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Walkability and urban capabilities: evaluation and planning decision support

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Abstract

We propose a methodology for the evaluation of urban walkability, and the related software tool for decision and planning support. In the introduction, we discuss the relevance of the concept of walkability for urban quality of life, and attempt to place it within the framework of the capability approach. The central part of the article is dedicated to the presentation of the spatial multi-criteria evaluation model for walkability. Our construction of the walkability in the model proposes a certain change of perspective with regard to the methods suggested thus far: rather than evaluating how a place is walkable in itself, the walkability score we calculate reflects how and where to one can walk from that place, in other words, what is the walkability the place is endowed with. Therefore, the walkability score combines three components: (1) the number of available destinations (urban "opportunities") reachable by foot; (2) their distances; and (3) the quality of pedestrian routes towards those destinations. The quality of pedestrian routes is evaluated on different attributes relevant for walkability, related to the characteristics of the streets and their surrounding environment which contribute to render the route pleasant, secure and attractive. By way of example, in the third part we present an example application on the city of Alghero (Italy).

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INTRODUCTION

In the debate on urban quality of life, the concept of walkability is drawing a growing interest among scholars and planning practitioners.[1]

The quality of life in cities of course depends on the presence of spaces, services and activities, and on their distribution in space. Yet, the concept of walkability is an attempt to push beyond the mere presence, distribution, and also beyond the crude accessibility of places: the spatial quality and the capability to embrace and promote pedestrian mobility of the urban environment influence how people perceive and use the city. What the concept of walkability is able to capture is, in fact, the *quality* of accessibility: how and how much the urban environment is capable to favour walking and to offer itself as a platform for an everyday life centred on pedestrian mobility (Porta and Renne, 2005; Ewing and Handy, 2009). In this sense, therefore, besides the mere presence of opportunities, places of interest and services in space, and besides their mere distance, it becomes relevant if they can also be reached by foot or bicycle, if the connective pedestrian routes are pleasant and spatially integrated with its surrounding, if it is brimful of activities, if it is well mantained and (perceived as) secure, if it is not surrendering to car traffic either by design or due to the predominant social practices of use of the space.

Ultimately, the presence and the distribution of services and activities are not the sufficient requisites to define the urban quality of life, for it depends also, perhaps above all, on the relation among those places and the effective possibility of inhabitants to "use" them as means to develop their well-being.

A consistent body of reflections produced in the recent years pinpoints walkability, intended as the predisposition of the physical environment "to be walked", as an important requisite of the quality of life in cities (Talen, 2002; Frank *et al.*, 2009). In this context, the walkability ought to be intended not only as an objective to pursue in order to improve the quality of life of inhabitants, but also as a tool planners and architects may avail themselves of to re-orient the methods for the evaluation of urban quality of life, to advance their project-oriented understanding of the city, and to innovate policies and urban projects promoting quality of life, in particular those of the marginal urban areas and of the disadvantaged urban populations.[2]

The concept of walkability is not in itself particularly new.[3] What is new is the proliferation and refinement of attempts of its operationalisation, its submission to systematisations and to procedures of formal evaluation, and the possibility to employ it in a more rigorous way as a support tool for decision making, urban design, and mobility planning. (Saelens and Handy, 2008; Capp and Maghelal, 2011; Talen and Koschinsky, 2013). This operational turn was fostered by the growing availability and diffusion of detailed spatial datasets, by the increasing computational capacity and by the development of geodata processing tools and computational techniques which jointly offer an opportunity to build methods and support tools for urban and territorial decision and design processes.

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[1] See Livi Smith and Clifton 2004; Cervero and Duncan 2003; Porta and Renne 2005; Frank *et al.* 2006; Clifton *et al.* 2007; Forsyth *et al.* 2008; Speck 2012; Paez *et al.* 2013; Blečić *et al.* 2015.

[2] For example, see: Bizzaglia, 2014; Careri, 2006; Cecchini and Talu, 2011; Illich, 2006; Labbucci, 2011; Nuvolati, 2013; Solnit; Viale, 2007; Soderstrom, 2008; Schmitz, 2006.

[3] So for example Kevin Lynch, in his *The Image of the City* (1960), underlines how the set of urban pathways, that is, the network of habitual and potential lines of movement within the urban structure – those routes we may define "prevalent" – are "the most potent *means*", (p. 96) to redesign the city In 1961, Jane Jacobs chooses to dedicated the first part of *The Death and Life of Great American Cities* – her vivid critique of the presuppositions and objectives which have guided the modern orthodoxy of urban planning – to the arguments in favour of the need to promote an intense and diversified use of streets, and in particular of the pavements. After all, to go even further aback, some intuitions, resonances and echos of these ideas can be found already in Camillo Sitte (1889).

But before stepping into operational questions, to which are dedicated the rest of the article, it is useful here briefly to dwell on a more general theoretical placement of the concept of walkability within the debate on the urban quality of life.

WALKABILITY AND URBAN CAPABILITIES

Far from being self-evident in its implications, the objective of promotion of urban quality of life rather raises questions on the normative level: in the face of a variety of methodological and operational proposals on how to reveal, measure and evaluate the quality of life for the construction and evaluation of plans, projects and urban policies[4], no general theoretical consensus exists on the definition of the concept itself of *urban* quality of life.

