

From mobility to accessibility by proximity: an Inclusive Accessibility by Proximity Index (IAPI)

Research group:
Paola Pucci, Luigi Carboni, Giovanni Lanza

Accessibility by proximity

The need to reduce the environmental costs of automobile traffic and make cities **more sustainable, inclusive, safe** and **resilient** has been a goal on the policy agendas of several cities around the world, even since before the outbreak of the Covid-19 Pandemic.

This policy goals are inspired by the concept of "**accessibility by proximity**" which concerns the provision of a **diverse set of neighborhood services** that can be **accessed through active mobility forms** (mainly walking and cycling), as well as the presence of **widespread and efficient digital networks** that enable remote working/ learning, telemedicine, and access to goods and services available online (Moreno, 2021).

Thus, the X-minute city model represents an operative approach to promote accessibility by proximity.



Source: Moreno et al., 2021

Recent interest in urban policies toward measures to ensure accessibility by proximity can be traced within a theoretical framework that has long recognized the role that **accessibility** plays as:

- A condition that enables **each individual's participation** in social opportunities and networks
 - An indicator of the ability to take part in the economic, political and social life of the community in relation to the **availability of transportation systems, the quality and distribution of spatial opportunities, and on the basis of each person's own skills and capabilities to move**, which depend on individual characteristics, as well as contextual constraints and opportunities.
 - From a **normative perspective**, as an assessment tool to target **integrated transportation planning and land use measures** selectively prioritizing people and socio-settlement contexts that directly experience limited mobility and access opportunities.
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As this research deepens, the implementation of accessibility by proximity-inspired policies require disposing of extensive knowledge of the current levels of accessibility to be built using appropriate diagnostic tools focusing on three main issues:

- 1) **Inclusivity.** In the view of envisioning a diffused accessibility by proximity, these tools should be able to identify inequalities in spatial accessibility by assessing the effect of the spatial and social characteristics of the context that may (not) favor active mobility for local social groups with different capabilities and attitudes;

