Capability-wise walkability evaluation as an indicator of urban peripherality

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Abstract
Urban peripherality is a multidimensional phenomenon, requiring operational tools for analysis and policy design. In this paper, we explore if and how the concept of walkability can be employed as an indicator of peripherality. For this purpose, we employ the capability-wise walkability score (CAWS) to assess neighbourhoods of two case study cities to classify them into four classes (periphery, semi-periphery, semi-core, core). In comparing neighbourhoods on both walkability and a set of neighbourhood-level socioeconomic variables, we argue that walkability should be incorporated as part of a comprehensive framework for the analysis of processes of peripheralisation, since walkability should be seen as one relevant factor of urban capabilities, and hence the lack thereof fits into the definition of urban periphery.

Keywords
Walkability, peripherality indicators, capability approach, decision support systems, multi-criteria spatial evaluation

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Introduction

The issue of peripherality has been widely debated in urban studies and scholars concur on its controversial meaning and on the need for a multi-dimensional perspective (Hall et al., 2013; Herrschel, 2011; Kühn, 2015; Pezzi and Urso, 2017).

Both scholars and practitioners are indeed apt to attribute a multidimensional and complex character to the concept of urban periphery, making it having to do both with (1) the relationships an urban area entertains with the wider urban and metropolitan context and (2) its intrinsic social, demographic, economic and spatial features. Kuhn (2015) observes a relevant shift in spatial research from the notion of periphery in its more traditional spatial understanding, based on distances from a centre, to a more process-centred perspective expressed by the notion of peripheralisation. In such a perspective, scholars often treat peripheralisation, marginalisation and exclusion as interrelated concepts to describe the phenomena in peripheries (Wacquant and Howe, 2008), from different theoretical and methodological perspectives and on different spatial scales (Bernt and Colini, 2013; Hills et al., 2002). This, for instance, is the case clearly made in the collection of essays and research papers edited by Naumann and Fischer-Tahir (2013) on the social production of peripheries, where

> peripheries emerge and are shaped according to modes of living space in the sense of lifestyle, practices of inclusion and exclusion and ways of interpretation, signification and action based on individual and collective experience, as well as on social norms, values and rules. Peripheralisation refers to a spatially organized inequality of power relations and access to material and symbolic goods that constructs and perpetuates the precedence of the centres over areas that are marginalized.

Indeed, drawing on the work of several scholars (Kühn, 2015; Wacquant, 1999; Wacquant and Howe 2008), we may group features that make an urban area a 'periphery' into five dimensions: (1) economic polarisation (the centre-periphery relationship as determined by economic processes, technological developments and housing market) (Friedmann, 1973); (2) spatial inequalities (in terms of isolation, absence of services, mixed uses and accessibility to urban opportunities) (Talen and Anselin, 1998); (3) urban quality (in terms of concentration of urban decay, organisation and quality of infrastructures, public spaces and built environment) (Martens, 2012; Van Wee and Geurs, 2011); (4) social inequalities (marginalisation of particular social or ethnic groups, unemployment, disparity in education and social capital (Lucas, 2012; Rietveld et al., 2007); (5) political power (absence of political influence and being 'out of sight' of the policy-making processes) (Herrschel, 2011).

The question of peripheries and of peripheralisation is not only a matter of academic debate. It is a highly relevant issue for policy makers and planning practitioners who express a strong demand for meaningful evaluation methodologies of the peripherality of neighbourhoods and urban areas, as a guidance for urban policies and for the distribution of public investments in urban projects.

Since urban planners typically place their attention on the factors of urban environment that affect citizens' freedom to use and experience the city, we propose to consider *urban walkability* – the features of the built environment that make it useful, safe, comfortable and interesting to walk – as an enabling urban condition and a measurable concept that allows to detect signs of urban peripheralisation. To operationalise this proposal, we present a methodology and a tool for measuring urban walkability founded on the capability

approach, which we hold to be apt for identifying and describing conditions of urban marginality and their spatial factors.

Before going onto describing in greater detail our theoretical framework, the methodology and the case studies, it is important to clarify the scope of our proposal. In light of the previous considerations, we acknowledge the peripheralisation as a complex multidimensional process that generates spatial and social inequalities in the effective freedoms of individuals to exercise their 'right to the city'. So, while we claim that walkability – in the way we conceptualise and operationalise it in terms of capability approach – is normatively relevant for the definition of peripherality of an urban area, we do not want to claim it to be an exhaustive definition. Therefore, our proposition is more modest, to draw attention on the relevance of until recently a relatively neglected dimension of walkability in this context, and to propose an operational method for its treatment. As we will see from our discussion of the case studies, it is probably in analysing it in combination and interaction with other dimensions of marginalisation that yields insights most useful for urban planning, policy and design.

Finally, there could be another way in which walkability may be argued to be inadequate, off the mark, even inapplicable indicator of peripherality. Certain territorially diffused urban systems may be said to 'function as a city' on an extended domain of spatial and social interactions, although they do not necessarily possess the compactness, densities and proximities of a conventional urban form. Such argument is for example made by Indovina (2009) about the so called 'diffused cities', where social and economic interactions inevitably take place at larger distances and are less reliant on local, strictly proximal availability of services, activities and functions to be accessible by foot at the neighbourhood level. More in general, reflecting on new and aging suburban realities, Kirby and Modarres (2010a, 2010b) offer an alternative perspective to the simplistic, and somewhat paternalistic, vision of sub-urban developments as subaltern non-places, reminding us that suburbs have rich history demanding a deeper understanding and a better tailored research agenda. We are not dismissive of these arguments. However, while acknowledging the fruitfulness of such perspectives, we still want to normatively commit to define 'periphery' a place lacking the constitutive elements of urbanity within the proximal space (i.e. general urban quality, availability and accessibility by foot to multiple urban activities, services and relational opportunities, at the neighbourhood level).

