Lecture Notes in Computer Science 10962

Commenced Publication in 1973
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Preface

These multiple volumes (LNCS volumes 10960–10964) consist of the peer-reviewed papers presented at the 2018 International Conference on Computational Science and Its Applications (ICCSA 2018) held in Melbourne, Australia, during July 2–5, 2018.

ICCSA 2018 was a successful event in the International Conferences on Computational Science and Its Applications (ICCSA) conference series, previously held in Trieste, Italy (2017), Beijing, China (2016), Banff, Canada (2015), Guimaraes, Portugal (2014), Ho Chi Minh City, Vietnam (2013), Salvador, Brazil (2012), Santander, Spain (2011), Fukuoka, Japan (2010), Suwon, South Korea (2009), Perugia, Italy (2008), Kuala Lumpur, Malaysia (2007), Glasgow, UK (2006), Singapore (2005), Assisi, Italy (2004), Montreal, Canada (2003), and (as ICCS) Amsterdam, The Netherlands (2002) and San Francisco, USA (2001).

Computational science is a main pillar of most current research and industrial and commercial activities and it plays a unique role in exploiting ICT innovative technologies. The ICCSA conference series has been providing a venue to researchers and industry practitioners to discuss new ideas, to share complex problems and their solutions, and to shape new trends in computational science.

Apart from the general tracks, ICCSA 2018 also included 33 international workshops, in various areas of computational sciences, ranging from computational science technologies, to specific areas of computational sciences, such as computer graphics and virtual reality. The program also featured three keynote speeches.

The success of the ICCSA conference series, in general, and ICCSA 2018, in particular, is due to the support of many people: authors, presenters, participants, keynote speakers, session chairs, Organizing Committee members, student volunteers, Program Committee members, International Advisory Committee members, International Liaison chairs, and people in other various roles. We would like to thank them all.

We would also like to thank Springer for their continuous support in publishing the ICCSA conference proceedings and for sponsoring some of the paper awards.

July 2018

David Taniar
Bernady O. Apduhan
Osvaldo Gervasi
Beniamino Murgante
Ana Maria A. C. Rocha
Welcome to Melbourne

Welcome to “The Most Liveable City”\(^1\), Melbourne, Australia. ICCSA 2018 was held at Monash University, Caulfield Campus, during July 2–5, 2018.

Melbourne is the state capital of Victoria, and is currently the second most populous city in Australia, behind Sydney. There are lots of things to do and experience while in Melbourne. Here is an incomplete list:

- Visit and experience Melbourne’s best coffee shops
- Discover Melbourne’s hidden laneways and rooftops
- Walk along the Yarra River
- Eat your favourite food (Chinese, Vietnamese, Malaysian, Italian, Greek, anything, … you name it)
- Buy souvenirs at the Queen Victoria Market
- Go up to the Eureka, the tallest building in Melbourne
- Visit Melbourne’s museums
- Walk and enjoy Melbourne’s gardens and parks
- Visit the heart-shape lake, Albert Park Lake, the home of the F1 Grand Prix
- Simply walk in the city to enjoy Melbourne experience
- Try Melbourne’s gelato ice cream

Basically, it is easy to live in and to explore Melbourne, and I do hope that you will have time to explore the city of Melbourne.

The venue of ICCSA 2018 was in Monash University. Monash University is a member of Go8, which is considered the top eight universities in Australia. Monash University has a number of campuses and centers. The two main campuses in Melbourne are Clayton and Caulfield. ICCSA 2018 was held on Caulfield Campus, which is only 12 minutes away from Melbourne CBD by train.

The Faculty of Information Technology is one of the ten faculties at Monash University. The faculty has more than 100 full-time academic staff (equivalent to the rank of Assistant Professor, Associate Professor, and Professor).

I do hope that you will enjoy not only the conference, but also Melbourne.

David Taniar

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ICCSA 2018 was organized by Monash University (Australia), University of Perugia (Italy), Kyushu Sangyo University (Japan), University of Basilicata (Italy), and University of Minho, (Portugal).

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Advances in Web-Based Learning (AWBL 2018)

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Understanding Kid-Friendly Urban Space for a More Inclusive Smart City: The Case Study of Cagliari (Italy)

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Abstract. The focus of this paper is to determine whether, and to what extent, a relation exists between a kid-friendly urban space, social inclusiveness, and smart city paradigm. In fact, the practicability for vulnerable city users, such as children, acquires an intrinsic meaning of inclusion and equality, as a necessary condition to be considered and planned in a smart city. Over the years the city is based on the logic of separation and specialization of spaces and functions, so as to further differentiate the different social categories (adults, children, elderly and disabled people). In particular, children play and learn through urban space, developing and consolidating skills and competences. Children use urban space, expressing intents, idiorhythms and, therefore, specific needs. This paper proposes a phenomenological study, developed in the form of a laboratory of Cagliari’s explorations, aimed at identifying the spatial, morphological and functional characters and elements of urban materials that determine children’s perception and experience of places. The results of this research are a starting point for further studies aimed at integrating, with the parameters identified, the variables already considered in the existing tool for the measurement of the walkability of urban spaces.

