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Exploring the 15-minute neighbourhoods. An evaluation based on the walkability performance to public facilities

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Abstract

Recent trends in urban policies are rediscovering a new focus on different urban life models that exclude the obsolete vehicle model and lead to renewed attention on the proximity dimension and active mobility. This vision takes concrete form in the concept of the *15-minute city* model, focused on pedestrian accessibility from one's home to nearby urban services and spaces. In this perspective, the paper aims at exploring the theme of 15-minute cities through a GIS-based model to evaluate pedestrian accessibility to neighbourhood facilities. The implemented methodology integrates the assessment of walking distances, considering the time factor as crucial, and mapping the resident population. The method is then applied to measure the current performances of an existing neighbourhood in Parma from the 15 minutes city perspective, assessing accessibility based on home-facility travel times and the resident population distribution within reach. A reflection is proposed on what has been learned and on the possible contribution that the method can bring to monitoring the 15-minute city and to urban planning.

Keywords: 15-minute neighbourhood; Pedestrian accessibility; GIS; Isochrones

1. Introduction

In recent years, shared programs (e.g., Urban Agenda 2030, EU Guidelines) have shown that one of the most critical challenges contemporary cities must face is enhancing proximity. Indeed, there is a heavy relation between the objective of improving sustainability and proximity. This challenge (and need) of the built environment have become even more evident in the context of the Covid-19 pandemic.

Interestingly, the emergency has introduced a new focus on different urban life models that excludes the obsolete

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vehicle model and tries to find a possible alternative to the commuter model. It has shown how generically ecological or exclusively technological solutions are no longer sufficient and how transport planning and active mobility must proceed with coherent urban planning. Specifically, the morphological and functional organisation of services must be rethought on the proximity dimension through a different neighbourhood unit's design based on well-defined quantitative and qualitative standards.

This vision takes concrete form in the so-called 15-minute city focused on the "pedestrian walkable distance" from one's home to nearby urban services and spaces. Exhortations on the issue are many and steadied in the academic field (e.g., Handy & Clifton, 2001; Bertolini et al., 2005). Also, the benefits induced are many and generally shared: the promotion of sustainability, the increase of sociality and inclusiveness (especially for disadvantaged groups), the improvement of psychophysical wellness (Weng et al., 2019; De Vos, 2020). This revival mostly concerns the recent pilot projects proposed in important European cities such as Milan, Paris and Barcelona. The schemes operate on modifying the urban public space favouring cycling, walking, and connecting effectively new and old public services and places. Therefore, the perspective is dual: on the one hand, urban planning, on the other transport planning. Nevertheless, many questions remain: have suitable methodological assumptions been established to detect the conditions in place to operate on the existing city? How is it possible to measure the 15 minutes city? Can such assessments become an opportunity for a general improvement of the urban layout organisation?

The paper investigates urban planning's role in favouring 15-minute cities at the neighbourhood scale by proposing a GIS-based method for evaluating pedestrian accessibility to public services at the proximity scale. The method is applied to the case study of a neighbourhood in Parma. The paper is organised as follows. Section 2 critically analyses the theme of urban accessibility from the neighbourhood unit model to the 15-minute city. Section 3 explains the GIS-based method to evaluate pedestrian accessibility to neighbourhood services and maps the resident population distribution/composition within reach. Section 4 presents the results of the method applied to the case study of the Cittadella district in Parma. Finally, Section 5 analyses the pros and cons of the method and provides a possible research agenda to the theme of 15-minute cities.

2. Urban accessibility: from the neighbourhood unit model to the 15-minute city

The concept of a 15-minute city is not new (Pozoukidou & Chatziyiannaki, 2021). Previous studies are several and can be divided into two main research themes: the concept of neighbourhood unit and accessibility.