The paper is organised as follows. In the next section we first briefly discuss how the capability approach may be adopted as a compelling theoretical framework to think about peripheralisation and more in general about urban quality of life. Next, we present the general methodology for the assessment of capability-wise walkability and how we propose to use it as a proxy of the condition of urban peripherality. Finally, as an empirical demonstration, we present the implementation and the findings from a comparative study of two cities in Sardinia, Italy: Sassari and Alghero.

Capability approach, urban quality of life and walkability

As argued elsewhere (Blečić et al., 2013; Cecchini et al., 2018; Talu, 2013, 2014), the capability approach, introduced by Amartya Sen (1992, 1993, 1999, 2009) and developed, among others, by Martha Nussbaum (2011), could be used as a valuable conceptual framework to investigate specific factors of the built environment which influence individuals' freedom to use the city.

The capability approach attaches central importance to the effective freedom people have to lead the kind of lives they value. It focuses on what people are able to do and to be in a

given context, namely on individual functionings (observable states of being, what a person actually is and does with what he/she has access to) and capabilities (the set of available functionings, that is, of valuable states of being and doing that a person has effective access to).

Using the capabilities perspective in urban studies implies that the presence of 'urban opportunities' (places, services, amenities) should be considered as instrumental to the achievement of the goal of extending capabilities: available urban opportunities have to be assessed in terms of their capacity of enabling each and every person to live a flourishing human life (Blečić et al., 2013; Talu, 2013).

Using the capabilities perspective implies the need to examine the relationships between the person and her/his social and physical environment, in order to identify – to discover and to pinpoint – the relevant urban obstacles that prevent people from using the city as a mean for pursuing their plans of life.

Following Belli (2006), by investigating the peripheralisation of an urban area in terms of its 'disabling effects' on people who live there, we are discovering the intrinsic disadvantage that the area entails. If an urban area should be considered more or less deprived, more or less peripherical with respect to the 'amount' and the 'intensity' of its disabling effects on people who live in it, then urban policies and projects aimed at improving the urban quality of life in periphery need to focus on the removal of such obstacles, the urban 'unfreedoms' (Samuels, 2005) that prevent people from using the city as an enabling environment.

Wolff and De-Shalit (2007) suggest that the task should be to find a way for de-clustering disadvantage, through the removal of corrosive disadvantages and the enhancement of fertile functionings. In this perspective, we propose to consider urban walkability not only as a relevant urban feature in itself, but also as a fertile functioning, and thus its deficit as a corrosive disadvantage.

In the debate on urban quality of life, the concept of walkability is receiving a growing interest among scholars (Blečić et al., 2015; Cervero and Duncan, 2003; Clifton et al., 2007; Forsyth et al., 2008; Livi and Clifton, 2004; Paez, 2013; Porta and Renne, 2005; Speck, 2012). The quality of urban environment and its capacity to embrace and promote pedestrian mobility influence how people perceive and use public space and the city in general. What the concept of walkability is able to capture is 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 (Ewing and Handy, 2009; Talen and Anselin, 1998; Talen and Koschinsky, 2013; Porta and Renne, 2005). In this sense, besides the mere presence of opportunities, places of interest and services, and besides their mere geographical distance, it becomes relevant if they can also be reached by foot, if the connective pedestrian routes are pleasant and spatially integrated with their surroundings, if they are brim-full of activities, if they are well maintained and perceived as safe, if they are not too surrendering to car traffic either by design or due to the predominant social practices.

Ultimately, to define the quality of urban life, it is important to consider also, perhaps above all, the relation between urban space and the effective possibility of inhabitants to 'use' it as a means to develop their well-being (Kaufmann et al., 2004).

Truth be told, the concept of walkability is not in itself particularly new. So, for example, Lynch (1960) already emphasised how the set of urban pathways, that is, the network of habitual and potential lines of movement within the urban structure, are 'the most potent means' to redesign the city. And Jane Jacobs (1961) offered vigorous and convincing arguments in favour of the need to promote an intense and diversified use of streets, centred on their use by the pedestrians.

Rather, what is new is the proliferation and refinement of attempts to operationalise the

concept by developing procedures of formal evaluation in order to consider walkability in a more rigorous way as a support tool for decision making, urban design and mobility planning (Capp and Maghelal, 2011; Saelens and Handy, 2008; 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 geo- data processing tools and computational techniques. The value of such tools resides in their capacity to more analytically examine and measure the interaction between the urban form and people's behaviours in space.

All pulled together, we argue that walkability – as operationalised through the capability-wise evaluation methodology we use in this study – should be understood as a relevant factor determining urban capability, and hence that the lack thereof is among the relevant factors of urban peripheralisation. In other words, since walkability is a fundamental enabling factor for the majority of people to appropriate their living environment, suitable walkability measures ought to be of assistance to identify the constraints the built environment poses on the exercise of human capabilities.

Research method

Figure 1 outlines the structure of the methodological stages of our research. The top part (1) of the figure summarises our discussion of the factors of peripheralisation, while the following parts illustrate the operational assessment method we employed in this study.

