented [4]. Children's individual factors include their specific socio-demographic attributes and refer to the impacts of gender, age, ethnicity, perceptions of self-efficacy and capacity constraints on their likelihood to engage independently in outdoor activities. Parental individual factors include parents' socio-demographic characteristics and account for the influence of their socio-economic status, education, age, ethnicity on parental styles and on propensity to support children's independence. Finally, Dwelling factors considers to what extent the typological characters of the housing, presence of semi-private transition spaces, and the setting influence children's propensity and opportunities to independently participate in outdoor activities.

3 Literature Review on Children's Activities Within the Public Space

3.1 Aspects of Children's Experience of the Public Space

Existing studies consider specific aspects or dimensions of children's outdoor activities: physical activity, defined as any bodily movement produced by skeletal muscles that results in energy expenditure [22]; children's independent mobility, defined as the freedom and/or ability of children to travel across the urban space without adult supervision; and outdoor play, conceptualised as a cheap, informal, and easily accessible vector to physical activity [23] and as a creative act of spatial appropriation and of meaningful engagement with spaces and objects, fostering dwelling with and enchantment [24].

3.2 Socio-Cultural Determinants of Outdoor Children's Activities

The existing literature shows that the levels of children's engagement in outdoor activities are affected by different factors: children's individual characteristics, parental styles, cultural constructs and socio-physical environment of the contemporary city. In particular, children's characteristics include their ability, wish and willing to be independent and issues related to their developmental stage or to their health [4].

Age and school stage are frequently considered as positively related to children's independent mobility (CIM) and phisical activity (PA), and they are associated to changes in patterns of activity, and in the definition of important places, thus of spaces that enable purposive behaviours [25]. Parental styles refer to parents' propensity and willingness to enable children to independently engage in outdoor activities within the public space. This aspect reflects parents' socio-economic status, familiar condition, education, ethnicity: in particular confidence in child's spatial competence, perception of social cohesion and connection, concerns related to the characteristics of traffic flows and to the presence of strangers strongly affect the degree to which children are afforded independence. Cultural constructs emerge as a central factor in influencing levels of outdoor practices, according to conceptualisations of childhood, of gender and of parental roles [4]. The presence of other children in the neighbourhood is positively associated to outdoor activities, particularly if associated with other enabling resources: quality of buildings, enabling materials, social cohesion, eyes on the street, available spaces [17]. The socio-economic status of neighbourhood emerge as a positive correlate of children's mobility and activity, particularly by affecting perceptions of the social *milieu* [9]. Finally, fragilities of the social *milieu*, including exposure to violent incidents, consumption of narcotics and alcoholics, segregation, poverty, bullying are negatively associated to levels of children's activities. Nevertheless, the literature identifies the perception of these phenomena, more than their actual significance, as a relevant determinant of limitations on parental propensity to support children's independence as well as on children's willing to engage in outdoor activities.

3.3 Built Environment Factors

Material, spatial and functional elements of the built environment associated to children's levels and patterns of activities refer to different levels of scale, from the configuration of the urban structure to material, compositional properties of specific pedestrian surfaces. BE factors include the configuration of the street network, distances from specific destinations, residential density, land-use patterns, the availability of informal or formal sites for play, the household settings. In particular path directness, the grid configuration of the road network, the continuity of the pedestrian network and its accessibility, intended as the absence of physical barriers are positively related to children's mobility and activities.

Density [6, 7, 9, 26–31], conceptualised as residential density, building density or population density, emerges as a significant correlate of children's independent mobility or leisure activities. Nevertheless, the direction of the relation between density and children's outdoor activities is ambiguous. Broberg et al. [32] individuate residential and population density as positively related to children's mobility to affordances and to the number of actualized affordances, but observed a negative relation between building density, operationalised as Floor Area Ratio, and children's mobility. Furthermore, Sharmin and Kamruzzaman [26] observe a negative association between CIM and residential density, yet underlining its insignificant effect and the heterogeneity of the results across the studies analysed. We raise the hypothesis that density might exert a non-linear relationship with CIM, which further complicates the generalization of results from different urban contexts.