Clarence Perry introduced the neighbourhood unit concept as an orderly urban structural unit as early as the 1920s. Indeed, the author highlighted how the neighbourhood unit is both part of a larger whole (the city) and a distinct entity in itself (a core). The proposed spatial scheme for the unit (Perry, 1929) already defined design standards that included dimensional factors (e.g., population density, 10% of recreation and park space) and functional amenities (e.g., shops, school, green areas, community centre). Next, in its traditional structure, Perry's scheme is strongly taken up by the New Urbanism (Calthorpe, 1993). The residential units are organically connected to the functional cores to minimise walking distances; moreover, the central area is characterised by mixed uses and varying densities within a few minutes of walking distance. The 15-minute cities model can be considered complementary also to the TOD's model or assimilable to the recent Slow cities' concept (Mezoued et al., 2021). Also, the Organic Urban Planning approach described in Italy by Columbo (1966), and the subsequent research on the Friendly City concept, also developed through the "Living and Walking in Cities" conferences, strongly recognises the role of pedestrian accessibility within the urban neighbourhood unit (Busi, 2011; Pezzagno & Tira, 2018).

Therefore, the issue of proximity is an old concept that has unfortunately acquired a new meaning due to the Covid-19 pandemic. Indeed, Carlos Moreno's proponent is indebted to the long-term debate on neighbourhood accessibility (Moreno et al., 2021; Handy & Clifton, 2001). Additionally, Moreno relates the concept of chrono-urbanism to a resilient, sustainable, and inclusive city *"where proximity is vibrant and where social intensity is real"*. Thus, applying objectives of Urban Agenda 2030 and following the recommendation of C40 Cities (2020) to bring activities within the neighbourhoods: decentralising core services with flexible uses, developing a social and functional mix, engaging people in urban planning processes, improving walking and cycling infrastructures.

In the perspective of the 15-minute city, many other authors have recently focused both on urban accessibility (Balletto et al., 2021; Da Silva et al., 2020; Tiboni et al., 2021) to assess the potential interaction between homes and destinations, residents and activities spatially distributed, and urban walkability (Weng et al., 2019; Ignaccolo et al., 2020; Campisi et al., 2020), providing indices to measure the performance of the pedestrian network and enhance active mobility. Several GIS models have been proposed as support tools, both on a vector or raster basis (Rossetti et al., 2020; Carpentieri et al., 2019; Mezoued et al., 2021), experimenting with survey methods, audit systems, and walkability indices, e.g., PEF, PEI (Weng et al., 2019; Ignaccolo et al., 2020; Campisi et al., 2020), etc. Despite the different techniques and indicators adopted, all the considerations over the 15-minute city introduce a fundamental temporal dimension. The time factor is frequently assessed using a buffer analysis (Da Silva, 2020), isochrone maps (Rossetti et al., 2020) or closest facility analysis (Zazzi et al., 2018). However, this type of analysis still seems in the background in the planning practice.

Within this framework, the paper presents a GIS-based methodology to measure the current performances of an existing neighbourhood of a medium-sized city from the 15 minutes city perspective, considering on the one hand the location of services and facilities, and on the other hand the population distribution.

3. A GIS-based methodology for the 15-minute neighbourhood

3.1. Evaluate pedestrian accessibility to neighbourhood services

In the proposed study, the 15-minute city theme is addressed with an analytical model designed and developed using GIS to assess existing conditions of accessibility to neighbourhood services for all the resident social groups. The methodology is applied to a peripheral area where pedestrian accessibility to proximity services is not generally preferred and therefore should be encouraged.

The GIS-based model has been implemented by improving and integrating a Territorial Information System (TIS) previously adopted to assess pedestrian accessibility to neighbourhood services (Zazzi et al., 2018; Rossetti et al., 2020). The original TIS, managed with the ArcGIS software, is based on a vector data structure and incorporates various layers - pedestrian paths, public services (schools, green areas), traffic areas, buildings, house numbers - implemented making use of open data and in-field inspections.

In particular, the pedestrian paths feature class, which is the TIS core dataset, has been generated as a link-node graph by detecting the actual pedestrian network. In the graph, all walking routes available on the public space have been mapped: pavements, crossing paths and walkways, especially those allowing users to walk across green areas. The network also comprises virtual pavements and virtual crossing paths, assuming that users, in the absence of a dedicated path or a marked crossing path, might choose to walk along road margins or cross in the proximity of road intersections.

The mapped links have then been associated with qualitative and quantitative attributes collected through a careful urban survey campaign. The data collected makes it possible to assess whether the routes can meet the needs of all possible users. Factors that can influence the quality of the walking experience have also been included, such as dimensional and morphological features, paving materials, safety measures, presence of attractive uses and functions and, above all, the time factor. In fact, for each link of the pedestrian network, a "cost" value, i.e., the ratio between the link length and pedestrian walking speed, estimated at 3 km/h, has been calculated. The National Research Council (2000) recommends a walking speed value of about 4-5 km/h. However, in urban areas with large numbers of older pedestrians (e.g., in Italian cities), it recommends a walking speed value of 1.0 m/s (about 3.5 km/h). Indeed, choosing a lower value allows a more inclusive approach to all road users, especially the most vulnerable ones.