In particular, we employ (2) the capability-wise walkability score (CAWS) method to evaluate urban space on walkability-centred capabilities (related to three categories of urban opportunities: retail and commerce, leisure and recreation, and services), and then propose a classification of neighbourhoods based on those scores. These results are then further refined, discussed and confronted with other neighbourhood-level socio-economic indicators (4) for the purpose of a comparative reading of the studied neighbourhoods, also to suggest policy recommendations.

A capability-wise walkability evaluation method

As mentioned before, to evaluate and compare the peripherality of neighbourhoods in terms of their walkability-centred capabilities, we employ the CAWS evaluation model (Blečić et al., 2015).

The CAWS evaluation method is designed to score every point in urban space by aggregating three sets of factors into a single indicator: (1) the number and variety of destinations ('urban opportunities') reachable by foot from that place (point in urban space); (2) their distances; and (3) the quality of urban environment and pedestrian routes leading to these destinations. So, instead of indicating how much a specific place is in itself walkable given its intrinsic place-specific characteristics (which is featured in many other walkability evalua- tion methods and indicators, e.g. Carr et al., 2010; Frank et al., 2009; Krizek, 2003; Saelens et al., 2003), CAWS rather reflects where to and how a person can walk starting from that place; in other words, CAWS does not evaluate how walkable the place is, but rather what is the walkability the place is endowed with.

This conceptualisation of walkability provides the link with the capability approach and specifically with the idea of urban capabilities, given that it takes into account both the opportunity sets distributed in urban space, as well as the quality of urban environment (specifically how it is conducive to walking) relevant for the relation people may entertain with their urban environment.

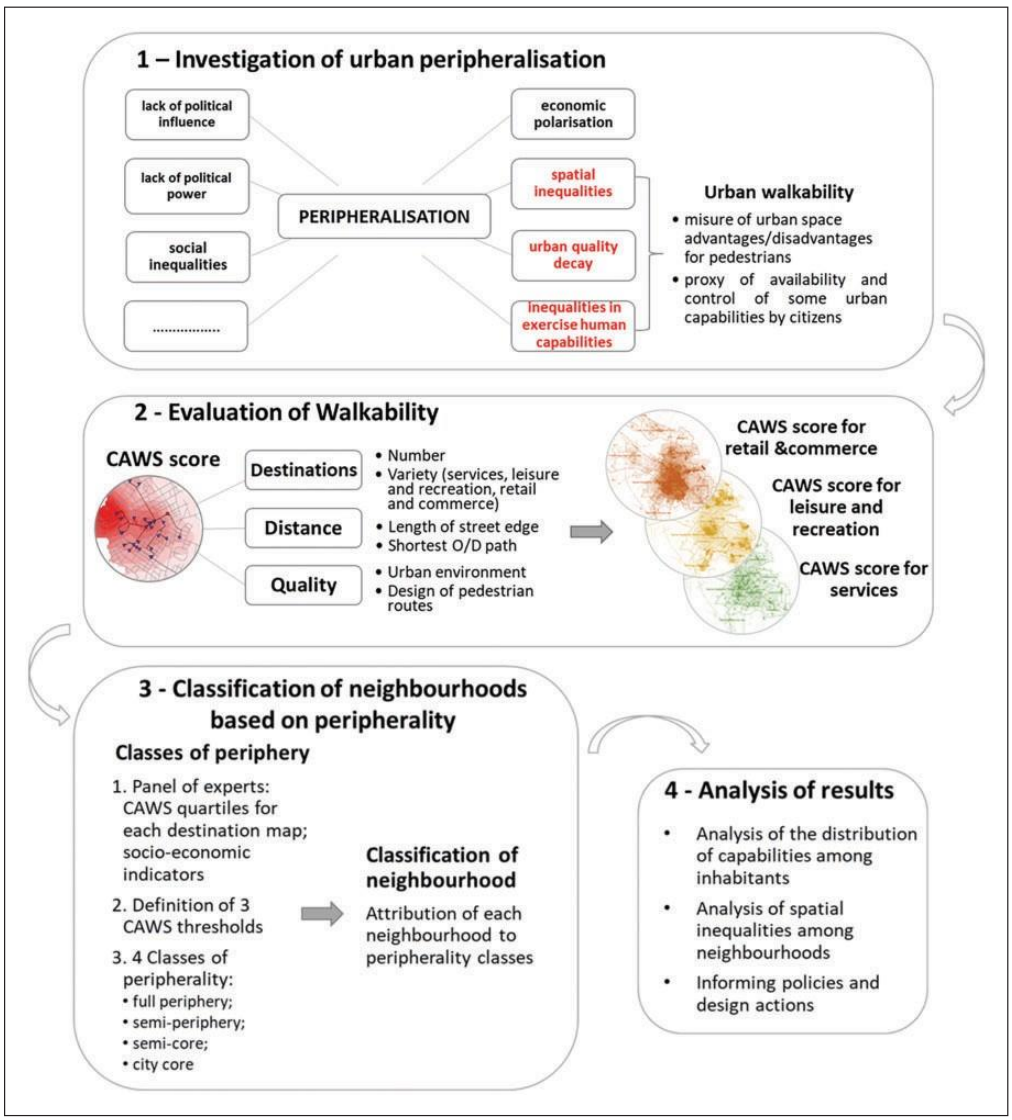

Figure 1. Methodological structure of the paper.

All the possible urban opportunities collected among a great variety of urban destinations were bundled into three different opportunity sets: (1) retail and commerce, (2) leisure and recreation and (3) urban services. This categorisation of urban opportunities allows us to compute the CAWS separately for each opportunity set and hence to obtain three distinct walkability scores for every point in space, one for each category of destinations.