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 - 2) **Essentiality of services and activities.** These instruments should consider what services and opportunities should be equitably distributed and offered in proximity to meet the different needs of different social groups while avoiding reproducing existing inequalities;
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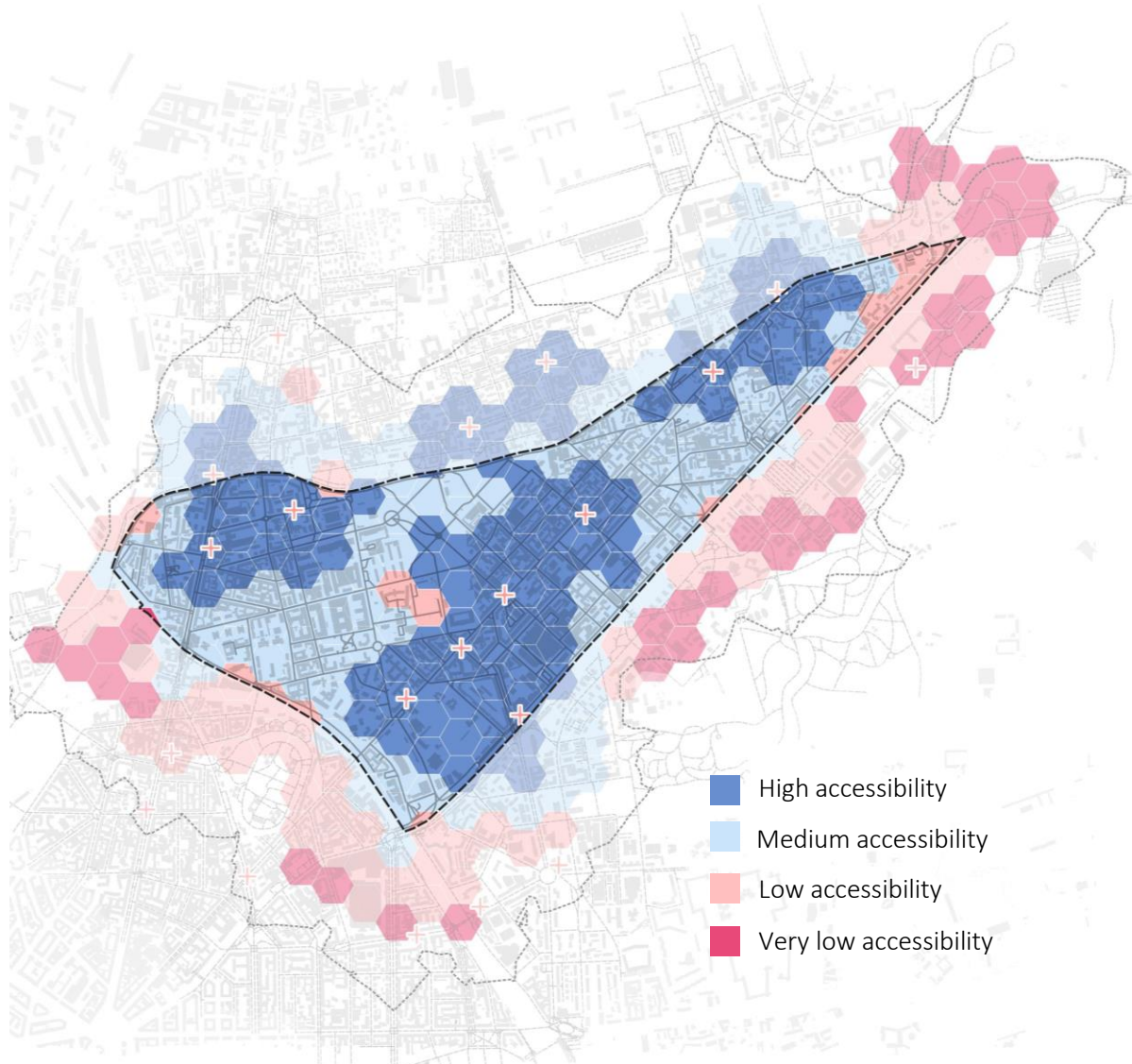
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 - 2) **Essentiality of services and activities.** These instruments should consider what services and opportunities should be equitably distributed and offered in proximity to meet the different needs of different social groups while avoiding reproducing existing inequalities;
 - 3) **Detail, legibility, and usefulness of the measurement.** At the same time, tools should be designed using very detailed spatial information - including subjective data about active mobility users' perceptions and behaviors - but also easily implementable, legible - in terms of obtained results - and easy-to-transfer to multiple cases while ensuring a good level of customization by target users (primarily policy makers and planning practitioners, but potentially also local community groups and citizens) to increase their context sensitivity.
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EXPERIMENTING WITH CITY STREETS TO TRANSFORM URBAN MOBILITY

Across Europe, cities are trying to radically reduce their reliance on car-based mobility in order to address sustainability challenges. Two things are lacking in these efforts towards a 'post-car' city: a proactive vision of cities that are both sustainable and accessible without cars, and effective strategies to deal with systematic resistance to change. The aim of EX-TRA is to address these shortcomings.

What is the IAPI?



IAPI (Inclusive Accessibility by Proximity Index) is a **GIS-based accessibility assessment tool** developed within the EX-TRA project.

IAPI represents a quantitative criterion for **measuring and visualizing** accessibility levels by **active mobility** to **essential daily services**. Its policy-related uses include:

- 1) Assessing neighborhood-scale accessibility based on both the conditions of public space favoring/disfavoring walkability, cyclability, and social interactions.
- 2) Identifying **disadvantaged areas** of a neighborhood in terms of access to basic services and opportunities.
- 3) Guiding the construction of **measures on the public spaces, streetscape, and the distribution of welfare services** aimed at improving walkability, cyclability

IAPI introduces three innovative features:

1) It measures accessibility considering objective and subjective walkability and cyclability factors at a high level of spatial detail.

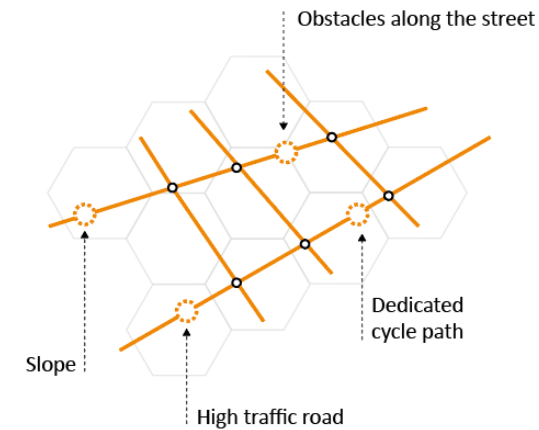
This is allowed by the extensive use of open data to build active mobility indicators to quantify and map the influence of spatial factors on the easiness of moving and accessing by walking and cycling inside the study area.