The computing of the cost, expressed in minutes, also considers a "delay factor" (DF) at pedestrian crossings that is slightly different depending on whether crossings are signalised (with traffic light) or unsignalised (see table 1). In the absence of a traffic control device, the average pedestrian waiting time at intersections has been estimated between 20 and 30 seconds, while in the presence of a traffic light, the DF is estimated between 40 and 60 seconds, equal to the average signal cycle length (NACTO, 2016; FHWA, 2008; NCHRP, 2015; National Research Council, 2000). A wide literature reports detailed modelling studies on pedestrian crossing behaviour and pedestrian waiting times at intersections. However, in this contribution, simplified average values have been collected only from manuals, being sufficiently functional to evaluate the average travel times along pedestrian paths. Planning the enhancement of pedestrian accessibility to public services brings in issues of time and distance besides quality. That is why the "cost" value is a crucial attribute in the analysis.

Table 1. "Cost" value computing.

Pedestrian path typology	COST *[minutes]*

Pavements, Virtual pavements Walkways		Length *[km]* / 3 *[km/h]* * 60
Crossing Paths		Length *[km]* / 3 *[km/h]* * 60 + DF *[minutes]*
		where:
	→	Unsignalised pedestrian crossing DF = 0.4 *[minutes]*
	→	Signalised pedestrian crossing DF = 0.8 *[minutes]*

The model has been first applied to the northern portion of the Cittadella district, a predominantly residential area of about 1.38 km^2 in the first outskirts of the medium-sized city of Parma.

Data processing with ArcGIS Network Analyst tools produced different simulations, mapping walking times and the quality of pedestrian accessibility to proximity services. In particular, the model pilot application produced, firstly, a pedestrian isochrone map considering a selection of public schools (middle schools) and walking distances of 3, 5 and 10 minutes; secondly, the closest facility map, considering the same public facilities and mapping all the fastest home-service routes starting from each house number, thirdly, the evaluation of the quality of the fastest routes, identifying possible criticalities.

The improved model also maps the detailed distribution of the resident population and identifies the main neighbourhood cores, i.e. urban nodes well served by necessities shops and services, such as supermarkets, grocery stores, bars, drugstores, and banks. Specifically, the improved study application focuses on preschool facilities (kindergartens) and these newly mapped neighbourhood cores (Figure 1).

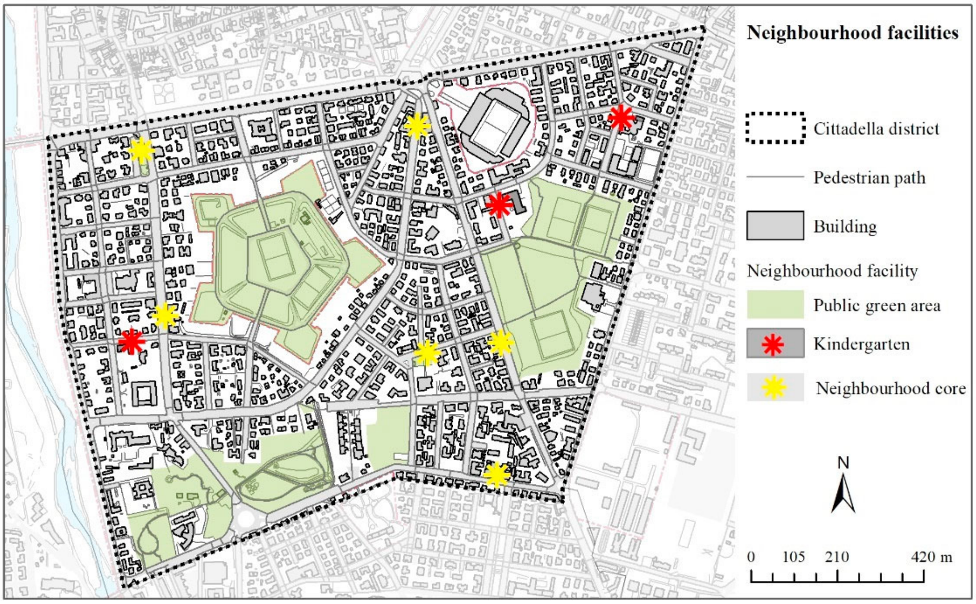

Fig. 1. Analysed neighbourhood facilities: kindergartens and neighbourhood cores.