A good theoretical approach should in this case also be good in particular and locally, that is, *applicable* and *usable* within the domain of *practitioners*. It is our hypothesis that the appropriate theoretical framework to place the *urban* quality of life in is the *capability approach* (whose elaboration derives from the seminal reflections by Amartya Sen[5]). Among other dimensions of well-being (income, access to health, education, and so on), the way in which our cities and physical environment "work" (the way in which they are built, organised and used by social practices) matters: the space must hence be considered an important component of some individual capabilities, which we may define *urban capabilities*.[6]

The adjective "urban" is here programmatic: the point is not merely to take people living in a city and to measure their overall capabilities, it is rather to establish how and up to what point their overall capabilities (which of course depend on many other a-spatial factors) are determined by eminently urban factors, related to the way in which the city and the urban environment work. In other words, to endow the concept or *urban* capabilities with meaningfulness, the point is to explore up to what point we can at least partially isolate the specific relation between individual capabilities and the space. Such a perspective could allow planners, designers and public decision-makers to more effectively interpret the multiple relations between the city and its inhabitants, to unveil the circumstances in which the city is an "obstacle" to the development of their capabilities, to better define the requirements and contents of plans and projects intended to remove those obstacles.

Hence, the concept of walkability, *in the way it is operationalised by us*, should here be understood in this sense, as one of the primary factors of urban capabilities. And talking of urban opportunities and services, we should certainly refer to the practice of urban planning standards, being them the sole institutionalised in the Italian urban planning system. The first key concept here is that of *urban functioning*, intended as what a person effectively do with and in the city. To employ urban functionings may in itself be an advancement over the practice of planning standards. To think in terms of urban functionings means to attribute a central role to the effective use of the city by the people, rather than assuming that planning standards – the intrinsic urban features – are automatically converted into a (pre)determined level of well-being of the inhabitants.

But, above all, it is the concept of *urban capability* that invites for a reflection on the practice of standards, and suggests a possible operative route for the integration of the information used for

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[4] See, for example: Altieri and Luison, 1993; Bonfiglioli and Mareggi, 2004; Capolongo (ed.), 2009; Chiappero Martinetti, *et al.*, 2011; Chiappero Martinetti and Pareglio (eds.), 2009; Martinotti, 1998; Nuvolati, 2003; Nuvolati, 1998; Nuvolati and Tognetti Bordogna, 2008; Nuvolati and Zajczyk, 1997.

[5] See: Sen, 1979; Sen, 1992; Sen, 1993; Sen, 1999. The capability is the effective freedom of an individual to choose between different things to do or to be that she has reason to value. In this conception, a capability constitutively requires two preconditions: (1) the ability, the person's internal power, detained but not necessarily exercised, to do and to be, and (2) the opportunity, the presence of external conditions which make the exercise of that power possible. A person is thus capable, has the capability to do or to be something, only if both conditions – internal and external, ability and opportunity – allow her to.

[6] For an extended discussion of the concept of "urban capability", see Blečić, Cecchini and Talu, 2013; Talu, 2013; Talu, 2014.

describing and evaluating the spatial component of the quality of life. The reference to urban capabilities in fact imposes two distinct but strictly related requisites: (1) the need not to consider relevant only the information which enumerates and quantify urban services, but also and above all the information describing what use people make (or don't make) of these services; (2) the necessity to address the *possibility* people have (or don't have) to use different urban services starting from peoples' characteristics and not only the actual use they make of those services.
The methodological proposals presented in this article should then also be intended as a contribution to reflect and rethink the practice of planning standards, also in the perspective of possible legislative revisions.

EVALUATING WALKABILITY

In what follows we present a methodology and the related software system, *Walkability Explorer* (WE), for the evaluation and decision support centred on walkability.[7]
Many researches on the walkability evaluation has been concentrated on the more immediate physical characteristics of the urban environment, which are easier to measure.[8] However, these do not offer an exhaustive frame of factors relevant for the walking experience, in particular because they leave out some more qualitative ones, such as sense of enclosure, imageability and "liveliness" (Mehta 2008). Furthermore, often, the proposed evaluation methods are oriented to identify how much a place (a street, a neighbourhood) is in itself walkable, for its physical characteristics and organisation. The method hereby presented is an extension of those proposals, but at the same time, on the latter point, offers a certain change of perspective: rather than evaluating how much a specific place is in itself walkable, the walkability score we constructed reflects how, and where to, a person can walk starting from that place; in other words, not how much walkable, but rather what is the *walkability the place is endowed with*. For that reason, as we shall see, the walkability score is an aggregate combining three components: (1) the number of destinations/urban opportunities reachable by foot; (2) their distances; and (3) the quality of the pedestrian routes to these destinations. The quality of the pedestrian routes is evaluated on several attributes relevant for walkability, related to the features of the streets and of the surrounding environment which may contribute to make the routes efficient, pleasant, secure and attractive. In operational terms, the street network is in the model represented as a graph composed of a set of nodes and edges, where each edge is described on a set of attributes relevant for walkability. Using this graph, the WE software assigns a walkability score to all the nodes, which are considered as possible origins of walks. The destinations are in their turn represented by a subset of graph nodes, selecting the nodes nearest to the destinations in question (in the case of point destinations, such as a school), or as centroids of the attractive areas (in the case of areal destinations, such as an urban park). The basic assumption of the evaluation model is that a person or an inhabitant located at a point in space will be able to walk a certain number of times towards the available destinations, and will from that obtain a benefit β defined by the following Constant-Elasticity-of--Substitution (CES) function:

$$\beta(x) = \left(\sum_{i=1}^{n} X_i^{\rho} \right)^{\frac{1}{\rho}} \qquad (1)$$

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[7] The software is freely available at the Web page: www.lampnet.org/walkabilityexplorer

[8] For a more extensive discussion of methods proposed for the evaluation of walkability, see: Blečić *et al.*, 2015a; Ewing and Cervero, 2010; Krizek, 2003; Iacono *et al.*, 2010.