To measure the spatial distances among places and destinations, the software Walkability Explorer, an implementation of the CAWS evaluation model, uses a detailed graph representation of the street network. To account for the quality of pedestrian routes and their surrounding environment, every edge of the street-network graph has been evaluated on several attributes related to both the features of the streets and the surrounding environment resulting relevant for making the urban space and pedestrian routes safe, pleasant and attractive (Figure A and Table A in online supplementary material). Some attributes are fairly straightforward to observe and measure: width of sidewalk, cyclability, number of car lanes, car speed limit, one-way streets, on-street parking, path slopes, paving quality and

maintenance, lighting. Other attributes, instead, refer to combination of urban design qualities which require an evaluative judgement by a trained observer: degree of separation of pedestrian route from car roadway, shelter and shade, sedibility, urban texture, frequency of services and activities, permeability of public–private space, environmental and architectural attractiveness.

The CAWS model combines the above-mentioned street attributes to calculate the 'walkability cost' of streets, indicating how walkable they are on a scale from 0 to 1 (see Figure B in online supplementary material). Using a path-finding algorithm over graphs, the model searches for all the destinations reachable by foot from each node in the graph, discounting the streets distances for the walkability cost. Next, taking into account both the number of destinations and their walkability-corrected distances, the model assigns a walkability score to each node of the graph. These scores are then interpolated to obtain a map of distribution of capability-wise walkability in space. Finally, we combine the distribution of CAWS in space with the census data to assign the score to the residential population at their place of residence. This allows us to represent the distribution of CAWS for inhabitants within neighbourhoods, for each of the three types of opportunity sets, and to analyse both the variability of urban capabilities among neighbourhoods, as well as among inhabitants within neighbourhoods. This more fine-grain analysis helps to identify neighbourhoods where the capability to access daily facilities by foot is homogeneously distributed between inhabitants or, vice versa, those where walking capability varies among different parts of the neighbourhoods. In the spirit of the capability approach, it allows to better focus on the 'distributional concerns' (Sen, 2009) and inequalities in urban capabilities on the local scale (for a more detailed and formal description of the CAWS methodology see Blečić et al., 2015).

Classification of neighbourhood peripherality based on capability-wise walkability

For descriptive purpose, we establish cut-offs in the average walkability score to designate neighbourhood degree of peripherality in terms of their deprivation of walkability-wise urban capabilities. Conceptually, we defined four classes of peripherality:

1. 'full periphery'
2. 'semi-periphery'
3. 'semi-core'
4. 'city core'

For the definition of the threshold value between classes, we engaged a panel of experts composed by a group of urban and transport planning scholars, practitioners, local stake-holders and administrators knowledgeable of the case study areas. Each expert was demanded to indicate the neighbourhoods of the two cities under study, Sassari and Alghero, and to select those in their opinion most representative of the qualities which mark the transition from one class of peripherality to another, specifically related to the combination of opportunity sets and the quality of urban environment. The chosen neighbourhoods served as reference profiles when assigning other neighbourhoods to the corresponding urban category.

Due to the different nature, distribution and densities of the three types of destinations (opportunity sets), the thresholds values from one to another class of peripherality have resulted differentiated per each of the three types of opportunity sets (e.g. the CAWS scores for retail and commercial activities are generally higher, being them usually more numerous, various and scattered around the urban fabric than is the case with urban services and leisure facilities which are less numerous but with larger range of influence).

Once the thresholds were defined, we were able to classify each neighbourhood based on the median CAWS value associated to the neighbourhood residential population.

Case study

As an empirical application of the methodology presented above, we applied the CAWS evaluation procedure on two different urban contexts located in the north-western Sardinia (Italy): the city of Alghero, a coastal town of about 40,000 inhabitants (which doubles-to-triples with the tourists during the summer season), and the city of Sassari, an administrative and tertiary urban centre of approximately 130,000 inhabitants. Compared with European and Italian urban settlements, Sassari and Alghero present the structural dimensions and functional organisation of medium-size urban centres (Tortorella, 2013). The two cities are part of a polycentric sub-regional system composed of medium-size towns with complementary services and resulting mutual interdependency. This fact makes the two urban contexts fairly comparable in terms of our reference profiles and related threshold values for the classification of neighbourhoods.

Our study focused on the constituent neighbourhoods of each town, which differ in size, period of construction, urban structure and socio-economic conditions. Neighbourhoods also differ in their relationship with the respective city centres, in the predominant urban activities as well as in the everyday practice of urban space.