Further ambiguity emerges in relation to the effect of land-use mix on children's activities: Despite being identified by Jane Jacobs [33] as central to increasing diversity and vitality of the urban realm, and being positively related to children's mobility by the Committee on Environmental Health [28] and by Whitzman and Mizrachi [16] a negative association with CIM is found by Sharmin and Kamruzzaman [26]: yet underlining the heterogeneity of results across the studies. Furthermore, positive associations to children's activity are found for availability, accessibility and proximity of local destinations, formal sites of play and informal sites of play. Local destinations include local shops [29], kindergarten, child-centre-based-care, family support service, child health clinic and playgroup [31] or cinemas, libraries and shopping centres [5, 16, 34]. Formal sites of play include the specialised spaces of playgrounds, Swimming pool, Swimming club, Tennis clubs, playfields and school grounds and the structured spaces of parks, community gardens and pocket parks [5, 25, 31]. Informal sites of play include thresholds spaces and transition spaces, such as woods, wastelands, alleyways, overgrown edges, vacant lots, construction sites and wild lands [5, 6, 35]. The identification of informal sites as important places enabling children's activities incorporates the relevance of spaces not subject to adults' restrictions and practices and the significance of loose, available spaces and elements as material resources enabling multiple purposive, intentional, social and creative activities. These factors emerge as pre-conditions for children's spatial appropriation, territoriality and satisfactory engagement with the public space.

Micro-scale elements and composition of the road space and of its spatial boundaries are often related to concerns about safety. In particular, the separation of pedestrian surfaces and passable lanes, the design of cross-roads, and the width as well as the function of streets are identified as determinants of perceptions related to traffic danger. Moreover, the presence of commercial activities and services along a street, the functional and spatial continuity between street space and buildings, the percentage of windows facing the street enable the natural surveillance of pedestrian spaces. On the other hand, the presence of elements regarded by users as signs of disorderliness, neglect and abandonment determine the perception of social milieu fragilities

associated to social dangers. The concepts of eyes on the street and "broken window", incorporate these antithetic characteristics of spaces and refer to the nexus between built environment factors and social milieu attributes, which constitute the children's experience of the public space. Finally, adults' control on children's activities, including authority constraints [36], interferences, and physical manicuring of the landscape which communicates adults' ownership [6] are related to restrictions on children's activities and spatial appropriations [16, 25].

4 Findings and Discussion: The Conceptual Apparatus

Witten et al. [17] observe that research on children's practices within public spaces focus on determinants of children's independent mobility identified and described through statistical modelling techniques within a socio-ecological framework. A fundamental yet neglected issue is how everyday practices of walking, cycling or scootering are experienced by different children and how relational or material aspects of diverse places may shape children's sensory and affective experiences of the public space. These observations lead to focusing of research on environmental resources effective for enabling behaviors directly contributing to changes in children's psychological experience.

The definition of place is a first fundamental element: places are intended as favoured or important settings. A place is imbued with both use value and conceptional value. Thus, it is a setting perceived as useful, and in particular, as a setting that supports purposive and intentional activities and meaningful psychological experience. The importance of a setting results from a combination of spatial, material and social affordances related to accessibility and spatial connections with other relevant settings, play opportunities and functional capabilities, sense of privacy and territoriality, opportunities to meet friends and peers (sense fo belonging and togetherness), exposure to environmental and social danger [25].

The concept of affective atmosphere underlines how the combination and overlapping of sensory - social, material, olfactory – and symbolic stimuli, determine the felt experience of a place and shape tactics to claim and use spaces. Tactics, intended as acts of interpretation and negotiation of use of space, articulate children's agency and patterns of activity within the public space [17].