Keywords: Smart cities · Smart children · Social interactions
Walkability · Cagliari · Kid-friendly urban space

‘No one will protect what they don’t care about, and no one will care about what they have never experienced.’

David Attenborough, 2016

1 Introduction

The city is an evolutionary organism in which not always the vulnerable users – such as children, disabled and elderly people – assume a significant role, for local administrators, in urban planning. Moreover, the city is often represented by literature as a

This paper is the result of the joint work of the authors. ‘Results and Discussion’ were written jointly by the authors. Alfonso Annunziata wrote the ‘Literature Review on Autonomy of Children in Urban Spaces’, ‘Methodology and objectives of a kid-friendly research’ and ‘The case study of Cagliari (Italy)’. Chiara Garau wrote the ‘Introduction’, ‘Strategies for Kid-friendly Safe Urban Spaces’ and ‘Conclusions’.

© Springer International Publishing AG, part of Springer Nature 2018
https://doi.org/10.1007/978-3-319-95168-3_40
‘nervous system’ constituted by people (with their habits and needs), ‘networks (due to globalisation), relationships (linked to local communities), and regulations (related to urban planning tools aimed at appropriate land use)’ [1] in which spaces and functions are characterized, over the years, by logics of separation and specialization, so as to further differentiate the different social categories [2]. Strategic inter-relationships that optimize resources, and improve the quality of life, represent the today’s challenge under the smart cities paradigm [3]. In this work, the authors focused on children because listening to their needs and their perception of public spaces can allow to think of a smart, inclusive and more appropriate city, not only to them but to all different types of city users [4]. In addition, the discourse on the contemporary city is characterized by the arising of the question of the significance of the public space, for children, as a privileged place for social interactions, for the producing of new experiences and codes and for the expression of the individual identity [5]. Henry Lefebvre calls ‘the right to the city’ [6] the phenomenon that implies the social ties, functions, services, the practicability of the urban public space and also its vocation to satisfy the individual, different instances of all city users. The practicability of outdoor urban spaces – with young people in mind – is a growing global concern, because, as Mimi Kirk [7] suggests ‘by 2050 around 70% of people will be urbanites, and the majority of them will be under 18. Today, over a billion children are growing up in cities’. For that reason, the practicability of outdoor spaces must be not only an indicator of the generic functionality of the city [8] but also, a condition for inclusion and equality in order to consolidate sustainable communities [4]. For children, the independent practice of urban spaces is a fundamental condition for maturing and consolidating abilities and relational competences. The ways in which children practice urban space express intents, idiorhythms and therefore specific needs. Children move by exploring space [8]. In this sense, the elements and conditions that define urban spaces, with respect to the uses and needs of children, acquire specific meanings and significance. This study is aimed at identifying the compositional, configurational, functional, environmental, social, properties relevant for the construction of meaningful, safe, stimulating places for children [1, 4].

The qualitative methods used allowed to detect the characters, materials, functions, stimuli of urban space more frequently perceived by children and, among these, to distinguish between desirable and negative elements. This study is developed in the form of a laboratory of urban explorations in the context of Cagliari (Italy) in which 42 children were involved. The results of this research are a starting point for further studies aimed at integrating, with the identified indicators, the variables already considered in existing tools for the measurement of the walkability of urban spaces. Namely, the focus is to make an index of children practicability in an urban area.

Starting from these assumptions, this paper begins by analysing the literature review on autonomy and independence of children in urban spaces also through the identification of main themes for the construction of practicable spaces. Then, a case study of Cagliari (Italy) is presented. The authors elaborate method and tools that defined the urban exploration laboratories. Finally, results of the study are exposed, by identifying a set of significant spatial, functional, social, environmental characteristics. The paper concludes by considering the validity of results as criteria for the design of inclusive urban spaces and as parameters for the construction of an indicator of the
practicality of urban spaces, which can be integrated into existing instruments for the measurement of walkability.

2 Literature Review on Autonomy of Children in Urban Spaces

The codes acquired during childhood not only define the individuality of each adult, but also determine in what way they will be for society in term of cost or resource [9]. The children’s fruition of urban space through spontaneous forms of play is essential for building a society of dynamic, enterprising people, as well as the urban space explored through the game allows children to develop considerable exploration and choice abilities, and to acquire interpersonal skills. A non-sedentary lifestyle also improves the cognitive abilities of children. Studies developed at the Policy Studies Institute in different periods (1971, 1990, 2013) reveal that independence in practicing urban space is for the youngest the most relevant opportunity for acquiring autonomy [10]. Thank to this, the child will also experience the unexpected, the ordinary and the extraordinary, the limit and obstacles. The value of independence in the growth of children also emerges from the Convention on the Rights of the Child [11]. This Convention establishes the right of children to rest, to forms of play suited to their age and to adequate living conditions and suitable to satisfy their social, physical and psychological needs. The denial of independence, vice versa, determines the loss of well-being and lower quality of life of children [12, 13]. In addition, a greater sedentary lifestyle leads to the decline of health conditions, in particular, the highest incidence of disorders and diseases due to obesity problems increasingly frequent among minors [4, 10].