where n is the number of available destinations, X_i is the number of times the resident visits the *i-th* destination and $1/(1-\rho)$ is the elasticity of substitution among destinations.[9]
We impose the following constraint on the pedestrian:

$$\sum_{i=1}^{n} c_i X_i \leq M \tag{2}$$

where c_i is the "cost" the pedestrian foregoes to reach the destination i, and M is the available budget with a conventional constant value.
Finally, it is necessary to define the "cost" term of a route (c_i in eq. (2)), which in our case takes into account both the length and the attributes relevant for its *quality* for pedestrians. So the cost of a route composed of p edges is defined as:

$$c = c_0 + \sum_{k=1}^{p} l_k \left(1 - \left(\sum_{l=1}^{r} w_l a_{k,l}^{r} \right)^{\frac{1}{r}} \right) \tag{3}$$

where c_0 is the fixed cost, l_k is the length of the k-th edge in the path, $a_{k,l}$ **· [0,1]** is the value of that edge's *l-th* attribute, w_l is the weight of the attribute $(\sum w_l = 1)$, and r is a parameter with $1/(1-r)$ being the elasticity of substitution among attributes. The variable part of the expression (3) yields unit cost of 1 when all attributes are at their minimum (*i.e.* 0), and approaches 0 when attributes approach the maximum of 1. Among all the alternative routes between an origin and a destination, the least costly one is used in eq. (2).[10]
Finally, the *walkability score* attributed to the point in space corresponds to the maximum benefit the person located at that point may attain, given the assumptions of the behavioural model in (1), (2) and (3). As we have said, this procedure is executed for each node of the graph, and thus to each node will be attached a walkability score w:

$$w = \max \beta(x) \tag{4}$$

[9] Our choice to model in this way the benefit is in strict connection to the way we conceptualise walkability. Eq. (1) exhibits convex preferences, which in our case means that the benefit deriving from multiple visits to a destination is marginally decreasing. It also incorporates the hypothesis of differentiation among destinations of the same type. For example, two urban parks are not considered perfect substitutes (otherwise the optimal individual behaviour that would derive would be to always visit only the nearest one). Besides not being in accordance to the actually observed behaviour (which instead indicates a general preference for variety even among destinations of the same type), it is worth to remember the basic theoretical attitude of the capability approach, which in grounded on the distinction between functionings and capabilities. To recall the distinction in question, a person's functionings are the set of her actual (observable) endowments and states of being (what the person has and is), while the capabilities are the set of all the possible functionings which are accessible to that person. All this has precise normative implications which have been incorporated in our choice of modelling the benefit: what we want to imply with eq. (1) is not so much that all the people, all the time, as a matter of their functionings, necessarily walk to all the available destinations, but rather that the availability of those destinations – intended as opportunities – is in itself a relevant fact as a matter of people's capabilities, and therefore of their quality of life.

[10] To determine the cheapest route, the system uses an efficient variant of the well-known Dijkstra search algorithm (1959). For implementation details, see Blečić *et al.* (2015a).

Resolving eq. (1) such that (2), the benefit is maximum when:

$$X_i = \frac{c_i^{\frac{1}{\rho-1}} M}{\sum_{j=1}^{n} c_j^{\frac{\rho}{\rho-1}}} \tag{5}$$

To arrive at the walkability score for an entire urban area, the procedure executed in WE is the following:

- determine all the least costly routes, in terms of eq. (3), between all the origin nodes and all the destination nodes;
- subsequently, compute the walkability score according to eqs. (1) and (5) for each origin node, using as routes the least costly ones towards all the available destinations;
- finally, given that the graph of the street network does not represent all the areas accessible to pedestrians, interpolate the walkability scores of nodes on a raster grid of a given resolution.[11]

AN EXAMPLE APPLICATION: HOW WALKABLE IS ALGHERO?

In what follows we present an experimental application on the city of Alghero.[12] The purpose in this article is to present the sources and the modes of data collection, to illustrate the basic procedures, but above all to show and discuss the main outputs and results that may be obtained with WE, from which emerge its characteristics proper of a decision and planning support system.

The graph of the street network and the green areas have been imported from Open Street Map project, while the location of the point destinations (commercial activities, services) has been automatically harvested from Bing Maps and Yellow Pages online services.

To account of the way in which we have attempted to capture the qualitative aspects of walkability, in Table 1 we report the attributes associated to every edge of the street network graph, and in Figure 1 we show an example illustration of a few attributes registered during the street survey campaign. The values of the attributes have been collected through direct observation of the streets between August and October 2014, *in situ* and using the panoramic photos available through Google Street View.

As one can observe from the attributes in Table 1, the analysis has been extended to many qualitative and detailed aspects of the urban environment, usually excluded from the studies on walkability. These are often determining aspects of the relation between the street environment and the behaviour of pedestrians, and regard elements and urban conditions which objectively and subjectively influence the choices and the attitudes of people in space. Some are requirements easy to observe, recognise and measure: cyclability (the possibility of bicycle riding on or along the road), number of car lanes, car speed limit, one-way streets, on-street parking, path slopes, paving quality and degree of maintenance, lighting.

Other attributes instead refer to conditions and combination of features which require an evaluative judgement by an attentive observer. So it is useful to briefly explain their meaning. The *width of the sidewalk or pedestrian area* is a qualitative evaluation of the effective possibility to walk without obstacles (physical or perceptive). The values range from wide sidewalk to complete lack of pedestrian space, and have been defined based on the number of individuals able to comfortably walk side by

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[11] The interpolation is carried out using the Inverse Distance Weighting method (Shepard 1968).