Pyyry [24] observes that the interaction with material and social resources, including exploration, experimentation and/or manipulation of loose elements, can produce a joyful and meaningful engagement with the public space. This intense involvement, defined as *dwelling with,* implies the acts of claiming, interpreting and appropriating spaces that determines the unusual experience of enchantment. Enchantment refers to a sense of wonder and as a moment of simultaneous disconnect and immersion. Thus, the concept of affordance emerges as central to the definitions of enabling conditions of children's activities. Affordances can be defined as the functional properties of the environment that offer a child opportunities to interact actively

with the environment [9, 26, 32, 37, 38]. Affordances include also the emotional and social opportunities and restrictions incorporated into an environment. Affordances can be potential or actualised through action. The concept of affordance overcomes the subject-object dichotomy. It refers to properties of the environment that are perceived by the user as opportunities, but this perception emerges only when children's characteristics, including abilities, physical attributes, social needs or personal intentions correspond to environmental features.

On the other hand, the developmental effect of children's CIAs is better understood by referring to the concept of capability. Capability is described as a valuable state of being or a condition that a person can access [6, 18, 19]. In particular, for children the foundational capability is the "capability to develop" [6].

These concepts constitute the theoretical framework for defining the concept of practicability and contextualising the findings of the comparative content analysis, which are discussed in the following sections. Building on notions of child-friendliness, walkability, affordance, functioning and capability, Practicability can be defined as the potential of the built environment to enable children's mobility, agency and experience of the public space, by increasing their possibilities to engage in independent functional, optional, recreational and social outdoor activities. Practicability is thus determined by the functional, emotional and social affordances incorporated in the built environment, by their availability, usefulness, usability and perceivability [9, 35].

5 Findings and Discussion: Natural Settings Correlates of Children's Independent Activities

Richard Louv [39] introduces the notion of "nature deficit disorder" to describe the loss of the opportunity for children to explore "wild lands" and Chawla [6] underlines the significance of landscaping as an essential a part of the basic infrastructure of a settlement as electricity, water, sewers, and paving. In particular, within the landscape urbanism and the landscape as infrastructure paradigms, the two networks strategy focuses on the design of blue/green networks as carrying structures that organize the contemporary city at different scales while facilitating the synergy of ecology, economy and social processes [40]. A trans-scalar mosaic of patches of natural spaces can constitute the framework of a multi-functional system that serves water purification, drainage, retention and biodiversity while incorporating a capillary network of public spaces and direct pedestrian and cycling paths [6, 40]. The comparative content analysis of the selected articles underlines that natural settings, landscaping and natural elements significantly increase the practicability of the public space and its conductivity to children's independent activities, by affecting built environment characteristics related to the dimensions of convenience, comfort, conviviality and conspicuousness (Table 1).

Table 1. Results of the Comparative content analysis for the most relevant selected articles

Article	Methodology	Conceptual apparatus	Correlates of children's CIAs related to natural settings
Min and Lee [25]	Data collection: Field interviews and place-centered behavioral observations; Data analysis: Chi-squared tests; t-tests; measure of inter-rater reliabilities	Place; Space; psycological realm; behavorial realms;	Availability of informal sites for play (vacant and undeveloped natural areas); Vegetation coverage; Variety of microclimatic conditions; Availability of loose spaces; Size and morphological regularity of available spaces; Privacy; Variety of spatial conditions; Articulation of edges; Availability of enabling materials;
Chawla [6]	Literature review;	Capabilities; self-construction of places; continuity with natural processes; Environmental congruence;	Distance to green areas; Availability of formal/informal sites for play; Presence of vegetation; Biodiversity; Presence of water features; Cleanliness of water features; Availability of enabling materials; Variety of spatial conditions; Imageability; Complexity; Management of planted areas (cleanliness; use of pesticides); Access to green areas affected by ethnicity and SES;
Villanueva et al. [30]	Literature review;	Ecology of childhood; exposure; resource;	Availability of formal and informal sites for play; Availability of enabling materials; Imageability, Human scale; complexity;
Witten et al. [17]	Quantitative data collection: GPS; Travel diaries; Accelerometers; Individual interviews, Group discussion, School based focus groups;	Hyperdiversity; Enabling places; Third places; Tactics; Affective atmosphere;	Access to formal sites for play; Availability of loose spaces; Availability of enabling materials for imaginative/creative/intra-active play;