3.2. *Integrating the methodology by mapping the resident population distribution/composition*

To assess accessibility within the 15-minute neighbourhood, it is essential to define the sources, the origins of the mobility need, which for a neighbourhood service are represented by the population distribution. The official census provides population data aggregated per census tracts, which within cities often coincide with urban blocks or even with entire neighbourhoods. Those data are very useful to assess accessibility at city scale or for wider/regional areas. However, they may be not detailed enough to describe accessibility to neighbourhoods' services and facilities. Therefore, a detailed spatial distribution map of the population can be defined to describe exactly how inhabitants are distributed within the neighbourhood. For the Cittadella case study, we located inhabitants through a georeferencing process of the demographic registry of the Municipality of Parma, as described in figure 2.

Fig. 2. Procedure to map the population distribution, starting from the municipal register database and the shape file of civic numbers.

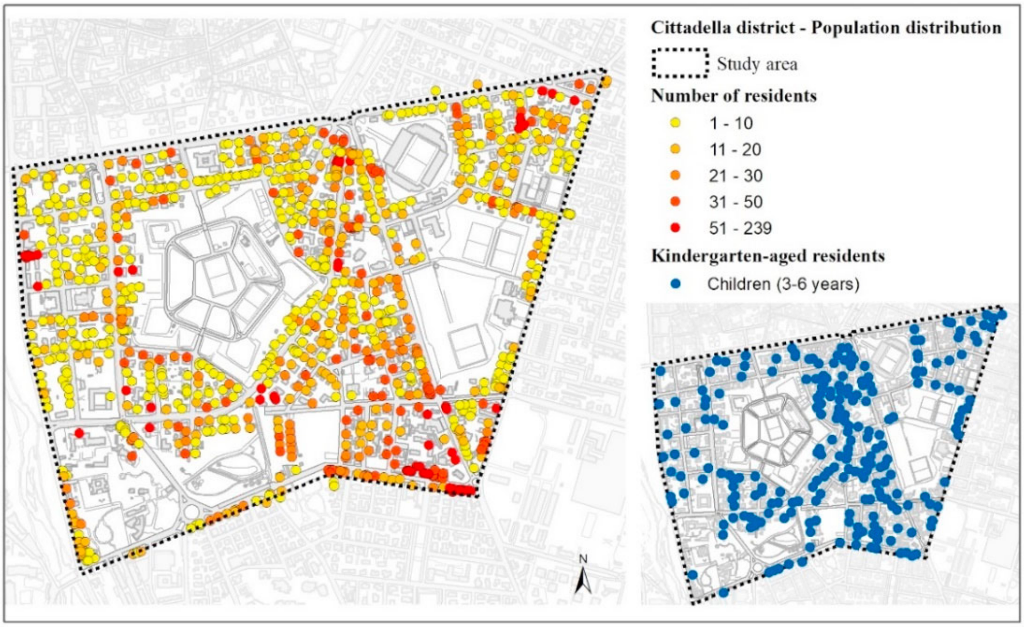

Fig. 3. Population distribution in Cittadella District: examples of elaborations based on the georeferenced inhabitants.

The result of this georeferencing process can be mapped through a set of punctual elements (Fig. 3). In correspondence with each house number, many points correspond to the inhabitants associated with that house number. In the attribute table, each point is associated with all the information available in the registry for each inhabitant (e.g., gender, age, date of birth, etc.).

4. Accessibility assessment in the Cittadella district in Parma

4.1. Isochrones map for assessing accessibility based on walking times

The accessibility assessment in the case study of the Cittadella district has been carried out processing data to determine the catchment areas of selected collective facilities in the neighbourhood through the Service Area analysis, an ArcGIS Network Analyst tool. Two isochrone maps have then been produced, identifying kindergartens and neighbourhood cores as the main locations, computing the "cost" value per each link in the pedestrian network, and choosing three benchmark values for travel times: 5, 10 and 15 minutes. Therefore, each network-based Service Area includes all pedestrian links that can be reached within a 5, 10 and 15-minute walk from chosen facilities, also considering probable slowdowns caused by street crossing.