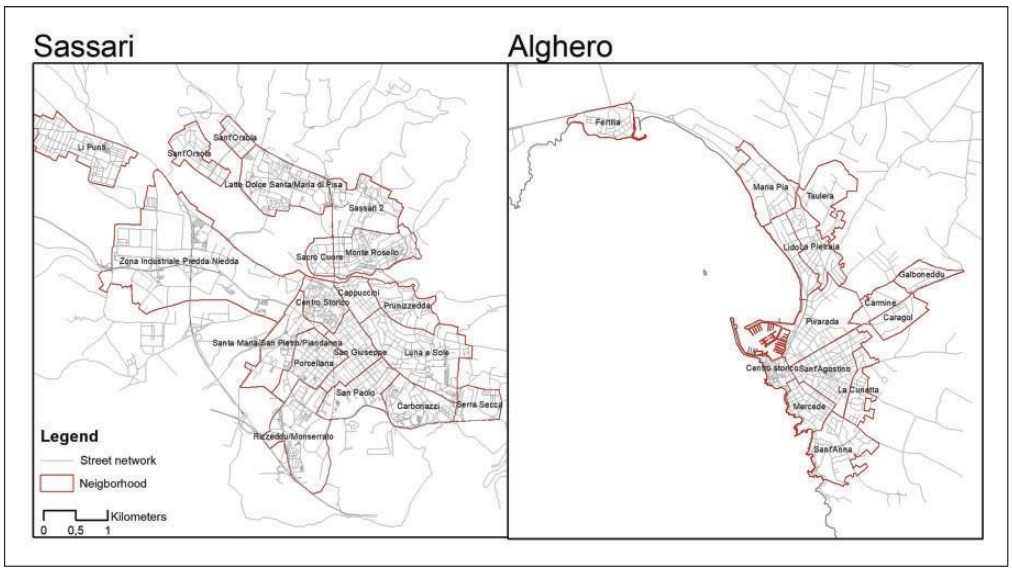

Figure 2. Maps of neighbourhoods of Alghero and Sassari.

Figure 2 shows the neighbourhoods of Alghero and Sassari delimited within red polygons. (For a more detailed description of each neighbourhood see Tables B and C in online supplementary material).

To feed the CAWS supporting software Walkability Explorer (WE), we took the street network graph from the Open Street Map repository; the localisation and types of destinations (urban opportunities) and services were harvested from online services, and the green and park areas were re-drawn from the available city maps. The centrepiece data – the scores of the walkability-related street attributes (see the section "A capability-wise walkability evaluation method") – have been collected by trained evaluators through direct observation of Google Street View imagery of streets.

As presented above (section "A capability-wise walkability evaluation method"), the WE software calculates the walkability cost for each street graph edge and then computes the CAWS for every point in space and for each destination category. The resulting maps are shown in Figure 3.

In interpreting these results, recall that the score associated to each point in space indicates on aggregate how many (the more the better), at what distance (the closer the better) and with what quality of pedestrian route and urban environment (the better the better) destinations may be reached by foot from that place. Therefore, a high score for a place indicates that there is a wide availability of destinations (urban opportunities) which are sufficiently close and can be walked to in a comfortable, pleasant and safe way. A place obtains an intermediate score either because there are few destinations, or because they are distant, or because the quality of the walk towards them is not adequate, or some combination of the three. Finally, a low score indicates that all three conditions are largely unfavourable, beginning from the lack of urban opportunities (for a more detailed exemplification of score values, see Figure C in online supplementary material).

As anticipated, the walkability maps in Figure 3 lend themselves to a classification of the neighbourhoods of Alghero and Sassari. With the support of the panel of experts, for each opportunity set we identified three neighbourhoods to be used as reference profile for the status of periphery, semi-periphery and semi-core respectively (Table 1). The median CAWS defined as thresholds between the classes are shown in Table 2. These thresholds are then used to classify neighbourhoods on the three opportunity sets (Table D in online supplementary material).

To give some examples, the neighbourhood of Sacro Cuore in Sassari was indicated by experts as the reference profile representative of the condition of threshold from semi-core to core on both retail and commerce and leisure and recreational destinations. Sacro Cuore is close to the core of Sassari, at a walking distance from a relatively large pool of services and amenities. It was built in the 1960s through a social housing planning initiative, with a regular grid pattern and predominance of residential use and basic equipment. The population is largely composed of elderly people (175 old people over 100 young) with a medium-low level of education living in buildings in relatively poor conditions, and unemployment rate of 19%, higher than the city average (17.7%). Accordingly, all neighbourhoods with a higher number and mix of retail and recreational destinations available by foot and with a better quality of pedestrian access (thus, having a higher median CAWS than Sacro Cuore) were classified as city core while the others fall within semi-core or a lower class. Similarly, the neighbourhood of Latte Dolce-S.M. di Pisa was given as reference profile of the condition of peripherality referred to commercial activities. This neighbourhood, built in the late 1970s, has predominantly public housing buildings with a limited variety of local shops and other commercial activities, low-income and ageing population, high unemployment rate and a relatively low level of education. Its distance from the city centre (4–5 km) together with a predominant car-oriented urban fabric were all indicative of a status of marginality and exclusion from urban opportunities.