[12] The preliminary collection and processing of data was undertaken by Francesco Fancello for his graduation thesis "Walkability Explorer: uno strumento di aiuto alla decisione e progettazione dello spazio urbano orientato alla pedo-abilità", whom we wish to thank.

side. The attribute *shelter and shade* evaluates the possibility to take shelter given the physical configuration of urban space; it considers both environmental and architectural features that allow pedestrians to shelter from the rain, wind or sun. The attribute *separation of pedestrian route from car roadway* relates to the presence of physical or perceptual elements, horizontal or vertical, which increase pedestrians' safety and comfort (planting strips, raised planters, trees, stakes, walls, etc.) The *sedibility* evaluates the possibility to seat and linger along the walk, where seating opportunities include benches as well as other urban elements not specifically designed for this purpose but used by people to sit on (stairways, walls, fountain borders, etc.) *Urban texture* accounts for building density and typology ranging from dense continuous urban fabric with presence of urban park, squares or green spaces, to low density referred to scattered urban fabric, and to undeveloped land, terrain vague, abandoned or obsolete spaces, buildings and green open spaces. The *frequency of services and activities along the path* intends to capture aspects of security (related to the presence of people and storekeepers) as well as aspects of attractiveness resulting from a high density of activities, which is one of the most stressed aspects of walkability argued by numerous researchers (Cervero and Kockelman, 1997). *Transparency and permeability of urban space* (public and private) aims to describe if and how the urban environment stimulates interaction with the pedestrian, from complete integration, to the presence of filter spaces and transition obtained by architectonical and natural elements, to the separation with walls and fences. Finally, there are two attributes related to landscape aspects, *environmental* and *architectural and urban*, relevant for the pleasantness of the walk: the two attributes register a qualitative evaluative judgement related to the presence (more or less intense) of enjoyable or disturbing elements along the path and in the surroundings.

Attributes	*Weight*	*Scale values*
Width of sidewalk (accessible)	*2/30*	*wide (0.8); comfortable (0.7); minimum (0.5); inadequate (0.3); lacking (0.1)*
Cyclability	*2/30*	*exclusive lane (0.8); off-road lane (0.5); on.road lane (0.3); not possible/prohibited (0.1)*
Car speed limit	*2/30*	*pedestrian way (0.8); 20 Km/h (0.7); 30 Km/h (0.5); 50Km/h (0.3); 70 Km/h (0.1)*
Width of the roadway	*1/30*	*pedestrian way (0.8); one car lane (0.6); 2 car lanes (0.5); 3 car lanes (0.3); >3 car lane (0.1)*
One way street	*1/30*	*pedestrian way (0.8); yes (0.5); no (0.1)*
On-street parking	*1/30*	*prohibited parking (0.8); permitted (0.5); illegal parking (0.1)*
Paving (quality and degree of maintenance)	*2/30*	*fine (0.8); cheap (0.5); bumpy (0.1)*
Path slope	*2/30*	*smooth (0.8); light (0.5); rise (0.1)*
Lighting	*1/16*	*excellent (0.8); good (0.6); inadequate (0.3); lacking (0.1)*
Shelter and shade	*1/16*	*strong (0.8); weak (0.5); lacking (0.1)*
Separation of pedestrian route from car roadway	*2/30*	*marked/strong (0.8); weak (0.5); lacking (0.1)*
Sedibility	*1/16*	*extended (0.8); thin (0.5); lacking (0.1)*
Urban texture	*1/16*	*dense (0.8); park or green space (0.6); low density (0.4); undeveloped land (0.1)*
Frequency of services and activities	*1/16*	*abundant (0.8); somewhat (0.6); rare (0.3); no services/activities (0.1)*
Transparency and permeability of the public-private space	*1/16*	*integrated (0.8); filtered (0.5); separated (0.1)*
Attractiveness from an environmental point of view	*1/16*	*preponderance of pleasant elements (0.8); presence of a few pleasant elements (0.6); lack of pleasant or disturbance elements (0.4); presence of a few disturbance elements (0.2); preponderance of disturbance elements (0.1)*
Attractiveness from an architectural and urban viewpoint	*1/16*	*preponderance of pleasant elements (0.8); presence of a few pleasant elements (0.6); lack of pleasant or disturbance elements (0.4); presence of a few disturbance elements (0.2); preponderance of disturbance elements (0.1)*

Table 1 Attributes of the graph edges

Figure 1 Example of a few edge attributes whose values were collected through direct observation

We have in our example application subdivided the destinations in three categories: *commercial* (food shops, bars, butchers, bakeries, fish shop, supermarkets, tobacco shops), *services* (health services, schools, banks and public offices) and *leisure and green urban areas* (city parks, beaches, sport services). Is it important here to mention the possibility, and our choice, to distinguish different categories of destinations/urban opportunities and to separately calculate the walkability score in relation to each. To resort to an aggregated index would in fact risk losing precisely those distinctions useful for the decision support in accordance to the capability approach, which on the theoretical level imposes strong restrictions on the possibility of compensation of a deficit in one capability with another one.

The parameters of the model used by WE in the evaluation procedure are reported in Table 2.

Parameter	*Value*
EOS – elasticity of substitution among destinations $1/(1-\rho)$	2.5
Budget M	1000.0
Fixed cost c0	0.0
EOS among attributes $1/1-r)$	0.3
Dimension of the raster cells for interpolation [meters]	100.0

Table 2 Parameters used for the evaluation of Alghero

The starting input data are presented in Figure 2: the street network and the localisation of destinations taken into account for the calculation of walkability scores. Furthermore, the figure includes a first elaboration obtained with WE: the colours of the graph edges represent the unitary "costs" of the pedestrian routes, calculated using eq. (3) and the edge attributes (Table 1). Higher costs indicate lower quality/walkability of the route. This map thus shows the "intrinsic" walkability of the edges, and is, we believe, in itself filled with useful information to support planning and mobility policies.