The experience of autonomy, therefore, concerns the wider issue of child well-being. In fact, any spatial policy that reduces the walkability of urban spaces falls concretely on children. Their ability to move independently is also a fundamental moment in the process of their integration in a society: interaction with adults and the discovery of their gestures or behaviours have a fundamental educational and training value. Children learn by acting, by replicating gestures and behaviours [14]. The presence of elderly city users can profitably contribute to this educational value of the practice of urban spaces. The daily practices in the contemporary city are characterised by a sensitive contraction in the level of independence and autonomy of children [10]. This results from interactions between specific environmental, social, individual variables and the parents’ preferences in the choice and in the degree of autonomy of their children. It depends on (i) the age of the children, (ii) their maturity, (iii) the parents’ trust in the social and environmental context, (iv) the modification of daily routines, (v) the increasing availability of technological devices for communication, (vi) the different articulation of times and practices related to work and leisure, (vii) the change of habits related to mobility, (viii) the transformation of collective practices and of public spaces, (ix) the perceived need to protect children and the road safety conditions [15]. In particular, this latter with the presence of strangers are the strongest factor in restrictions on children’s independent mobility [10, 13, 16].
Besides, the primary studies published between 1980 and 2016 aimed at identifying the characteristics of the built environment that affect children’s independent mobility - particularly dead-end street, percentage of residential land, of commercial land, residential location type, traffic volume, vehicular street width, road density, intersection density, major road proportion, land use mix, availability of recreational facilities, residential density, and distance to destination) provide inconclusive results even if the findings are useful to inform context specific children’s independent mobility-related policies [17]. Furthermore, a research conducted in Rome [18] involving 417 children attending the fourth and fifth grades of the primary school, indicates the unsatisfactory hygienic conditions among the reasons of the decreasing of children’s propensity to autonomously frequent public spaces. This factor was mentioned by 81.6% of respondents, while the social danger by 21%, the presence of cars by 15.1% and the environmental danger, generically understood, was mentioned by 6.8% of children. These considerations underline the issue of the safety of public spaces. Consequently, in the subsequent paragraph, requirements and strategies for the construction of safe public spaces are discussed.

3 Strategies for Kid-Friendly Safe Urban Spaces

Generally, the construction of a safe kid-friendly space involves the ways in which any citizen uses urban spaces: its configuration and composition must satisfy to requirements associative to children’s modes of using a space; the general functional requirements must correspond to the basic needs of any user such as the children demand of usable comfortable and safe spaces.

The urban regeneration initiatives implemented in Rotterdam, Vancouver and Sidney demonstrate the relation between the promotion of strategies aimed at increasing the availability of urban spaces to children’s practices and the achievement of wider economic, social and environmental benefits [4]. Strategies aimed at confronting social and environmental conditions of danger and at designing inclusive and practicable spaces are based on a set of requirements, related to protection and continuity of pedestrian surfaces and to the spontaneous control of public spaces.

The first set of requirements underlines the need for the resolution of the configurational and compositional issues related to the design and adaptation of road networks and of road spaces. The Barcelona super blocks, the Liveable cities project in India, the children’s priority zones in Bogotà as well as the Vauban’s streets experimented in Freiburg, demonstrate the potential of actions that intervene on the pattern of connections amid different arcs, on the infrastructure’s layout, on transverse and longitudinal sections, on the treatment of surfaces, on the connection to the soil, on the design and organization of margins and residual spaces, on the implementation of traffic calming devices. These interventions not only reduce the vehicular traffic, by ensuring continuity, quality and protection of pedestrian surfaces, but also create playable spaces, producing significant benefits related to safety of urban spaces, to social cohesion, to independence, and to wellbeing of kids [4].

The second set of requirements relates to the vitality of public spaces and underlines that an intensely frequented space is also a safer one. In fact, people who use an
urban space encourage the formation of a community, because they recognize each other and share a sense of responsibility towards their own space of life [4]. In addition, children prefer roads and areas more intensely frequented, because they consider them as a safer space. The construction of sustainable communities can be fostered by creating spaces that facilitate intergenerational interaction [4]. To pursue this objective, the City of Rotterdam reframed patterns of co-presence in spaces around social infrastructures, transforming schoolyards into local-scale squares for the districts communities. Moreover, the creation of vibrant public spaces is deemed to require global strategies that - thanks to spatial, financial, administrative and legal tools - determine or reinforce four fundamental conditions: variety of primary uses, porosity of the urban fabric, typological and compositional heterogeneity of buildings, elevated densities and concentrations of users and functions.

The requirements here discussed are central to the construction of the children’s infrastructure: this can be defined as an isotropic, continuous network of safe public spaces, streets, natural areas, constituting the primary features of a child-friendly city. The children’s infrastructure provides a fundamental support for children’s everyday freedoms [4] and for social interactions. Nevertheless, these requirements, even if respondent to a fundamental need of safe spaces, only establish the conditions required for supporting generic and elementary modes of using spaces: for instance, moving and staying. Nonetheless, children express intentions, idiorhythms and, therefore, specific needs: the space of children is, primarily, a space in which children’s creativity and symbolic expression manifest. It is constituted of surfaces and materials that children can reinterpret, conferring them specific functions and meaning, building, in some cases, spatial systems, consisting of new geometries, signs and figures [19]. Therefore, the properties and elements that define urban spaces acquire, for children, different meanings and significance. A question arises, concerning the specific social, environmental, functional, configurational, compositional and factors that determine the attractiveness of specific places or elements, sequences and combinations of urban materials, thus orienting the patterns of children’s movements and activities. The identification of a set of indicators to formalise these factors constitutes the object of the research discussed here. As suggested by literature, this identification is very important in the context of the smart cities paradigm because through them it becomes possible to study and standardize an urban context, starting from emerging issues. In the following paragraphs authors present the methodology and the case study (the city of Cagliari).