Results show that from most of the residences, it is possible to access the kindergartens and neighbourhood cores within 15 minutes on foot (Figures 4 and 5). Furthermore, the analysis does not consider kindergartens and neighbourhood cores located outside the analysed area in the surrounding neighbourhoods but may efficiently serve Cittadella's inhabitants.

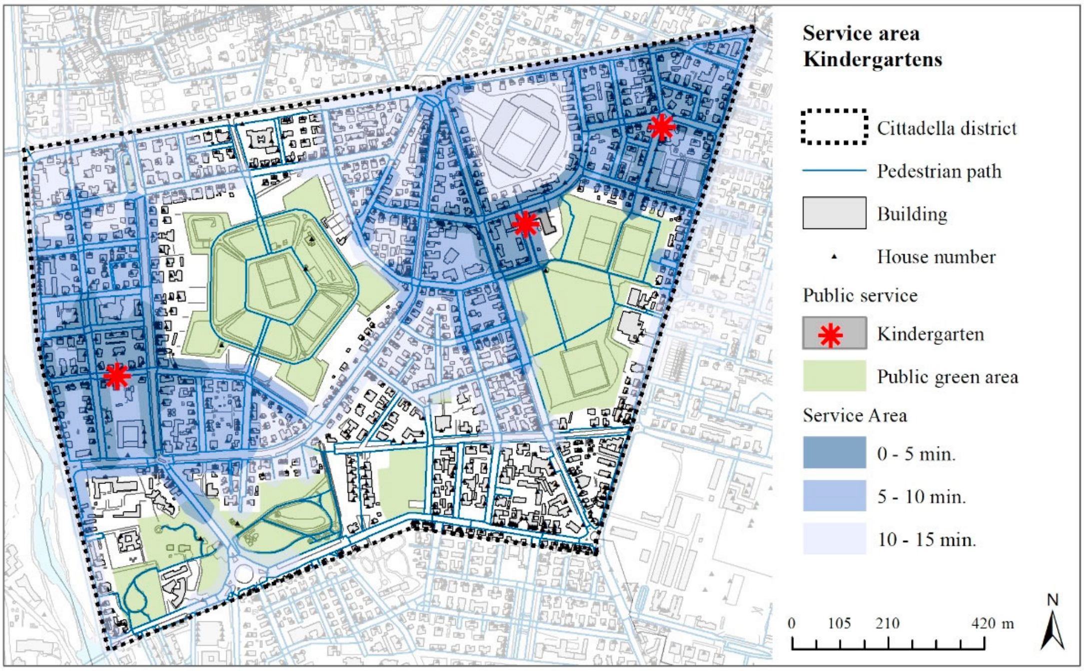

Fig. 4. Service Area isochrone map concerning preschool facilities (kindergartens).