(*continued*)

Table 1. (*continued*)

Article	Methodology	Conceptual apparatus	Correlates of children's CIAs related to natural settings
Chaudhury et al. [41]	Qualitative study: go-along neighbourhood walking interviews and homebased interviews. Deductive thematic analysis;	Potential, perceived, utilised and shaped affordances;	Distance to Public open spaces; Availability of Public open spaces; Meeting places; Availability of loose spaces; Variety of spatial conditions; Availability of enabling materials;
Garau et al. [3]	Data collection: Focus groups; Urban exploration; Secondary data. Determination of the I_{SCOPE} Index of practicability	Autonomy; Affordance; Capability	Vegetation density; Urban water features incorporated in public space design; Availability of regions (clusters) of space for play; Imageability; Complexity; Management of planted areas

5.1 Convenience

The literature review underlines the function of natural settings as formal and informal sites of play. Natural settings can incorporate different "third places", including destination spaces, threshold spaces and transition spaces relevant for children's socialisation and community life. In particular, green areas, parks, nature/conservation areas, woods, wastelands, vacant lots, river banks, beaches, ponds and construction sites are identified as places enabling experimentation, exploration, manipulation, including making constructions with loose parts, quietly resting, watching or dabbling in sand or water, climbing, sliding down slopes, sitting and talking with other children, or playing non competitive games like 'hide and seek' and 'tiggy' [6, 15, 23, 28, 29, 35].

The availability, accessibility and sense of territoriality emerge as fundamental characters of these spaces, for enabling children's spatial appropriation, and for determining the conceptional and use value of a natural setting. At a different scale, pockets of nature, integrated in the design of the public space, incorporate loose, available spaces for children's independent activities. This condition is identified as a correlate of children's recreational and social practices [9, 15–17, 25, 35, 40–43] as opposed to the manufactured, rigidly designed tight space of the playground [24]. In particular, the openness, undeterminedness of loose surfaces enable sense of territoriality, appropriation, thus allowing for children to engage in intra-active play with spaces and things, and with other living materials. In other words, loose spaces are a fundamental condition for increasing the child-friendliness of cities. Min and Lee [25]

and Garau et al. [3] identify size and morphological regularity as a fundamental condition for increasing the openness of a space to diverse informal and structured recreational and social practices. A further positive effect on children's outdoor independent activities is determined by the function of natural settings as meeting places [30, 34, 41, 43]. A meeting place can be defined as an available and accessible place for social interactions and developing networks of support.

5.2 Comfort

The integration of natural elements in the public space is related also to improved conditions of comfort and well-being, resulting from the control of micro-climatic conditions and from the emotional affordances incorporated in natural elements and settings. Jamme, Bahl, and Banerjee [9] and Nordström [34] observe that the presence of vegetation and green spaces determines a sense of belonging and positive perceptions on the child-friendliness of spaces. Min and Lee [25] underline that the presence of natural elements is conducive to the identification of a setting as an important place. The integration of water features in the public space, water cleanliness and opportunities to sit in proximity of the water features incorporate functional and contextual/emotional affordances that positively affect children's perceptions of the public space and their propensity to engage in recreational and social activities [6, 16].

Broberg et al. [32] observe a positive association between the proportion of green structure, defined as the proportion of fields, forests, parks, and water out of the total grid cell area with emotional and action level functional affordances. Yet, this factor is negatively related to the amount of leisure-time, activity-level functional affordances and social affordances and to the number of actualised affordances. This finding seems to indicate the potential of dense built environment to incorporate a greater number and variety of social, functional and emotional opportunities: this assumption recalls Jane Jacobs's recognition of variety of primary and secondary function as a pre-codition for diversity and vitality [33]. Nevertheless, Witten et al. [17] underline that the identification of a setting as an important or enabling places results from the combination of material, social and symbolic stimuli. Consequently, similar spatial conditions, including similar natural settings, can be characterized by different affective atmospheres, producing different felt experiences. Furthermore, vegetation and bio-diversity are related to positive effects on physical health. According to Rook [44], the great variety and number of microbiota that coexist with diverse vegetation, animal species, and fertile soils is associated with the development of a well-regulated immune system.