4 Methodology and Objectives of a Kid-Friendly Research

The methodology adopted is a qualitative one and it is based on the combination of two techniques: the ‘phenomenological approach’ and the principle of saturation. The first methodology implies a suspension of the moderator’s perceptions in order to understand the experience of the research participants. The second technique is based on an original idea, elaborated from the scientific literature and employs field surveys to confirm or refute the original idea: this includes some compositional, configurational, functional, social, environmental properties indicative of fundamental conditions that determine the practicability of a space. These properties include porosity [20],
availability, priority and continuity of pedestrian spaces [21], vitality and, therefore, the variety of primary and secondary functions, the transformation of spaces for children into social spaces, the intensification of the meeting points between different individuals, the multifunctionality of open spaces [4], the articulation of the edges, the variety of spatial and environmental conditions, the combination of different scales in the surfaces delimiting spaces [22], hygienic conditions [23], the presence of natural elements [23], participation and co-creation [4, 9, 10].

Field surveys continued until further interviews would not add new information, consistently with the saturation principle [24, 25]. In the subsequent paragraph, the authors illustrate the case study (Cagliari) and the application of the methodologies described.

4.1 Cagliari (Italy) and Applications to Case Studies

Cagliari is the core of the Metropolitan City of Cagliari constituted by 17 municipalities and its territory is defined by a polycentric structure, in which a complex pattern of relations of communication and social dependence is easily identifiable. Cagliari emerged as an optimal case study because of the integration of this study into a set of previous policies and projects for promoting children’s rights related to accessibility and participation. In 2014, the local authorities joined the program ‘Child friendly cities’ promoted by Unicef Italy (inspired by the principles of the Declaration of Rotterdam) [26] through the drafting of the document ‘Costruire Città amiche dei bambini’ [9] in which Cagliari is committed to promote a child-oriented urban planning and design, by encouraging children’s participation and by creating well-lit and safe public spaces available for children, also including safe routes to travel through the community. After this initiative, several programs develop actions for the promotion of children’s mobility, in particular along home-to-school itineraries (Pedibus and a peis programs). These projects are in line with more general policies, able to foster sustainable modes of transport, including the introduction of a service of bicycle-sharing, sporting events (Cagliari respira – since 2008), experimentation and promotional campaigns (Zeus - Zero Emission Urban Bus System – Project, started in 2015) and the reorganisation of public open spaces. This last action is articulated in the following interventions: (i) the network extension of lanes reserved for public transport means and of cycling paths; (ii) the pedestrianisation of different areas of Cagliari (such as the Villanova and Marina districts) and of roads (such as the Corso Vittorio Emanuele, starting from 2016), and finally, (iii) the restoration of significant outdoor urban places (such as via Manno, piazza Garibaldi and piazza San Michele, starting from 2017). In addition, several social and cultural organisations (such as Associazione Efys, Associazione CoSas, Associazione Cicofficina Sella del diavolo, Associazione Punto Zero) operate to foster children’s creativity, socialisation, active citizenship and participative knowledge of the City of Cagliari. These objectives are pursued by workshops of photography and of urban exploration (through the project ‘Esplora Città’, 2013); by laboratories of territorial mapping (through the project called ‘Ci sono più posti che strade’, 2017) and by temporary ludic appropriation of relevant urban places. As a result, the proposed study builds on methodologies and findings of different workshops,
The study focused on a large urban area of Cagliari, that includes part of the historic districts of Stampace, Marina, Villanova (Fig. 1).

![Fig. 1. Cagliari: representation of urban spaces explored during the study.](image)

The choice of these districts depends on three factors: (1) high population density (respectively 4,260 in/km2, 12,258 in/km2, 14,494 in/km2); (2) variety of functions and services – residential, political and administrative functions, accommodation and catering facilities, commercial activities – which encourage a constant presence of different people at different moments of the day; (3) continuity of spaces partly or entirely closed to vehicular traffic.

The criterion is to concentrate the analysis on spaces in which certain fundamental conditions to produce diversity and autonomy of children are verified. These conditions are: limited environmental dangers, priority of pedestrians, plurality, intensity and liveliness of spaces, variety of stimuli [1]. Finally, the spaces explored can be referred to the basic categories of urban space: the district, the edge, the path, the node [27].