IAPI considers two types of indicators:

Network indicators.

They are **mapped on each arc of the network** and describe the **technical performances of the streets and the interaction with car traffic.**

Category	Indicator	Aim
1. Paths' technical performance	1.1 Pedestrian friendliness	Describing how much a route explicitly encourages pedestrian transit
	1.2 Cyclist friendliness	Describing how much a route explicitly encourages cyclists' transit
	1.3 Sidewalk width	Describing how the width of the pedestrian routes can have an impact on walkability and cyclability along an arc
	1.4 Presence of obstacles	Describing how easy is to walk along an arc based on the presence of potential obstacles and barriers to movement
	1.5 Type of surface and smoothness	Describing how the path surface can obstacle walkability and cyclability
	1.6 Slope	Describing how the slope (%) of the pedestrian routes can have an impact on walkability and cyclability along an arc
	1.7 Lack of lighting	Describing whether an arc is lit. Lack of lighting may result in difficulties in displacing and sense of unsafety
2. Traffic safety and road impacts	2.1 Car traffic interaction	Describes the level of stress on pedestrians, wheelchair users and cyclists due to proximity to high traffic roads
	2.2 Traffic calming impact	Describing the sense of security related to the presence of vehicles marching at low speed by rule
	2.3 Number of lanes	Considered as a proxy to calculate difficulties in crossings, noise and pollution along the road



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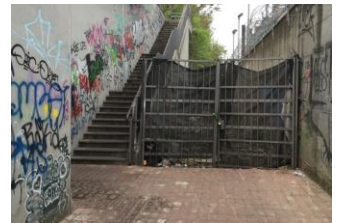
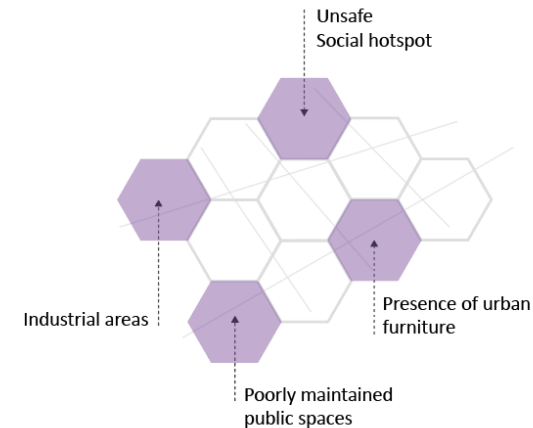
Relational indicators.

They are mapped on a hexagonal grid overlapped on the street network.

They describe the perceptions and quality spatial and relational environment.

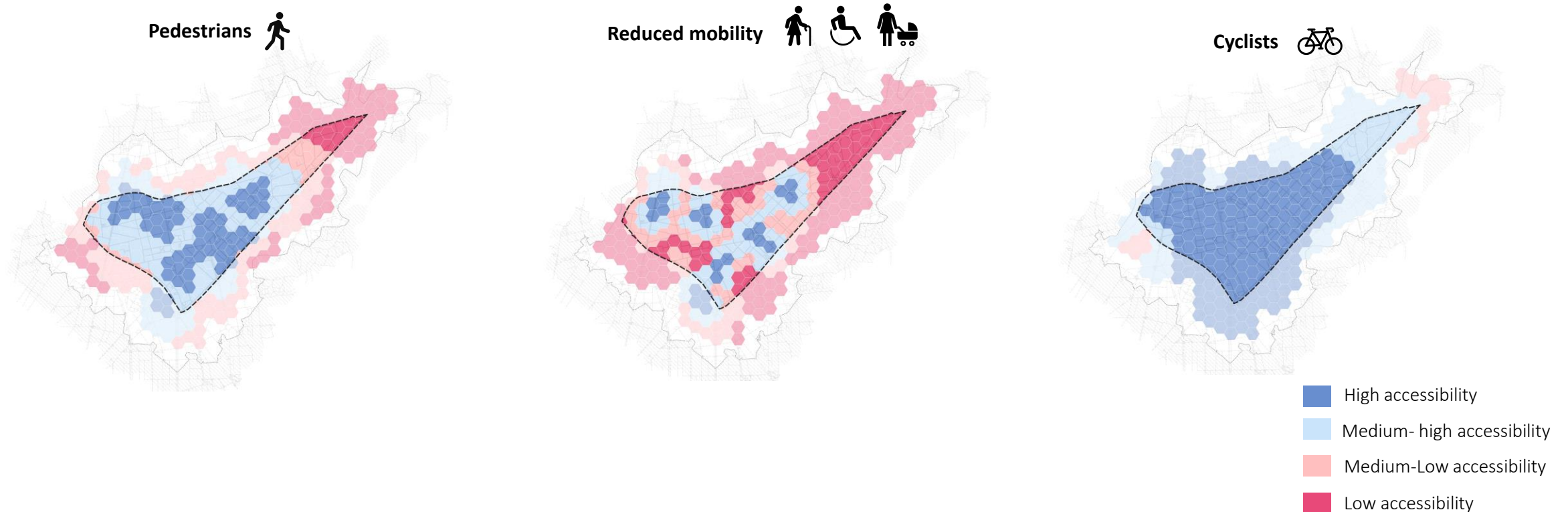
Subjective indicators (3.1 and 3.2) are collected through **Indirect public Participation processes.**