Contact with natural spaces is related with benefits in terms of cognitive functioning and self-control. The frequent view of natural settings is associated by Faber, Taylor, Kuo, and Sullivan [45] with better performances on tests of concentration, control of impulsivity, and delay of gratification.

Finally, Ferré, Guitart, and Ferret [42] and Min and Lee [25] observe a positive association between levels of independent activities and variety of microclimatic conditions. This aspect emphasises the complex relationship between perceptions of thermal comfort and macro and micro-climatic conditions, individual activity, physiology, adaptation – including clothing, change in metabolic heath, posture and position – as well as personal choice, memory and expectation [46]. Vegetation, depending on

its position, orientation, extent, density, physiology, acts as a versatile, self-regulating element of control of conditions of ventilation and irradiation [47].

5.3 Conviviality

The functional affordances incorporated in natural settings affect the conviviality dimension of public open spaces, by increasing the opportunities for children's functional, optional, and social activities. The diversity of spatial conditions is a further positive attribute of public open spaces, and of natural settings, associated with children's possibilities to engage in independent activities. The diversity of landscape elements and topography (slopes, steps, terraces, level changes) are positively associated with children's independent activities by Chaudhury et al. [41] and by Min and Lee [25]. The minimal geometry designed by variations in the morphology of surfaces thus incorporates potential functional affordances for different informal or structured recreational and social activities: a shaded area incorporates a repaired space for resting, a sloped lawn a surface for playing sliding, a hill encloses an obstacle to climb on, a partition can be re-signified and transformed in a springboard for jumping or in a balance beam [2]. Finally, vegetation, grass, dirt surfaces, water features, loose elements incorporating affordances for contacts, exploration and manipulation, are identified as significant correlates of children's independent outdoor activities. Chawla [6] and Chaudhury et al. [41] underline the relevance of a tree, as well as of lawns, sand banks, of a brook, or bushes as enabling materials for physical activity, for retreating and resting, for play activities; patches of dirt or loose parts (earth, water, stones, grass, and branches) are resources for creative and imaginative play, including manipulation and construction. Vilanueva et al. observe that natural play environments, incorporating natural elements and vegetation appear more conducive to children's cognitive and physical development than physical man-made play areas [30]. Opportunities for contact with insects and small animals habitats, vegetation, sand, stone as well as water, are found to be positively related to adults' and children's perceptions of natural play spaces. Witten et al. [17] observe in which ways vegetation incorporate enabling resources, and thus constitute a material condition for determining the affective atmosphere of enabling places: a tree, located in a threshold space lying between and within view of surrounding buildings, is appropriated by a group of children and imbued with meaning.

The tree is identified as a material resource and is transformed in a place of inclusion and belonging through frequent practices. The materiality of the tree and the sociability it generates produce an affective atmosphere, reflected in the act of naming a tree the "family tree"; the affective atmosphere, incorporated in the materiality of the tree, is both the product and the constitutive condition of the relational bonds among the children [17]. This process of appropriation and transformation of a space through social activities is a manifestation of childhood tactics. Kyttä et al. [35] and McGlone [43] underline the opportunities to interact with small animals. McGlone [43] also observes that garden beds constitute opportunities for gardening and for semi-structured activities, including hiding, chatting, sitting and observing insects. Furniture can be perceived by children as an affordance for semi-structured, informal activities: a seat bench is thus appropriated and transformed through play, in open, adaptable,

versatile object for jumping and climbing. In general terms, the availability of temporary, adaptable features is positively associated to children's propensity and possibility to engage in independent activities. Finally, Pyyry [24], observes that the manipulation, experimentation and appropriation of spatial elements and loose objects, can result in intra-active play and can generate a meaningful, affectual engagement with a specific setting or place. Reflecting on two children climbing up a stone wall with the help of a tree, Pyyry [24] observes that the children were invited to exploration by the diverting and fascinating character of the setting. This can be referred to as things powers: the potential of material elements to affect human bodies.