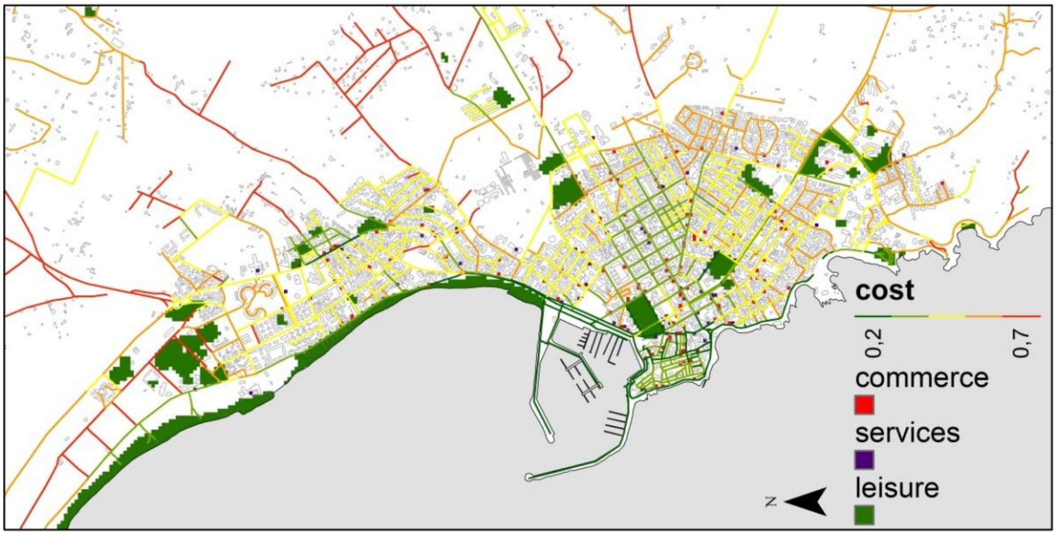

Figure 2 The street network (with costs of the pedestrian routes in terms of walkability) and the destinations taken into account in the evaluation

By combining the "costs" of graph edges and the available destinations, the WE software follows the evaluation model presented above to calculate the walkability score associated to each node of the graph[13], and once calculated, it executes the interpolation procedure to obtain a map of estimated distribution of walkability score in space. In Figure 3 we report these results for Alghero, for the three categories of destinations.

In interpreting these results, one must keep in mind how the walkability score has been constructed and what it represents. Again, the score associated to a point in space does not indicate how much it is in itself walkable (that is, how that specific point is attractive, pleasant, secure, etc. for walking). Rather, it *jointly* indicates how many destinations (the more the better), at what distance (the closer the better) and with that quality of the pedestrian route (the better the better), may be reached by foot from that point. A high score of a place stands for a wide availability of destinations, which are sufficiently close *can* be reached by foot in a comfortable, pleasant and secure way. Vice versa, a place obtains not a particularly high score either because there are few destinations, or because they are distant, or because the quality of the walk towards them is not high. Finally, a very low score indicates that all the three conditions are unfavourable.

At the city level, one can thus observe that the capability to walk towards commercial activities is better developed around the historical centre, while that related to the category of services is slightly removed from the centre with two peak areas. Differently, the walkability scores related to the green and recreational areas are more diffused and higher values are distributed externally, above all because they are influenced by numerous environmental attractors along the coastline.

[13] To reduce the time of execution, we have in WE implemented a procedure of parallel multi-thread computing, to take advantage of multi-core CPU computers.