Once the area of the study has been determined, the qualitative method, based on the techniques of the saturation principle and of the phenomenological approach, has been applied in order to detect the characters, the materials, the functions, the stimuli of an urban space more frequently perceived by children, distinguishing between those deemed positive and those considered negative. In this way, the parameters extrapolated from the scientific literature have been confirmed, refuted or more precisely
understood with respect to their relative importance. Subsequently, the operating phases were defined. These are:

1. a first focus group, aimed at identifying on a map of the historical districts of Cagliari the open public spaces most frequently visited by children. The latter were then invited to describe the most significant and distinctive characters of these spaces and the organised or informal activities practised within these places. Then, the participants were invited to explicit the reasons of their attitudes towards the public open spaces and of their propensity to regularly frequent specific places.

2. an urban exploration, aimed at investigating a significant route (Largo Carlo Felice) and two local scale nodes (Piazza Yenne and Piazza del Carmine).

3. an urban exploration during which the figures of the district (the Marina district) and of the edge (the Port) were investigated. During this exploration a more meandering route is individuated from the ‘Centro di Quartiere’ to the Port, reflecting children’s preferences for specific district scale public spaces, individuated during the first focus group.

4. an urban exploration in which two nodes of urban and metropolitan scale were investigated (Piazza Matteotti and II Parco della Musica), as well as the shortest route from the ‘Centro di Quartiere’ to the bus stop located in Piazza Matteotti, selected for its function as an inter-modal node of urban scale. During the explorations each participant was provided with a note pad, which included a map of the area explored and a form on which to report the elements and the significant components, desirable and undesirable, of spaces. These elements were grouped within the two elementary categories (‘I like’ and ‘I do not like’). The genericity of these categories depends on the decision not to constrain the interpretation of spaces into more complex formulas considered less understandable and more rigid. Therefore, we opted for a format that allows children to record the broadest set of sensations.

5. a conclusive focus group, during which the spaces explored during the study were highlighted on a map and analysed regarding their most distinctive characteristics and their potential to accommodate different activities. The children were thus encouraged to discuss their opinions about public open spaces and the possible ways of using them (Fig. 2 shows the urban explorations and the workshop phases).

Trips were made by walking, departing from the ‘Centro di Quartiere’; only the trip from the intermodal node of Piazza Matteotti to the metropolitan-scale node of the Parco della Musica was made by bus. The research involved 42 children (18 girls and 24 boys) whose ages ranged between 5 and 13 years: this age group is defined at its lower end by the age required for accessing the education system and at the upper end from the age that constitutes the threshold beyond which a general increase in the autonomy of children and a marked tendency to renegotiate constraints are noticed [10]. The participation of children aged from 5 to 8 years relies upon the intention to gain a deeper understanding of elements of the built environment conducive to intensification of children’s activities, by involving participants of different age and motoric and cognitive abilities. The participants are selected among residents or
customary users of the Marina district. This criterion relies on the intent to identify attitudes of children related to different conditions of spatial familiarity and, hence, variations in perception of familiar local scale nodes, routes and open spaces (Piazza Savoia, Piazza San Sepolcro, Piazza Yenne, Piazza del Carmine, Darsena) and of unfamiliar public and open spaces (Parco della Musica, Piazza Matteotti). Spatial familiarity, in fact, influences perceptions related to safety and security of public spaces, strategies of adaptation determining individual preferences and tactical decisions made during usual trips to face regulations and forms of control of pedestrian spaces and functions and uses of the public space [28].

**Fig. 2.** The urban explorations in Cagliari and the workshop phases. The Park (called Parco della Musica) appeared as the most significant place because it satisfies many of the desirable conditions of places for children. The combination of regular surfaces for organised group activities and of articulated regions of space for more intimate practices; the availability of spatial elements; the presence of elements of naturality and of singular elements (the artificial river, the bridge, the vertical volume of buildings) emerging as focal points and the variety of environmental conditions.

The number of participants is because, coherently with the saturation principle, the 42nd child allowed to complete saturation of the required information. The different phases of this study were conducted with the help of the educators of the ‘Centro di Quartiere’ of the Marina district. Educators’ activity consisted in facilitating maps reading and comprehension of the objectives of the focus groups and in structuring techniques for observing children attitudes during urban explorations: these techniques included: (i) direct questions on specific spatial elements or properties and on individual memories related to space observed; (ii) annotation or recording of children’s
impressions and comments; (iii) description of children’s attitudes towards observed spaces; (iv) collection of sketches, made by children, of significant element of the public space.

5 Results and Discussion

This study shows the complexity and specificity of the relation between children and spaces: their interpretation of urban spaces can not be reduced to the adults’ perception, and in several case a competition for public space emerges between adults use of space and children’s practices. A vast and specific set of demands and needs emerges both as an implicit reflection of the representation and description of spaces formulated by the children and as the explicit object of precise instances. The participants revealed a profound consciousness of their relationship with spaces, translating it in original, surprising potential, alternative images of public spaces: a girl imaged a space where various music instruments were made available to children; a younger girl, observing a spacious square, noticed that if in large squares there were radios playing music, children could dance; again, many boys observed that the pervasive presence of tables and seat of the numerous restaurants facing many public spaces, made it impossible, for children, to play football, riding a bike or skating.