Category	Indicator	Aim
3. Sense of safety	3.1 Population density	Higher population density is associated with a greater sense of safety and higher relational opportunities
	3.2 Poor maintenance of public spaces	Describing the presence of public spaces perceived as poorly maintained
	3.3 Presence of social hotspots	Describing the presence of no-go or high-quality social spaces impacting livability and walkability
4. Design and diversity of the built environment	4.1 Urban furniture density	Describing the level of equipment and presence of street furniture that enhances the livability of public spaces
	4.2 Predominant land use	Describing the presence of land uses favoring stop over activities such as residential, commercial, and recreational
	4.3 POI density	Describing the density of activity along a path increasing opportunities for activity participation while displacing



IAPI introduces three innovative features:

2) It considers **three different modes of accessing** neighborhood services in the local streetscape. IAPI does so by evaluating how the attributes of each local street network and the surrounding perceived spaces described by the indicators can favor/disfavor accessibility through active mobility for **pedestrians, cyclists, and people with reduced mobility**.

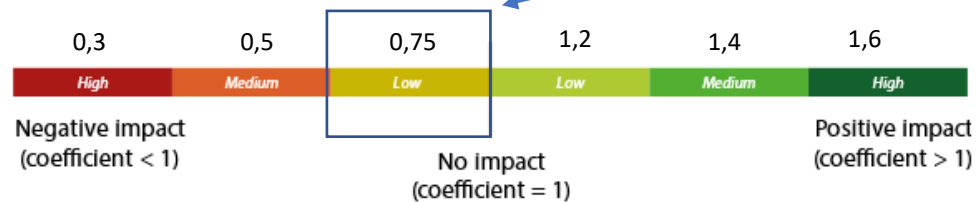
























































IAPI introduces three innovative features:

2) The three modes of access are simulated based on the presence of the indicators mapped on the network and in each hexagon of the grid.

The indicators describe conditions that can impact positively (favoring walkability and cyclability) or negatively (disfavoring walkability and cyclability), and with different intensities for the three profiles.

Such impact is quantitated through empirically-defined coefficients that are multiplied, in different steps of the methodology to the accessibility value making it increase or decrease.