Finally, natural elements, including plants, mature trees, landscaping, major landscape elements, affect the conspicuosness of the public space by reinforcing its complexity, human scale and imageability [5, 16, 35, 43].

6 Conclusion

This extensive review aims to contribute to the academic research on child-friendly cities, to the governance processes within the smart-city paradigm [2, 3] and to the urban-planning practice, by supporting the understanding and the re-shaping of the relationship between green/blue infrastructure, grey infrastructure, built environment and children's functional, optional and social practices. The contribution of the literature review involves two aspects: (i) structuring a conceptual apparatus for describing children's experience of the public space, and the enabling conditions of their independent activities; (ii) clarifying how and to what extent natural settings and elements integrated in the public space affect children's practices. The first aspect is articulated by the introduction and definition of the concepts of important place, of enabling place, of capability, and of affordance. The latter, in particular, emphasizes the relation among the characters of the public space that incorporate functional, emotional and social opportunities, the individual abilities, competences and tactics, and the resulting spatial practices and perceptions.

The concept of practicability is introduced to broaden the notion of child-friendliness, and to highlight the material, spatial, functional and social conditions of the public space that affect children's mobility, agency and experience by maximizing their propensity and possibilities to engage in independent outdoor activities. The notion of independent activities itself implies a shift from the concepts of independent mobility and physical activity, emphasizing both the aspect of the independence and of the multiplicity of activities, including exploration and spatial appropriation. These are regarded as conditions for a meaningful experience of the public space that restores children's right to the city and significantly affects their physical, cognitive, social and emotional development.

The third aspect focuses on the significance of natural settings and elements as affordances and spatial focus of children's independent activities. The literature review emphasizes that natural settings, including destination, threshold and transitory spaces, emerge in children's accounts as behavior settings, and as spaces imbued with meaning and use and symbolic value. Natural settings are identified as important places. Hence, children identify natural settings as spaces both useful and conducive to purposive

behavior. It is the variety of emotional, social and functional opportunities, the sense of territoriality and of belonging that determine the potential of natural settings to support practices respondent to children's multiple purposes and needs. Thus, the characters of looseness, vagueness and availability of natural settings and elements integrated in the built environment emerge from this literature review as instrumental to maximizing children's possibilities of choice among different social and recreational activities, including physical activity, imaginative, creative and intra-active play and structured group activities.

These findings produce an image of green/blue infrastructure as a transcalar and continuous mosaic of natural settings, including both formalized spaces and vague, thresholds and transitory spaces, connected to the networks of public space, pedestrian paths and services and amenities relevant for children. The future development of this research will focus on the definition of indicators for the operationalization of the characters of natural settings identified as correlates of children's activities. The definition of indicators, of use-value function and quality thresholds, will be instrumental to the improvement of the synthetic index of practicability and of Survey on Conditions of Practicable Environments [3]. The structuring of a methodological framework for the assessment of the public space is aimed at supporting the implementation of governance practices, policies and strategies, within the smart-city paradigm, for designing and building networks of safe, stimulating, vibrant public spaces to promote equality and inclusivity.

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References

1. Lefebvre, H.: The right to the city. In: Kofman, E., Lebas, E. (eds.) Writings on Cities, pp. 63–184. Blackwell, Cambridge (1995)
2. Annunziata, A., Garau, C.: Understanding kid-friendly urban space for a more inclusive smart city: the case study of Cagliari (Italy). In: Gervasi, O., et al. (eds.) ICCSA 2018. LNCS, vol. 10962, pp. 589–605. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-95168-3_40
3. Garau, C., Annunziata, A., Coni, M.: A methodological framework for assessing practicability of the urban space: the survey on conditions of practicable environments (SCOPE) procedure applied in the case study of Cagliari (Italy). Sustainability **10**(11), 4189 (2018)