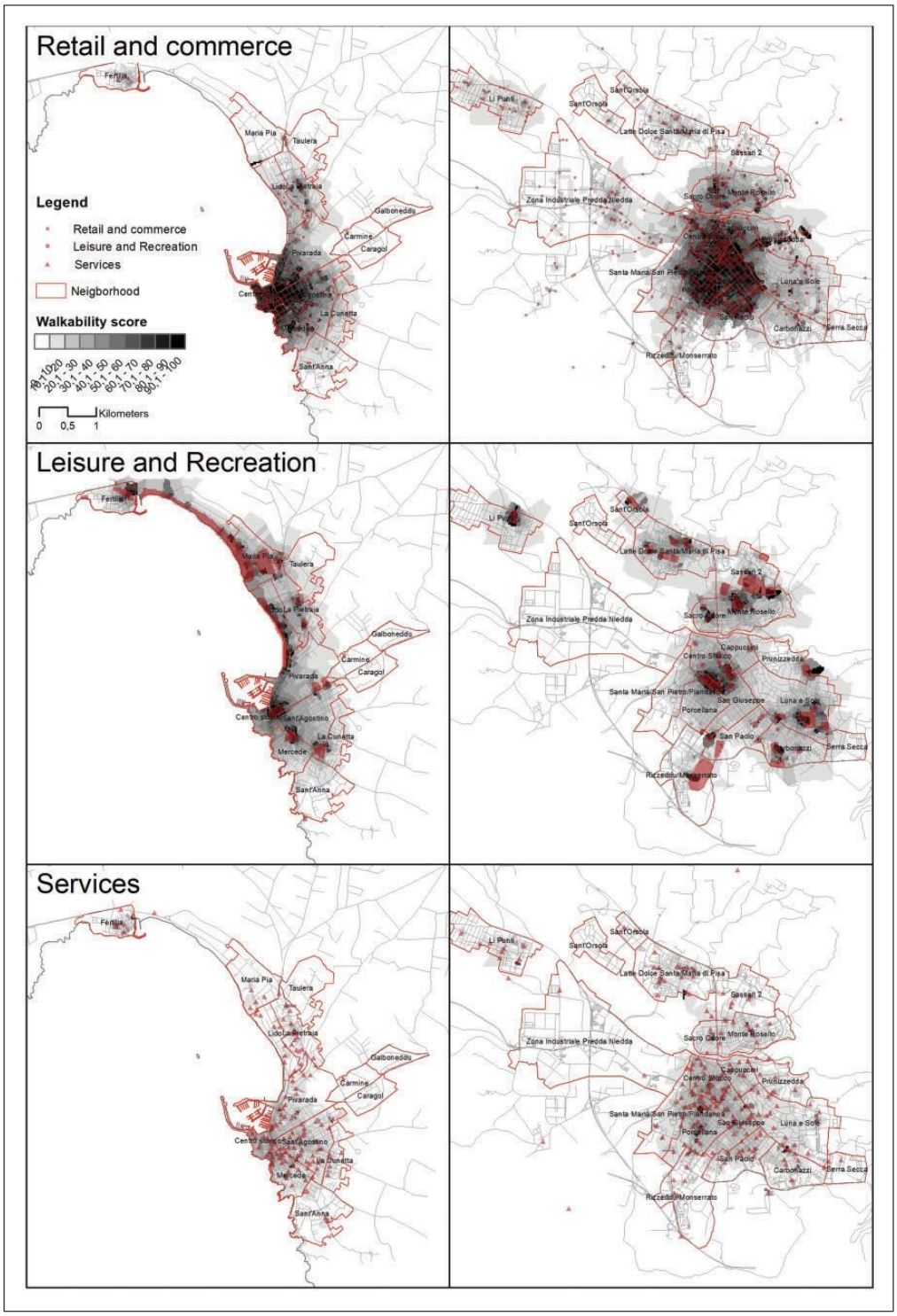

Figure 3. Walkability maps of Alghero (left column) and Sassari (right column) for the three different classes of urban opportunities.

Table 1. Reference profiles.

	Reference profile		
	Periphery	Semi-periphery	Semi-core
Retail and commerce	Latte Dolce – S.M. di Pisa (10.91)[a]	Prunizzedda (30.23)	Sacro Cuore (43.75)
Leisure and recreation	Li Punti (11.34)	San Paolo (21.8)	Sacro Cuore (31.7)
Urban services	Serra Secca (4.63)	Luna e Sole (10.84)	San Paolo (21.36)

[a]Values given in parenthesis denote median CAWS.

Table 2. Neighbourhood walkability score thresholds for each destination class.

		Class of peripherality (CAWS)			
		Periphery	Semi-periphery	Semi-core	City core
Class of destinations set	Retail and commerce	0 to <11	11 to <31	31 to <44	≥44
	Leisure and recreation	0 to <11.5	11.5 to <22	22 to <32	≥32
	Urban services	0 to <5	5 to <11	11 to <21.5	≥21.5

CAWS: capability-wise walkability score.

Discussion of results

The empirical results revealed patterns of inequalities in the pedestrian access to urban opportunities. In general, with some notable exceptions we will return on, both cities present (1) a clustering pattern with higher walkabilities and better socio-economic conditions within the compact urban fabric and (2) a spatial pattern with lower values of walkability and worse socio-spatial conditions in the surrounding car-oriented suburban areas. Observing the results in Figure 4, Alghero is overall better off on green and recreational facilities. This is only partly due to the presence of structured urban parks and sports facilities and instead greatly hinges on the landscape features such as beaches and seaside waterfront. In Sassari, a group of neighbourhoods with a relatively high scores would require a fairly limited set of adaptations and interventions to be classified as city core on all three opportunity sets. Indeed, Centro Storico (S1), Cappuccini (S2), San Giuseppe (S3), San Paolo (S4), Porcellana (S5), Santa Maria, San Pietro, Piandanna (S7) all scored as city core on retail and service facilities and as semi-core on leisure and recreation. Given their compact urban form and mutual proximity, it would seem relatively straightforward how they could be improved by providing better pedestrian connections and public spaces amelioration and maintenance to upgrade their status.

The rather heterogeneous and mixed socio-economic structure and conditions of many of these neighbourhoods (Table B in online supplementary material) could be seen as a favourable precondition for the enhancement of fertile functionings and the resulting urban capabilities.