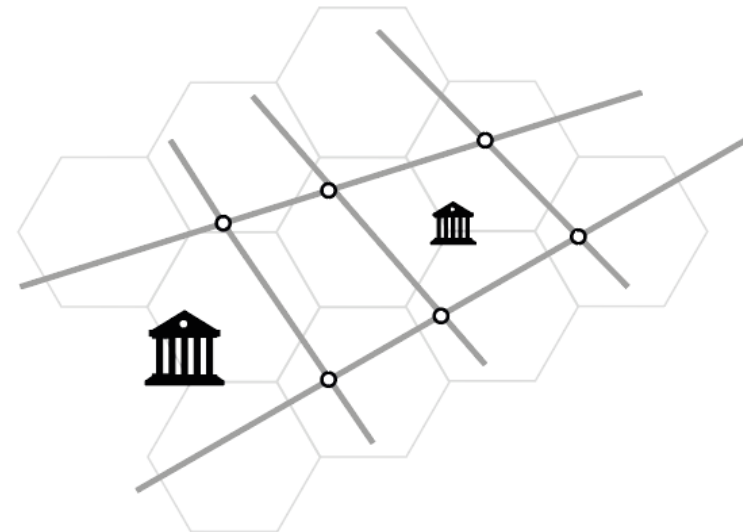
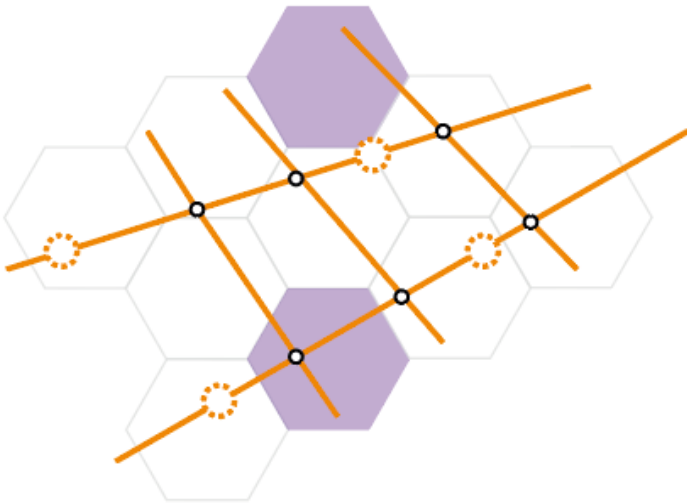
Category	Indicator			
1. Paths' technical performance	1.1 Pedestrian friendliness			
	1.2 Cyclist friendliness			
	1.3 Sidewalk width			
	1.4 Presence of obstacles			
	1.5 Type of surface and smoothness			
	1.6 Slope			
	1.7 Lack of lighting			
2. Traffic safety and road impacts	2.1 Car traffic interaction			
	2.2 Traffic calming impact			
	2.3 Number of lanes			
Category	Indicator			
3. Sense of safety	3.1 Population density			
	3.2 Poor maintenance of public spaces			
	3.3 Social hotspots			
4. Design and diversity of the built environment	4.1 Urb. furniture density			
	4.2 Predominant land use			
	4.3 POI density			

IAPI introduces three innovative features:

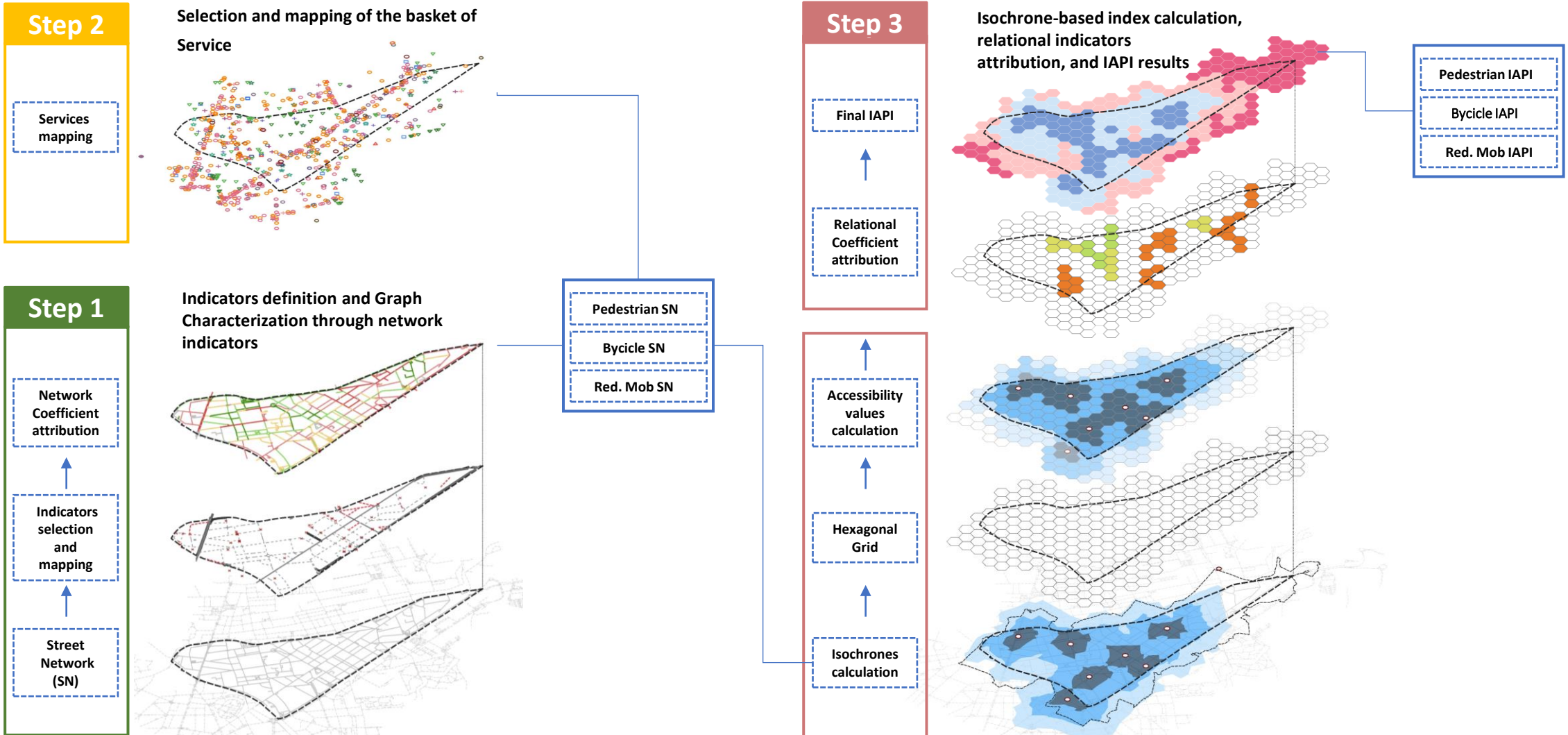
3) It can be integrated with crowdsourced data for a context-sensitive analysis.