4. Churchman, A.: Is there a place for children in the city? J. Urban Des. **8**(2), 99–111 (2003)
5. O'brien, M., Jones, D., Sloan, D., Rustin, M.: Children's independent spatial mobility in the urban public realm. Childhood **7**(3), 257–277 (2000)
6. Chawla, L.: Benefits of nature contact for children. J. Plan. Lit. **30**(4), 433–452 (2015)
7. Galvez, M.P., et al.: Associations between neighborhood resources and physical activity in inner-city minority children. Acad. Pediatr. **13**(1), 20–26 (2013)
8. Burdette, H.L., Whitaker, R.C.: A national study of neighborhood safety, outdoor play, television viewing, and obesity in preschool children. Pediatrics **116**(3), 657–662 (2005)
9. Jamme, H.T.W., Bahl, D., Banerjee, T.: Between "broken windows" and the "eyes on the street:" Walking to school in inner city San Diego. J. Environ. Psychol. **55**, 121–138 (2018)
10. Lopes, F., Cordovil, R., Neto, C.: Children's independent mobility in Portugal: effects of urbanization degree and motorized modes of travel. J. Transp. Geogr. **41**, 210–219 (2014)
11. Christian, H., et al.: The influence of the neighborhood physical environment on early child health and development: a review and call for research. Health Place **33**, 25–36 (2015)
12. Kyttä, A.M., Broberg, A.K., Kahila, M.H.: Urban environment and children's active lifestyle: SoftGIS revealing children's behavioral patterns and meaningful places. Am. J. Health Promot. **26**(5), e137–e148 (2012)
13. Goltsman, S., Kelly, L., McKay, S., Algara, P., Wight, L.: Raising "free range kids": creating neighborhood parks that promote environmental stewardship. J. Green Build. **4**(2), 90–106 (2009)
14. Lin, E.Y., et al.: Social and built-environment factors related to children's independent mobility: the importance of neighbourhood cohesion and connectedness. Health Place **46**, 107–113 (2017)
15. Furneaux, A., Manaugh, K.: Eyes on the alley: children's appropriation of alley space in Riverdale, Toronto. Child. Geographies **17**, 204–216 (2018)
16. Whitzman, C., Mizrachi, D.: Creating child-friendly high-rise environments: beyond wastelands and glasshouses. Urban Policy Res. **30**(3), 233–249 (2012)
17. Witten, K., Kearns, R., Carroll, P., Asiasiga, L.: Children's everyday encounters and affective relations with place: experiences of hyperdiversity in Auckland neighbourhoods. Soc. Cult. Geogr. **9365**, 1–18 (2017)
18. Sen, A.: Capability and well-being. In: Nussbaum, M., Sen, A. (eds.) The Quality of Life, pp. 30–53. Clarendon Press, Oxford, UK (1993)
19. Nussbaum, M.C.: Creating Capabilities, p. 2011. Harvard University Press, Cambridge (2011)
20. Carroll, P., Witten, K., Kearns, R., Donovan, P.: Kids in the city: children's use and experiences of urban neighbourhoods in Auckland, New Zealand. J. Urban Des. **20**(4), 417–436 (2015)
21. Moura, F., Cambra, P., Gonçalves, A.B.: Measuring walkability for distinct pedestrian groups with a participatory assessment method: a case study in Lisbon. Landscape Urban Plan. **157**, 282–296 (2017)
22. Caspersen, C.J., Powell, K.E., Christenson, G.M.: Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep. **100**(2), 126 (1985)
23. Aarts, M.J., Wendel-Vos, W., van Oers, H.A., van de Goor, I.A., Schuit, A.J.: Environmental determinants of outdoor play in children: a large-scale cross-sectional study. Am. J. Prev. Med. **39**(3), 212–219 (2010)
24. Pyyry, N.: Thinking with broken glass: making pedagogical spaces of enchantment in the city. Environ. Educ. Res. **23**(10), 1391–1401 (2017)
25. Min, B., Lee, J.: Children's neighborhood place as a psychological and behavioral domain. J. Environ. Psychol. **26**(1), 51–71 (2006)