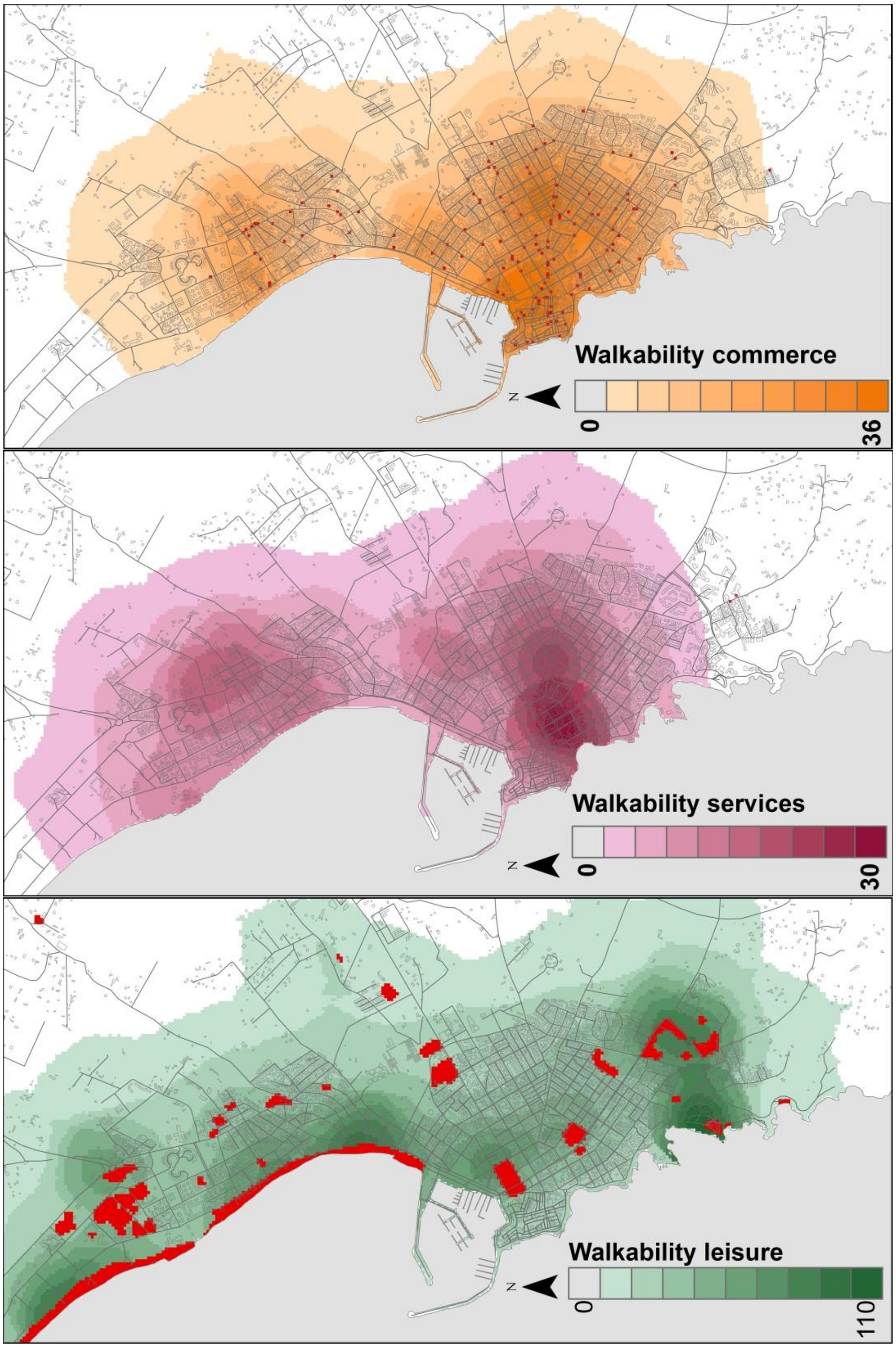

Figure 3 Alghero, walkability scores for the three categories of destinations: commercial, services and green and recreational areas (leisure).

These results can be submitted to further analysis related to the distribution of inhabitants in space. For that purpose, WE allows importing the data on the spatial distribution of the inhabitants, to be combined then with the walkability maps. In this manner it is possible to assign a walkability score not only to cells in space, but also to inhabitants residing in those cells. The graphs in Figure 4 represent the distribution of walkability scores among the approximately 35.000 inhabitants of Alghero, for each of the three categories of destinations.

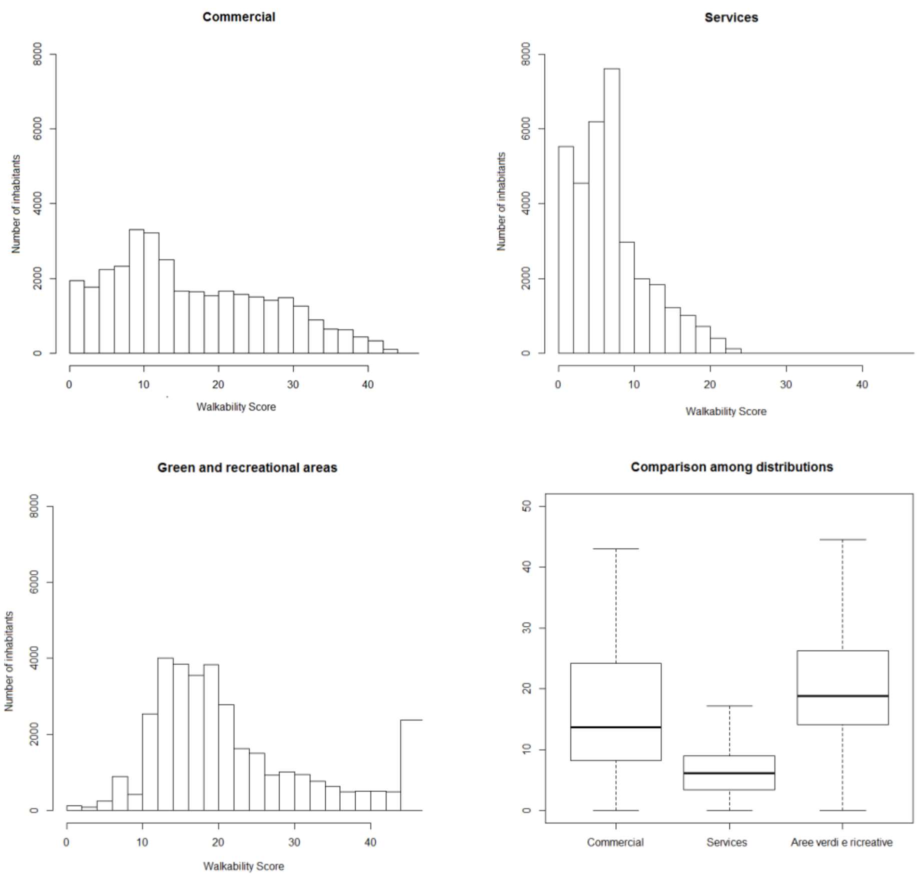

Figure 4 Distribution of walkability scores of the Alghero population's place of residence

The flexibility of WE is related to the possibility, very much in accordance with the capability approach, to take into account different attitudinal variable and different urban populations which may exhibit variable interest for destinations, and different walking propensity and behaviour. To satisfy analytical needs of this kind, the system allows to produce differential walkability evaluations, based on the profile of the pedestrian, for example on the basis of age, gender, disability or social group.