The flexible architecture of the IAPI allows the introduction of data from direct or indirect public survey to:

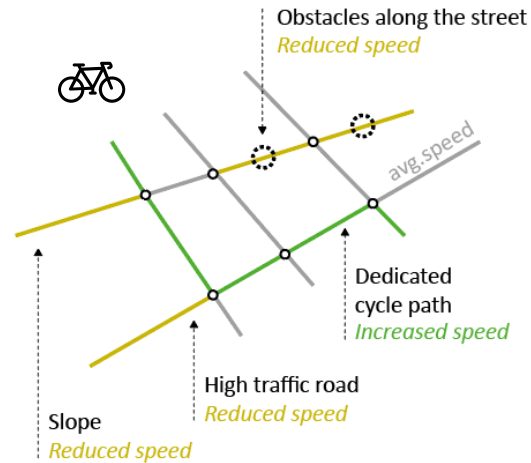
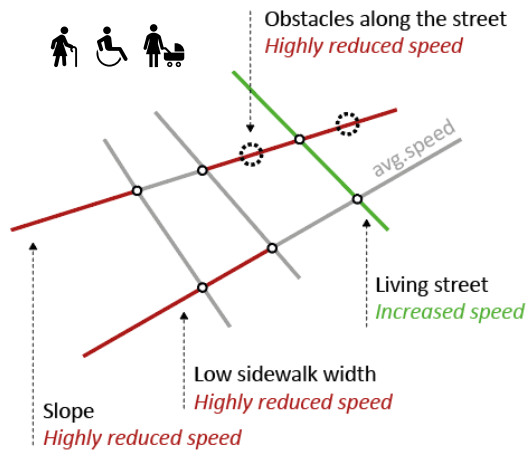
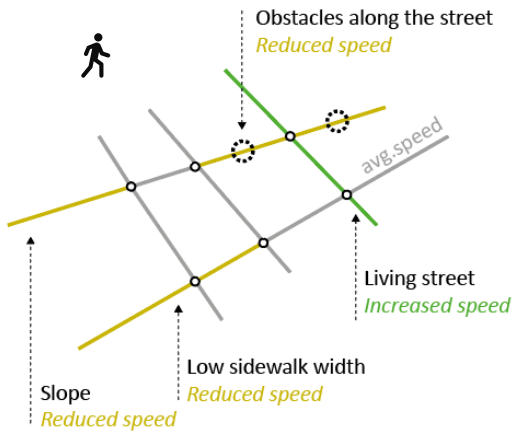
- Mapping indicators related to perceptions (3.1 and 3.2)
- Weigh the impact of indicators and coefficients based on people's stated preference
- Weighting the relevance of the services selected to be included in the measurement



IAPI methodological steps



Step 1: Application of the network coefficients



The first step concerns the mapping of network indicators on each arc of the digital street graph and in calculating their impact through the attribution of coefficients.