Several properties and components are individuated as relevant aspects of urban places. Presence of elements of nature, of instable, transforming elements is perceived as a positive feature of space: water, either still as in a pool or in motion as in a fountain, either as a natural element, or as a component of an artificial setting, is a focal point of space. Water is at the same time, an element to be observed and a focus, an inspiration, a tool of spontaneous pastimes.

Trees also are appropriated in the processes and patterns of playing and are transformed into useful repairs to hide behind or testing obstacles to climb on. Equally, basements of sculptures, pieces of furniture, variations of surfaces grade, steps, partitions, become focal points in the patterns of movement and of use of spaces. A partition dividing a flat pedestrian surface from a ramp is re-signified and transformed in a springboard for jumping or in a balance beam. A basement is converted, by use, in an informal seat. Among the material, configurational, positional or compositional features of spatial elements, two variables appear to be the most valuable: (1) the variability, hence, the constitutive instability of mobile and mutable parts or elements, and (2) the availability of spaces and elements to informal and spontaneous uses.

Then their inclination to being appropriated, re-interpreted and re-signified by means of playing appears important. Viceversa, it is observed a general bland interest for repetition and regularities in compositional aspects and elements of urban spaces: it is observed a difficulty in finding qualities or components identifiable as distinctive, relevant or memorable, in urban spaces whose surfaces and boundaries are constituted of serial buildings [6] or homogeneous urban materials; differences, exceptions, singularities seem to be regarded as more relevant aspects.

In general, it can be considered as a significant feature of a public space the presence of reference points [28], intended as significant, unique elements, identifiable because of singular features related to shape, colour, alignment, position, dimension,
combination of scales, details, variability. The presence of singular elements (the fountain, the artificial river, the bridge, the sculptures, the obelisk) is observed to stimulate a more instinctive and intense reaction, reflected in the vividness of descriptions and in the articulation of patterns of movements and practices, particularly, in the intensification and concentration of uses around these focal points.

Moreover, modest-scale objects or details, such as decorated façades, a coloured windmill on a balcony, a store sign, or element of the urban landscape, such as a tall building emerging from a compact curtain, can be identified as relevant elements, and can structure the image of places. Strictly associated with this aspect of public open spaces is the presence of flat, vast, free surfaces, available for more organised, articulated activities or for practicing sports: football, bike races, skating, cricket. Spaciousness is in fact considered as a positive feature of an urban space and is recognised as a distinctive aspect of several urban nodes (Piazza del Carmine, Piazza Yenne, Parco della Musica).

Several spaces (Piazza del Carmine, the square under the Palace of the Regional Council) are defined in terms of possible practices, hence, in terms of the degree to which these spaces are practicable for a vast set of spontaneous leisure activities. For instance, considerations made by 3 participants describe a square (Piazza del Carmine) as a spacious space, almost as vast as a stadium, a suitable place for playing football, cricket or hide and seek. These spatial properties emerge as the most relevant aspects, in structuring the opinion of children, and, hence, in conferring to a space a significance as a place [24].

A consequence of this fact is that urban spaces considered as banal by adults can be regarded by children as significant places, because of their potential to be stimulating, available, varied scenarios for a vast set of informal, spontaneous practices and social interactions. In general, the combination of different spatial conditions emerges as a fundamental issue to be considered when designing practicable public spaces: flat, regular, open surfaces, heterogeneous regions of space – articulated by pieces of furniture, partitions, vegetation, singular elements (pools, fountains, sculptures) or variations in textures, materials or gradient of surfaces— and edges structured by a sequence of corners, recesses, interstices, repaired spaces; the variety of spatial conditions determines the variety of social interactions. Thus, it increases the practicability of a place for various uses and interpretations: for the structured and formalised activities of large groups, for the informal, spontaneous pastimes of individuals or of non-numerous groups, for rest and observation. This finding is consistent with the concept of spatial interface defined [8] as a specific component of the two-steps logic structuring spatial layouts conceived to organise and regulate patterns of movement.

Moreover, this combination of spatial conditions is also consistent with the required variety of environmental conditions: the combination of sunlit and ventilated areas and of more protected, shaded regions of space is regarded as a fundamental aspect in order to structure a space apt to host a vast set of practices, i.e. both of static activities and of dynamic activities.

Again, it is noticed that density and combination of functions and activities seem to be concretely and positively significant only if associated with the possibility of independently using spaces. In fact, the intrusive presence of pieces of furniture related to private commercial activities is perceived as a negative feature since it prevents children from appropriation and informal use of space. This question relates with the
more general issue of the complex, contradictory character of the relationship between adults and children which hence emerges as a relevant aspect of the configuration of public spaces; forms of control of space – for instance, particular regulations or the presence of the Police or of private security guards – or of use of space – for instance, the pervasive presence of seat and tables of restaurants facing a square, intense pedestrian movements – are perceived by children as a constraint on their opportunities of spontaneously practicing a space. At the same time a girl underlines the absence of seats for parents to rest and observe children playing as a negative aspect of a portion of space within Parco della Musica. Thus, even if the presence of adults is a fundamental issue in order to increase the safety and vibrancy of public spaces, the specific characters of children’s spatial practices and their demand for independence lead to competition for space or to a preference for places not subject to the direct and persistent control of adults; children tend to explore and appropriate spaces hence, they tend to converge to the most integrated spaces not intersected by the main lines of movement. These aspects urge for strategies of redistribution of urban space aimed at structuring a balanced co-presence of adults and children’s spatial practices.