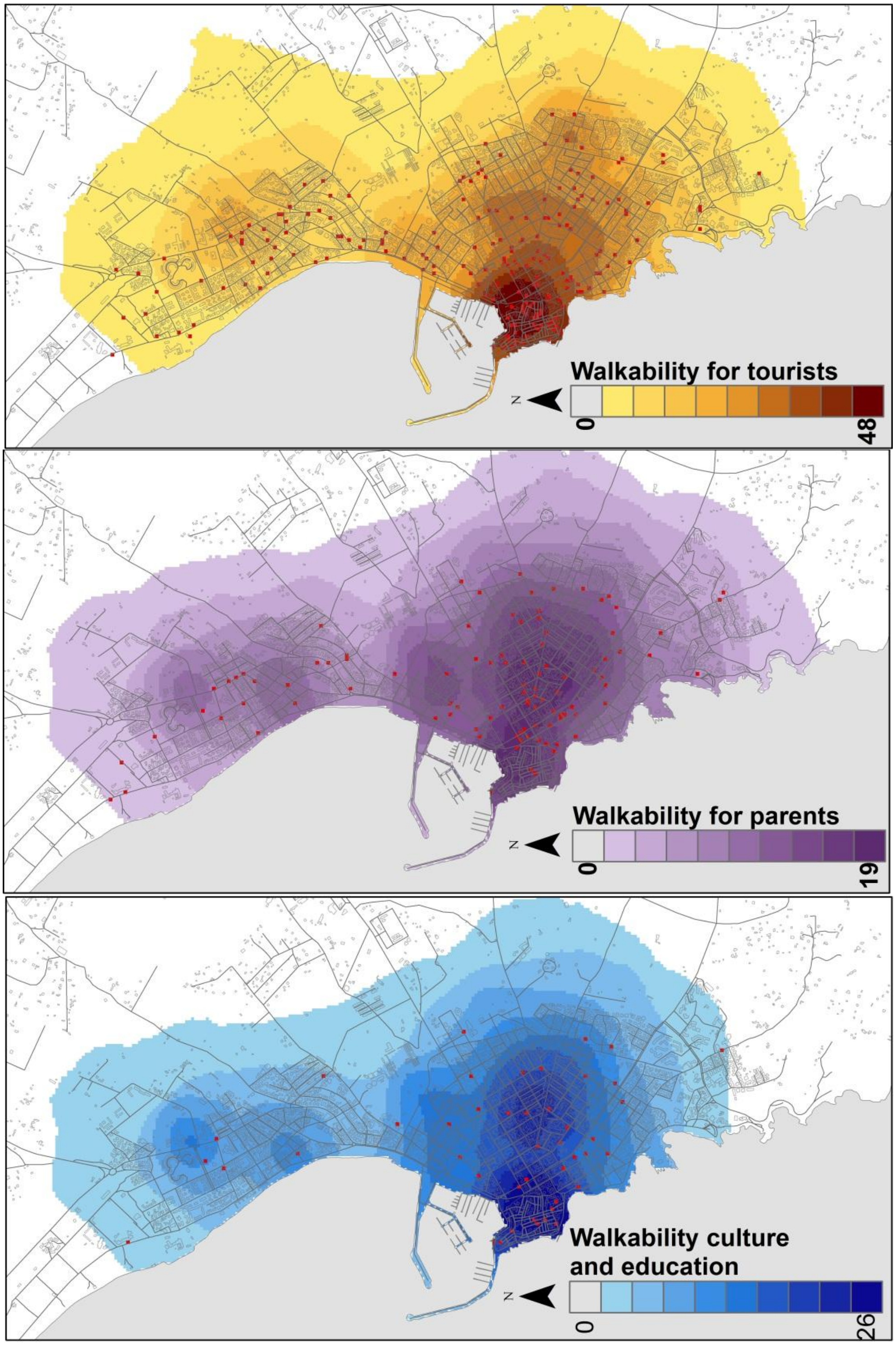

Figure 5 Walkability of three different bundles of destinations, in relation to profiles of users (tourists, parents and cultural and educational services)

This possibility passes through a different parametrisation and specialisation of the evaluation model, in terms of the weights of attributes, as well as in terms of the bundles of destinations relevant for the profile of users.

By way of example, we report in Figure 5 the walkability for three different bundles of destinations: (1) the first, centred on tourists (includes accommodation services, entertainment, bars and restaurants, commercial services of touristic interest); (2) the second, centred on the parents (includes elementary and secondary schools, supermarkets and food shops, markets, institutional services, banks and urban parks); and finally (3) the third, with cultural and educational services (includes theatres, libraries, cinemas, schools, universities, book shops, and other cultural institutions and services).

A further possible use of the tool as a decision support is to estimate the effects on future walkability of urban projects and street network improvements. The WE software is, in fact, capable of simultaneously importing the current and the future (project-based) street network, as well as hypotheses of alternative localisation of destinations, for the purpose of generating results with this kind of comparisons.