Yet, as we mentioned, there are some notable exceptions which may be of interest for planners and decision makers. Centro Storico (S1), the old city centre of Sassari ranked core on semi-core on all opportunity sets, but having notably worse socio-economic conditions. So, it is a case of divergence between CAWS scores and non-geographic socio-economic variables, especially related to the clustering of disadvantage in the southern part of the neighbourhood

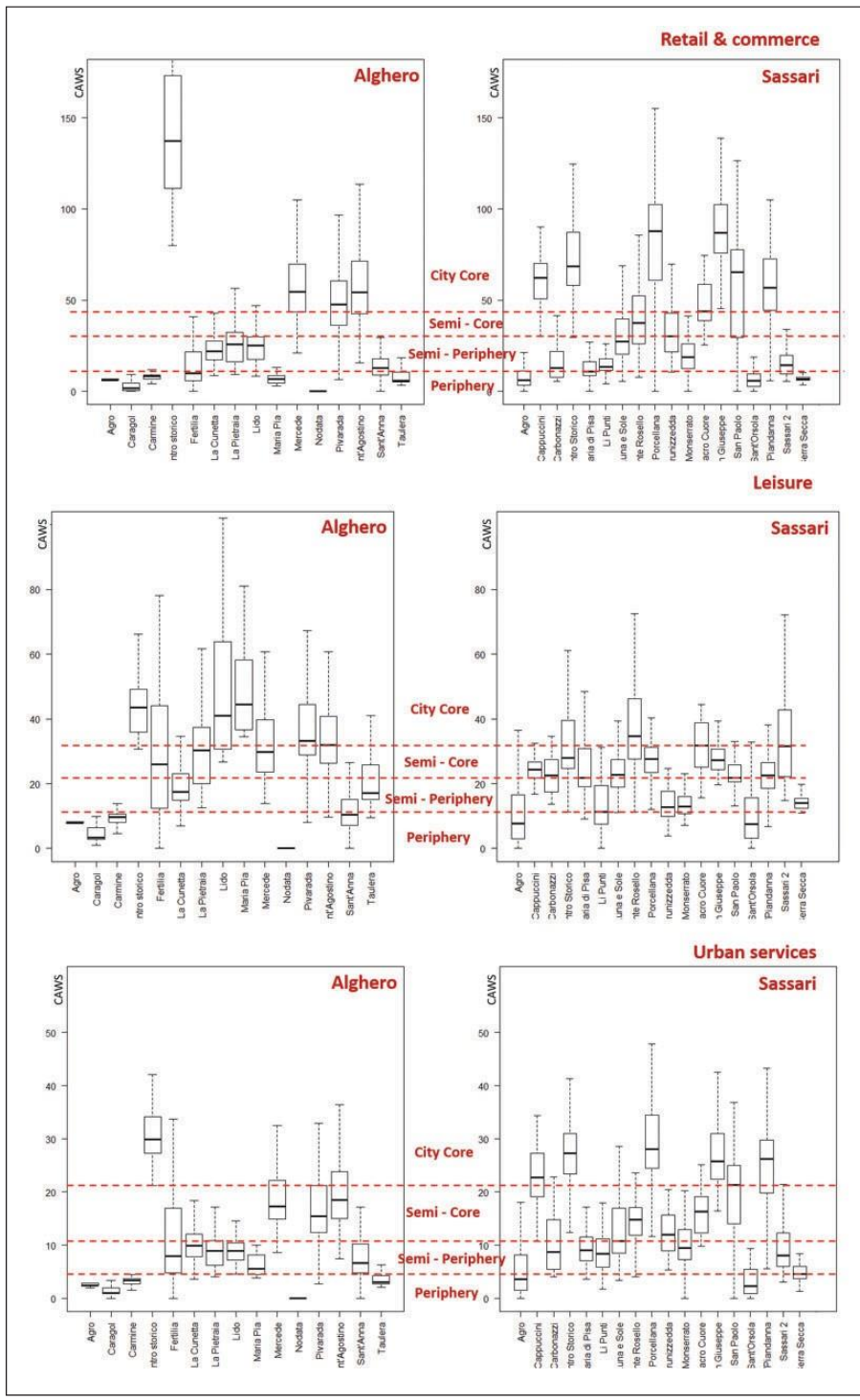

Figure 4. Distribution of CAWS among inhabitants.

(immigrants, low-income single person households, low education attainment; old and relatively decayed buildings). For the inhabitants of Centro Storico, the proximity to other neigh- bourhoods and a favourable walking environment seem to represent an important factor of urban quality of life and of economic and social participation in the city life.

Similarly, in Alghero the census data on the formerly low-income working class neighbourhood of Sant'Agostino (A2) ranked core and semi-core in all opportunity sets, show a prevalence of unemployment, high percentage of elderly people with low levels of education and limited economic resources living alone in old buildings. Although there are observable trends of improvements in the socio-economic conditions, mainly related to changes in the composition of the population, with new inhabitants attracted by the closeness to the city core and the availability of mixed functions.

These examples of divergence between CAWS scores and socio-economic indicators are notable in offering us the opportunity to reiterate a larger point on our overall approach. While we claim the capability-wise walkability – with its grounding in the capability approach (available opportunity sets) in relation to the spatial features (distances and the quality of the urban environment) – to be normatively relevant for the definition of peripherality of an urban area, we do not want to claim it to be an exhaustive definition. Its operational usefulness for urban policy and design resides precisely in the possibility to at least partially distinguish specific factors within a larger, unavoidably multidimensional, definition of urban peripherality. For instance, in our two last examples of neighbourhoods, while the CAWS analysis may in itself be helpful to pinpoint and fine-tune the strategies to improve the walkability-centred capabilities, the divergence we were talking about may hint there is also a favourable terrain for the phenomena of rent gap and gentrification pressures, suggesting the need for more comprehensive policy responses.