Moreover, the terms and the categories the participants used to qualify places revealed the synesthetic character of their experience of spaces: noises, sounds, scents, tactile sensations and bodily relations with spatial elements can typify a space and, thus, determine a specific subjective image of it.

A relevant concern is related to the conditions of maintenance of public spaces: garbage, grime, degraded pavements and surfaces are considered as relevant negative features. A further relevant negative aspect, pointed out by the participants during the focus groups, is the absence, in main urban spaces, of public lavatories and of drinking fountains.

Another element of concern is related to the stranger danger, i.e. to the presence of people perceived, because of their condition or attitude, as a potential threat. In conclusion, an interesting issue is related to presence of vehicles; a pervasive presence of automobiles is considered as an obtrusive presence and as a potential danger, thus preventing people from practicing a space. At the same time, during the exploration of the local nodes and of the route, it was observed that several participants considered vehicles as elements of interest, to observe. As a consequence, a moderate presence of vehicles can be regarded as a positive element; this consideration seems to confirm the importance of exploring strategies of domestication of mobility spaces [15], through the re-distribution of road space, the reconfiguration of longitudinal and transversal sections and the regeneration of road edges; these strategies are meant to transform mono-functional arterials and distributors in multi-functional spaces and, thus, are instrumental to the construction of a continuous, isotropic, fine-scaled matrix of practicable spaces [6].

In conclusion, the authors observed substantial variations in the perception and interpretation of spaces associated to differences in the degree of spatial familiarity [28]. In familiar spaces, a profound sense of identification and of belonging is observed: for instance, the pedestrian surface under the Palace of the Regional Council was defined by a group of children as ‘a space that belongs to us’. Moreover, spatial familiarity resulted in tactical decisions related to route choices aimed at increasing number of elements of interest encountered during usual trips and at avoiding spaces considered as not suitable
for spontaneous pastimes. Familiarity resulted also in strategies of adaptation and resilience determining a sense of self-confidence in moving across public spaces. For instance, a group of participants aged from 10 to 13 years felt not constrained by the barrier effect determined by the Via Roma, an urban distributor road, not renouncing to cross it and reach the pedestrian surface of the Darsena and its fountain, seen as a fundamental focal point. Strategies of adaptation also resulted in resignification of banal elements, residual spaces, degraded surfaces (for instance, disconnected pavement slabs) as opportunities for leisure activities or useful tools for testing one’s abilities. Children also focused more on details and on micro-scale elements identified as reference points of individual landscapes since associated to particular, intimate memories: a memorial located near the Darsena emerged as a relevant element for a young girl since she used to climb on it to be photographed by her parents. In general, perceived significance of familiar public spaces seemed to depend on availability of surfaces and of elements located inside public spaces for informal uses and group activities. Vice versa, in unfamiliar spaces interest seemed to be focused on large scale elements, such as buildings, as the tower of a Hotel adjacent to the Parco della Musica. This consideration leads to suppose that as spatial familiarity increases, because of proximity and accessibility of public spaces, interest of children moves from compositional and configurational features related to comfort and aesthetics to conditions and aspects related to conviviality and to availability of urban spaces for informal uses.

The findings presented in this section and the parameters deduced from the literature can be formalised as a set of indicators of practicability, grouped and organised in 6 categories related to configuration, composition, environmental aspects, social aspects and function (Table 1).

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<thead>
<tr>
<th>Category</th>
<th>Objective</th>
<th>Indicators</th>
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<tbody>
<tr>
<td>Configuration</td>
<td>Accessibility of practicable spaces</td>
<td>Porosity</td>
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<td></td>
<td>Continuity of movement</td>
<td>Coarseness</td>
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<td></td>
<td>Safety</td>
<td>Contiguity of pedestrian spaces</td>
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<td></td>
<td></td>
<td>Connectivity of pedestrian spaces</td>
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<td></td>
<td></td>
<td>Separation of surfaces for different modes of movement</td>
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<td></td>
<td></td>
<td>Articulation of space (variety of spatial conditions)</td>
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<tr>
<td>Composition</td>
<td>Creation of stimulating and meaningful spaces</td>
<td>Complexity (combination of elements of different scales)</td>
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<td></td>
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<td>Presence of reference points</td>
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<td>Variability</td>
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<td>Width of pedestrian routes</td>
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<td></td>
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<td>Longitudinal and transversal slope</td>
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<td></td>
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<td>Stability, regularity and roughness of pavements</td>
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<td>Extent of free surfaces</td>
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<td>Morphological regularity of free surfaces</td>
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<td>Articulation of edges</td>
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<td>Informal seats</td>
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(continued)
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<thead>
<tr>
<th>Category</th>
<th>Objective</th>
<th>Indicators</th>
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<tbody>
<tr>
<td>Environment</td>
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<td>Congestion</td>
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<td>Climate and disaster resilience</td>
<td>Levels of footfall</td>
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<td></td>
<td>Liveability</td>
<td>Presence of elements of naturality</td>
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<td>Olfactory environment</td>
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<td>Variety of micro-climatic conditions</td>
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<td>Multifunctionality of spaces as areas for water management and for climate mitigation</td>
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<td>Maintenance</td>
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<td>Social</td>
<td>Preventive healthcare</td>
<td>Intergenerational activities</td>
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<td>Safety and active travel</td>
<td>Levels of reported anti-social behaviour</td>
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<td>Social cohesion</td>
<td>Reported crime</td>
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<td></td>
<td>Active citizenship</td>
<td>Road traffic accidents</td>
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<td></td>
<td>Sense of ownership</td>
<td>(Child) pedestrian casualties</td>
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<td>Control of space</td>
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<td></td>
<td>Restriction on uses of space</td>
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<tr>
<td>Function</td>
<td>Availability of public spaces to organised activities and formal uses</td>
<td>Priority of pedestrian spaces</td>
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<td>Variety of primary and secondary uses</td>
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<td>Multifunctionality of spaces for children as district-scale spaces of sociality</td>
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<td>Availability of regions (clusters) of space for play</td>
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<td>Availability of furniture and partitions for play</td>
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<td>Lavatories</td>
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<td>Fountains</td>
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In the following paragraph the authors consider the validity of these indicators as central factors to the design of inclusive urban spaces and as parameters for the construction of an indicator of the practicality of urban spaces, which can be integrated into existing instruments for the measurement of walkability.