Coefficients are multiplied to an average speed value, different for each mode.

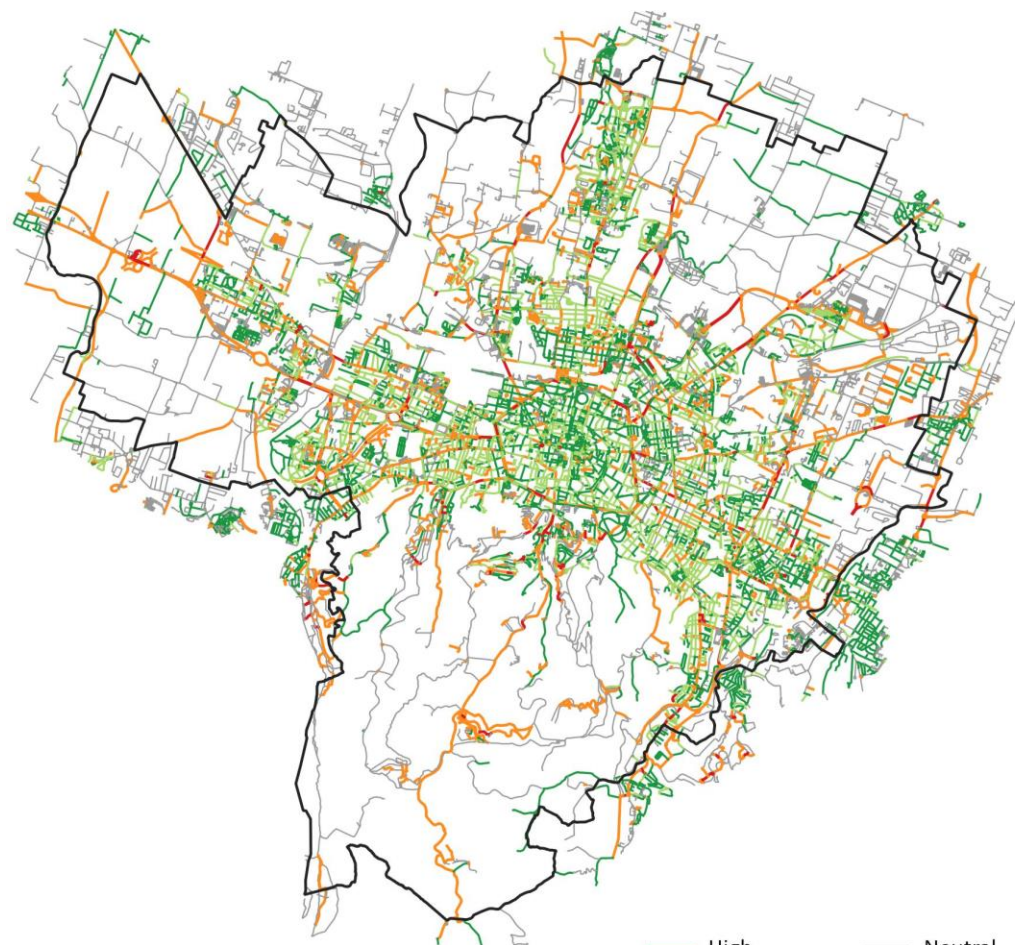
The copresence of **mostly favorable** conditions will result in **increased speed** along the arc, above the average speed for each mode.

Conversely, a higher presence of **unfavorable conditions** will result in **decreased speed** along the arc, below the average speed for each mode.




Step 1: Level of walkability along the network

 Pedestrian Street Network



High Neutral Low
Medium-High Medium - Low No walkable

 Reduced mobility Street Network



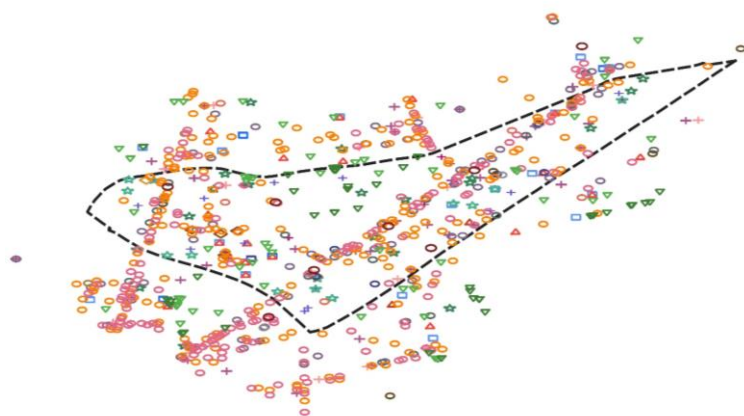
0 5 km

Step 2: basket of services

This step is aimed at **selecting and mapping the local services considered essential for daily life**.