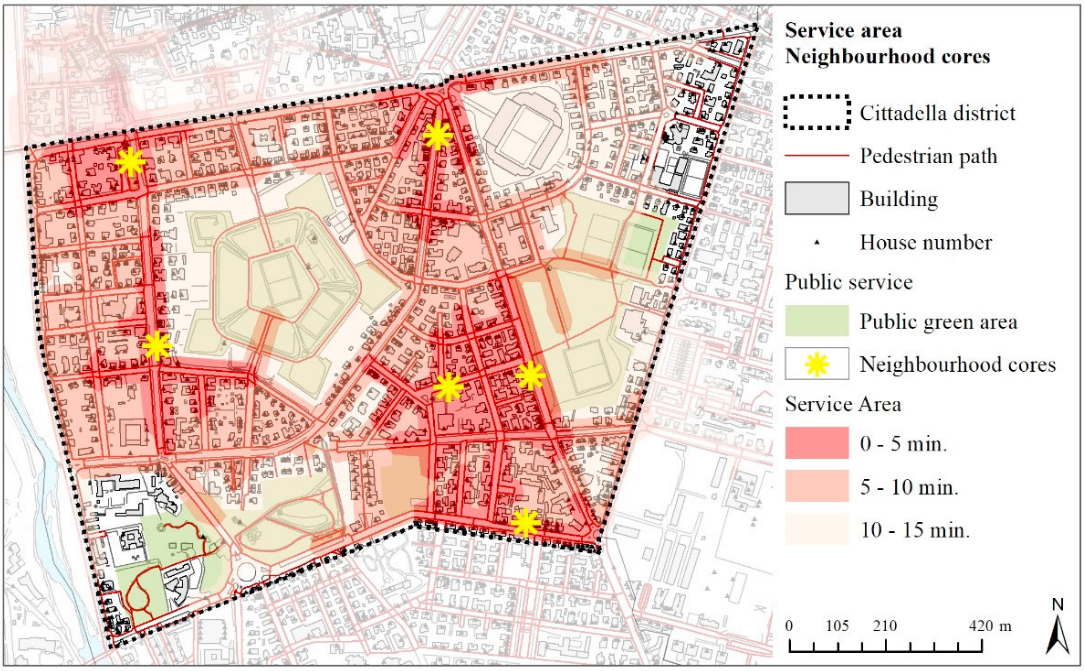

Fig. 5. Service Area isochrone map concerning neighbourhood cores.

4.2. Population distribution within the 5, 10 and 15-minute walking distance from the analysed facilities

The following table (Tab. 2) shows the inhabitants distribution considering the distance from the analysed facilities located within the neighbourhood. Concerning kindergartens, it emerges that more than 70% of Cittadella's inhabitants have access to a kindergarten located in the same district within walking distance of 15 minutes. The percentage of inhabitants within walking distance from the neighbourhood cores with shops and facilities is even higher (up to 91% of the total), but of course there is a need to distinguish among the different types of shops and facilities to which access is needed.

Table 2. Inhabitants within walking distances from kindergartens and within walking distances from neighbourhood shops and facilities

		Inh. within walking distance from kindergarten					
	Total	5 min		10 min		15 min	
	nr.	nr.	%	nr.	%	nr.	%
Number of inhabitants	10,692	1,509	14%	4,830	45%	7,553	71%
Number of kindergarten-aged inhabitants (3-6 years)	352	48	14%	184	52%	261	74%
		Inh. within walking distance from neighbourhood cores					
	Total	5 min		10 min		15 min	
	nr.	nr.	%	nr.	%	nr.	%
Number of inhabitants	10,692	3,678	34%	8,111	76%	9,736	91%

5. Discussion and Conclusive remarks

Within the framework of the 15-minute city, the paper proposes a methodology to assess the pedestrian accessibility at the neighbourhood level, starting from the creation of detailed isochrones around basic neighbourhood services and facilities (in the case of this paper kindergartens and neighbourhood cores) and looking at the population distribution within the neighbourhood through a georeferencing process of its inhabitants.

Cities that, also looking at the post-pandemic emergencies, wants to return to more compact dimensions and to enhance proximity and walking, should encourage pedestrian mobility at the neighbourhood level, necessarily starting from understanding the daily needs of its inhabitants and ensuring them adequate conditions to easily and safely reach the various possible destinations they wish to engage with. The analytical model designed and developed using a Geographic Information System can support and facilitate the decision-making process by recognising and assessing the current walking accessibility levels within the neighbourhood and developing appropriate simulations designed to prefigure possible interventions on the public space.

The outcomes of this analytical approach stress the dependence on a widespread localisation of neighbourhood services and facilities. Therefore, it is clear that to achieve the 15-minute city, transport and slow mobility infrastructure planning must fully intertwine with more coherent urban plans and policies, based on a detailed functional organisation of the urban activities and a widespread location of services within the urban neighbourhood unit. The applied 15-minute isochrone represents a benchmark value that, of course, can be re-assessed in the decision-making process, also looking at a widespread offer of services and facilities.

Further developments of the presented work may compute the isochrones of a wider range of services and facilities, including amenities located outside the analysed area but in close proximity, e.g. in the surrounding neighbourhoods.

The analytical model, which can be further improved considering further services and facilities, can therefore represent a support in future public actions, especially in the operational processes of planning intervention priorities to enhance the pedestrian infrastructure and the facilities distribution. Ensuring the best possible accessibility conditions, in particular, to public services and facilities becomes an essential aspect, on the basis of a more complex process of encouraging walking, towards a more resilient city capable of really rethinking itself ' beyond the car '.

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