### 6 Conclusions

This contribution presents the results of the preliminary stages of a broader study on indicators of practicability, for children, of public open spaces. The concept of practicability of public open spaces is central to the smart-city paradigm because understanding kid-friendly urban spaces is a condition for more inclusive smart-cities.

This preliminary stage of the study permits to state that children reveal a conscious and specific relation with the urban environment, structured by essential physical interactions with spaces and with materials that articulate spaces. Children’s interpretation of a
place seems to be related to the potential of spaces of being practiced by tools of informal activities: consequently, elements and conditions of urban spaces acquire, for children, specific meanings and significance. The specificity of interpretations results in the specificity of instances and of images of alternative configurations of urban spaces. Thus, structured processes of co-creation and participation of children – aimed at stimulating a confrontation among different experiences and alternative images related to the use of public spaces - is a central issue for designing kid-friendly urban spaces.

Moreover, this study, through the collection of data related to the characters and aspects of public spaces emphasised by children, is aimed at confirming or refusing parameters related to practicability extrapolated from the literature review and at individuating new indicators. The analysis of the case study (a vast area of the historical districts of Cagliari) underlines relevant aspects in finding in what way children are inclined to practice a space. In particular, the urban explorations reveal:

(i) positive or interesting elements (fountains, trees, green surfaces, sculptures, partitions, colours, tall buildings, particular store signs, decorated facades)
(ii) potentialities of spaces (opportunities for organised activities or informal uses, contact with animals)
(iii) negative urban aspects (scarce maintenance of pavements and furniture, inadequate hygienic conditions, stranger danger, occupation of space for adults’ activities).

These aspects and the parameters deduced from the literature review are combined and formalised as a set of indicators, organised in 5 categories (Configuration, Composition, Environment, social aspects, Function). The main criticality of this preliminary stage is related to the modest number of participants (42) even if this number is considered consistent with both the purpose of this phase of the study and the criteria of the techniques that constitute its methodology, hence the saturation principle and the phenomenological approach.

The findings of this study constitute the basis for future investigations: a first phase will tend to establish the relative importance of the indicators of practicability here presented and to structure a set of sub-indicators for determining their value. These indicators will be based on qualitative evaluations, for instance of compositional aspects, or on the quantitative analysis of specific topological, climatic, geometric, statistical variables related to the configurational, environmental, social and functional indicators; then, for each quantitative sub-indicator, a benchmark will be established. A second phase will be aimed at integrating the indicators within existing tools for the measurement of the walkability of urban spaces. The recalibration of the set of indicators included in the existing walkability toolkits is intended to support the identification of the spaces available for informal uses that constitute for children - together with institutional and dedicated spaces (as well as for schools, oratories, sports fields) – a set of destinations, and the evaluation of the intrinsic practicability of the paths and of the spaces crossed. The aim is the construction of an analytical tool, calibrated according to the specific target considered - in this case the children - to measure the practicability of an urban area.
Acknowledgments. This study was supported by the MIUR (Ministry of Education, Universities and Research [Italy] through a project entitled Governing the smart city: a governance-centred approach to Smart urbanism - GHOST (Project code: RBSI14FDPF; CUP Code: F221I5000700008), financed with the SIR (Scientific Independence of Young Researchers) programme. We authorize the MIUR to reproduce and distribute reprints for Governmental purposes, notwithstanding any copyright notations thereon. Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors, and do not necessarily reflect the views of the MIUR.

This study was also supported by the project ‘Healthy Cities and Smart Territories’, founded by the Foundation of Sardinia and Autonomous Region of Sardinia (Fondazione di Sardegna – Convenzione triennale tra la Fondazione di Sardegna e gli Atenei Sardi Regione Sardegna 2016).

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