In Figure 6 we show the current situation and that estimated in the future following a project of requalification of an abandoned Cotton Mill into a cultural services, together with several interventions on the street network.[14]

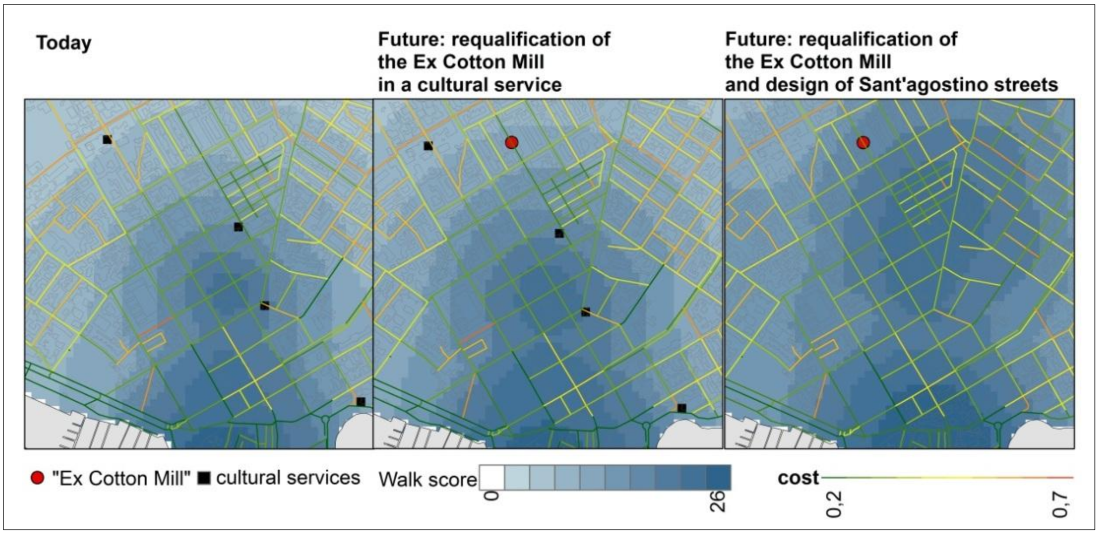

Figura 6 Comparison among the current walkability (left) ant that estimated following a project of a new cultural services (Ex Cotton Mill). Figure in the middle shows the walkability scores only due to the localisation of the new service, without interventions on the street network. The scenario on the right is instead calculated taking into account both the new cultural services and a series of measures on the street network and improvements of the pedestrian routes. In this last figure one can observe a reduction of costs for some graph edges, which determines a further general increase of the neighbourhood's walkability scores

[14] In particular, the localisation of the new cultural services is taken from a project under consideration of the current local administration in the Alghero's neighbourhood of Sant'Agostino. The improvements of the street network are taken from the measures presented for the new Urban Plan of Mobility. For an example of this kind of comparative evaluation on a wider urban scale, related to a project of urban requalification and re-design along the Lisbon's *Secunda Circular* (Second Ring Road), see Blečić *et. al.* (2015a).

In the figure, one can observe both the change of costs of pedestrian routes, as well as the changes of the overall walkability scores calculated for destinations of the type "cultural services". This shows a possibility of use of the WE tool which – by allowing to estimate the *joint* effects of improvements of the street network and of the changes of land uses and localisation of new destinations – may prove useful to aid decision makers in taking more effective and efficient design and planning decisions.

CONCLUSIONS

In this article we have argued that the capability approach, coupled with the analysis of the dimensions relevant for the pedestrian accessibility, represents a promising theoretical framework, which may be made operational for the evaluation of several aspects relevant for the quality of life in cities.

The urban capability to walk can, in our opinion, be considered a "fertile" capability, following the definition introduced by Wolff and De Shalit (2007) and recently revisited by Nussbaum (2011): a capability, that is, not only relevant in itself for its direct contribution to the individual well-being, but at the same time able to produce indirect benefits also in relation to other capabilities (for example, health, physical integrity, belonging, play, control of own environment, just to mention a few among ten fundamental capabilities defined by Nussbaum (2011)) and thus to the quality of life in general.

In this sense, we have presented a methodology and a tool, *Walkability Explorer* (WE), for decision and planning support centred on the capability of people to walk in the city. While discussing the results of a case study, we have pointed out the decision support characteristics of the tool, which reside in its capacity and flexibility to generate articulated spatial analysis and to operate comparisons between the current situation and the estimated effects of street network improvements and urban projects.

There is in this another promising perspective, to develop not only procedures for evaluating projects, but also for an automatic and assisted generation of design alternatives themselves. It is in fact possible to glimpse the possibility – once the user has set certain objectives and constraints – to have the system itself generate hypotheses of projects. Given that this problem presents a vast combinatory space of possible alternatives, it requires that specific search heuristics be devised, which is a stimulating, yet challenging task.[15]

To promote urban walkability, as it has been defined and treated in this article, means – in concrete, not only in theory – to contribute to a construction of a more just city, because it entails a rethinking of the city (in the first place of its streets) through spatial solutions which are attentive to individual specificities and in the same time capable of multiplying the possibility of use – also and foremost those non-planned and un-plannable – of the street as public space. This may become so if such solutions are defined taking into account the relationship different inhabitants entertain, or can choose to entertain (and – if one wants to couple our tool with some form of interaction with the inhabitants – affirm to want to entertain) with the space.

These are reasons to warrant and extend the urban capability of people to walk – in a wide sense of the term, which includes not only the capability to access, but also more in general to "use" the walked places – and to take it as an objective of policies and urban projects oriented towards the urban quality of life (Blečić *et al.*, 2013; Talu, 2013; Talu, 2014). But to promote the capability of people to move with autonomy and security is not only an end for architects and planners: walking and walkability can be used as tool to innovate the processes of evaluation and of construction of policies and projects,

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[15] For a first take on the problem of generative procedures in relation to the hereby presented model of walkability, see Blečić *et al.* (2015b).

improving their effectiveness and inclusiveness. For that, it is indispensable to develop methods for the construction of a analytical spatial knowledge in support of urban policies. The point is to go beyond the purely descriptive dimension. All in all, ours is an attempt to build an evaluative knowledge (Tsoukiàs *et al*, 2013) useful to guide and improve the effectiveness, relevance and inclusiveness of the urban design and planning processes.

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