So, in general, rather than a bug, the possibility of such divergences should be seen as one of the features of our approach, which may prove operationally useful for supporting urban policy and design.

Moving away from the compact city, both towns present neighbourhoods with variable walkability but worsening spatial and social conditions (S.Maria di Pisa, Rizzeddu, S.Orsola, Serra Secca in Sassari and Carmine, Caragol, Taulera, S.Anna in Alghero). This is due to their larger distance from the central areas, their mono-functional character, paucity of activities and facilities or "bad reputation". Except for a few basic services and collective spaces, they are completely reliant on the centre and lack in attractivity for people from other districts.

In general, we found that low CAWS values correspond to disadvantaged socio-economic conditions and vice versa. In Sassari, an example of full marginalisation is given by the former working-class neighbourhoods of S. Maria di Pisa and Latte Dolce (S10). Far away from the city core and with a bad reputation due to socio-economic conditions, they present a limited availability and a difficult walking access to all three classes of destinations (ranking as periphery and semi-periphery). The semi-periphery ranking on leisure and recreation and on services reveals the recurring planning practice of providing disadvantaged areas with several and well-equipped public facilities, with the aim of enhancing attractiveness and overcoming segregation. However, the lack of coordination between projects, their location at the edge, the neglected state of public facilities discourages citizens to use them. These circumstances gave evidence that more integrated policies based on stronger links with the rest of the city, starting from walkable connections and public transport, could contribute to give these neighbourhoods a more central role in the metropolitan system.

In the eastern parts of Alghero, a condition of peripherality is experienced by the residents of Carmine (A3) and Caragol (A4).

Although somewhat different in social composition (A3 less well-off and A4 with mainly middle-class house-owner), they both have many common features of urban periphery: distance from the city core, lack of commercial activities and services, high dependence

on car mobility, poor quality of public space. The inhabitants of the two neighbourhoods are unable to reach the city core without owing a car due to an inefficient public transport system.

An opposite situation, tending to self-isolation, is given by some neighbourhoods on the city edges (Serra Secca (S16) and north S. Orsola (S15) in Sassari and S. Anna (A5) in Alghero, classified as periphery and semi-periphery on all three opportunity sets) which present the characters of middle- to high-income enclaves: the location at the city outskirts, the mono-functionality with a prevalence of upscale residences (well-maintained single houses with gardens or luxurious apartment buildings) inhabited by the local upper class (lowest level of unemployment, highest level of education) make these districts set apart from the rest of the city and car dependent for every basic need.

A similar process is traversing the old town of Alghero which has become too expensive but the wealthier. Driven by touristic development, the real estate market recorded a huge hike with the consequent expulsion of the lower-income inhabitants.

These general trends of both towns reflect the intrinsic complexity of peripheralisation thus requiring a deeper interdisciplinary approach. Some more specific results indicative of each city are available in online supplementary material.

Conclusions

The interpretation of peripherality discussed in this paper hinges on the presence of spatial and social inequalities in cities that undermine a realisation of human capabilities among inhabitants and consequently the participation to urban life. A capability-wise walkability assessment method combined with a socio-economical investigation at the neighbourhood level was proposed as an operational procedure to describe and explore this phenomenon and to identify some possible causes connected to the organisation of the urban environment.

The application of the CAWS method to two different cities produced a composite geography of urban capabilities, tangibly variable both in space and over different dimensions of opportunity sets. Such results, we believe, open up the perspective for a detailed ‘urban analytics’ supporting urban policy, planning and design. Its usefulness resides first of all in supporting the recognition of differences in the possibility of people to access urban opportunities based on the walkability of the built environment. Second, the concept of urban capability suggests a possible operative route for the integration within urban planning and policy of the information used for describing and evaluating the spatial component of the quality of life. The reference to urban capabilities in fact imposes the need not to consider relevant only the mere presence of urban services, but also on what use people are able (or unable) to make of these services; in other words, the need to address the actual possibility people have (or do not have) to use different urban services.

On this account, the CAWS evaluation model does not merely offer a measure of people’s urban capabilities; it allows to establish how and up to what point people’s overall capabilities (which also depend on many other a-spatial factors such as age, culture, social status, abilities, needs, preferences) are determined by eminently spatial and urban aspects, related to the way in which the city and the urban environment work. Due to its constitutive fine-grain analysis, CAWS does not represent only an evaluation method of neighbourhoods, but it offers practical cues for the design of more liveable environments.

Moreover, to satisfy analytical needs, the method allows producing differential walkability evaluations for different profiles of citizens, for example on the basis of age, gender, disability or social group.

This study has limitations: first, the collection of fine-grain spatial data used for walkability measurement is time and resource consuming and can represent a hindrance espe- cially during decision making processes. An advancement can be obtained by automatizing data gathering and walkability assessment using machine learning techniques

(Blečić et al., 2018). Also, certain socio-economic and demographic data can be difficult to obtain at a disaggregate level. At least in Italy, for example, many data such as household income data, health status of citizens or origin-destination trips are unavailable at the level of analysis smaller than the municipal scale, thus requiring ad hoc field surveys.

In conclusion, to promote pedestrian capabilities related to the quality of urban environment is to contribute to rethinking the 'public city', beginning from where already Jane Jacobs invited us to begin from: the streets, through spatial solutions and planning policies which are attentive to personal specificities and capable of multiplying the possibility of use of the street as public space. This may come to be so if such solutions are defined by taking into account the relationship different inhabitants entertain, or choose to entertain, with urban space. These are all 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, 2014).

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