26. Sharmin, S., Kamruzzaman, M.: Association between the built environment and children's independent mobility: a meta-analytic review. J. Transp. Geogr. **61**(2017), 104–117 (2017)
27. Gillespie, J.: Being and becoming: writing children into planning theory. Plan. Theory **12**(1), 64–80 (2013)
28. Committee on Environmental Health: The built environment: designing communities to promote physical activity in children. Pediatrics **123**(6), 1591–1598 (2009)
29. Oliver, M., et al.: Associations between the neighbourhood built environment and out of school physical activity and active travel: an examination from the Kids in the City study. Health Place **36**, 57–64 (2015)
30. Villanueva, K., et al.: Can the neighborhood built environment make a difference in children's development? Building the research agenda to create evidence for place-based children's policy. Acad. Pediatr. **16**(1), 10–19 (2016)
31. Christian, H., et al.: Relationship between the neighbourhood built environment and early child development. Health Place **48**, 90–101 (2017)
32. Broberg, A., Kyttä, M., Fagerholm, N.: Child-friendly urban structures: bullerby revisited. J. Environ. Psychol. **35**, 110–120 (2013)
33. Jacobs, J.: The Death and Life of Great American Cities. Random House, New York (1961)
34. Nordström, M.: Children's views on child-friendly environments in different geographical, cultural and social neighbourhoods. Urban Stud. **47**(3), 514–528 (2010)
35. Kyttä, M., Oliver, M., Ikeda, E., Ahmadi, E., Omiya, I., Laatikainen, T.: Children as urbanites: mapping the affordances and behavior settings of urban environments for Finnish and Japanese children. Child. Geogr. **16**(3), 319–332 (2018)
36. Davis, A., Jones, L.J.: Children in the urban environment: an issue for the new public health agenda. Health Place **2**(2), 107–113 (1996)
37. Kyttä, M.: Children in Outdoor Contexts. Affordances and Independent Mobility in the Assessment of Environmental Child Friendliness. VDM Verlag Dr. Möller, Saarbrücken (2008)
38. Gibson, J.J.: The Ecological Approach to Visual Perception, p. 1986. Lawrence Erlbaum, Hillsdale (1979)
39. Louv, R.: Last Child in the Woods. Algonquin Books, Chapel Hill (2005)
40. Tjallingii, S.: Planning with water and traffic networks - carrying structures of the urban landscape. In: Nijhuis, S., Jauslin, D., Van Der Hoeven, F. (eds.) Flowscapes – Designing infrastructure as landscape, pp. 57–80. Delft University of Technology, Delft (2015)
41. Chaudhury, M., Hinckson, E., Badland, H., Oliver, M.: Children's independence and affordances experienced in the context of public open spaces: a study of diverse inner-city and suburban neighbourhoods in Auckland, New Zealand. Child. Geogr. **17**, 49–63 (2017)
42. Ferré, M.B., Guitart, A.O., Ferret, M.P.: Children and playgrounds in Mediterranean cities. Child. Geogr. **4**(2), 173–183 (2006)
43. McGlone, N.: Pop-Up kids: exploring children's experience of temporary public space. Aust. Planner **53**(2), 117–126 (2016)
44. Rook, G.: Regulation of the Immune System by Biodiversity from the Natural Environment. PNAS Proc. Natl. Acad. Sci. USA **110**(46), 18360–18367 (2013)
45. Taylor, A.F., Kuo, F.E., Sullivan, W.C.: Views of nature and self-discipline: evidence from inner-city children. J. Environ. Psychol. **22**, 49–63 (2002)
46. Nikolopoulou, M., Baker, N., Steemers, K.: Thermal comfort in outdoor urban spaces: understanding the human parameter. Sol. Energy **70**(3), 227–235 (2001)
47. Klemm, W., Heusinkveld, B.G., Lenzholzer, S., Van Hove, B.: Street greenery and its physical and psychological impact on thermal comfort. Landscape Urban Plan. **138**, 87–98 (2015)