Services will be considered as the destinations to be reached while performing accessibility analysis.

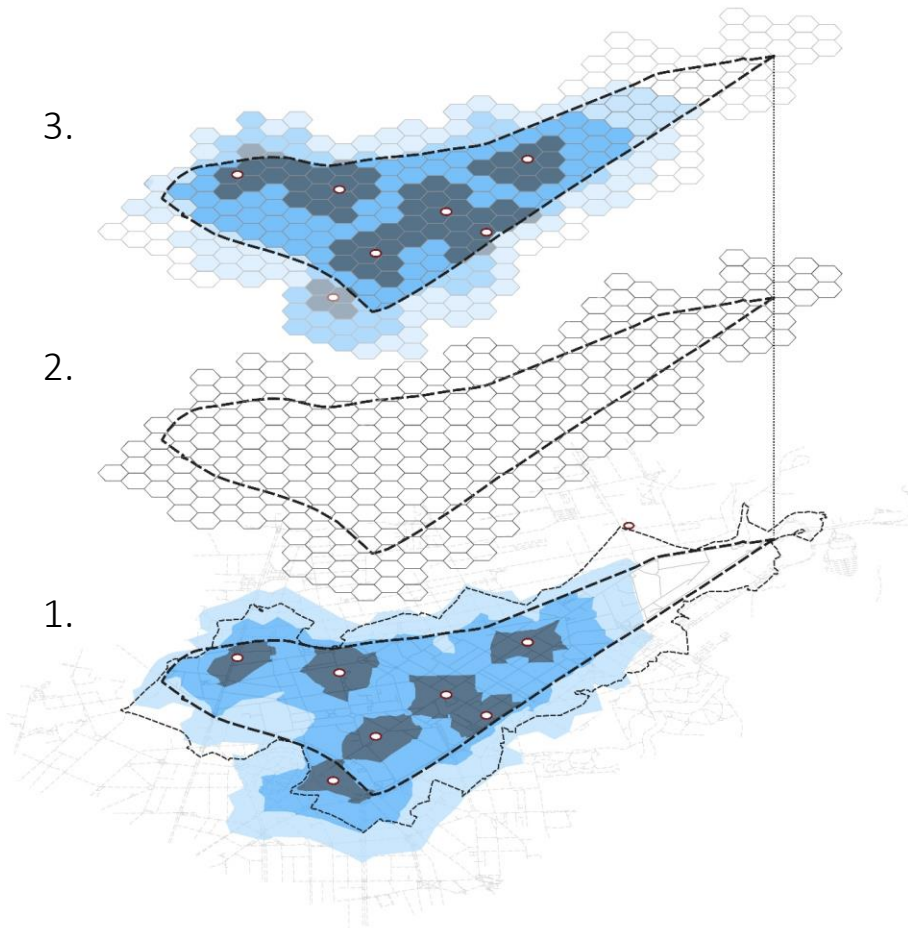
The selection is made taking into account hourly and weekly availability, as well as the service's performance (defined by service frequency in the case of public transport).



Category	Service
Public open spaces	Gardens, parks
	Playgrounds
Commercial Activities / services to the public	Grocery stores, supermarkets
	Street markets
	Bars, restaurants
	Newsstand, kiosk
	Post office, bank
Gathering and cultural spaces	Cultural and creative spaces
	Theaters and cinemas
Sport	Gyms and sportfields
Health and social care	GP, Pharmacies, clinics
	Social services

Category	Service
Education spaces	Libraries
	Nurseries, kindergartens, primary, middle schools
Public transport	Metro station
	High frequency bus stop
	Low frequency stop
Sharing mobility	Bike sharing stations
	Car sharing stations

Step 3: Isochrones sampling and calculation



Measures the **accessibility levels by isochrones** based on different time thresholds (5, 10, 15) and speeds (walking, cycling, or reduced mobility)



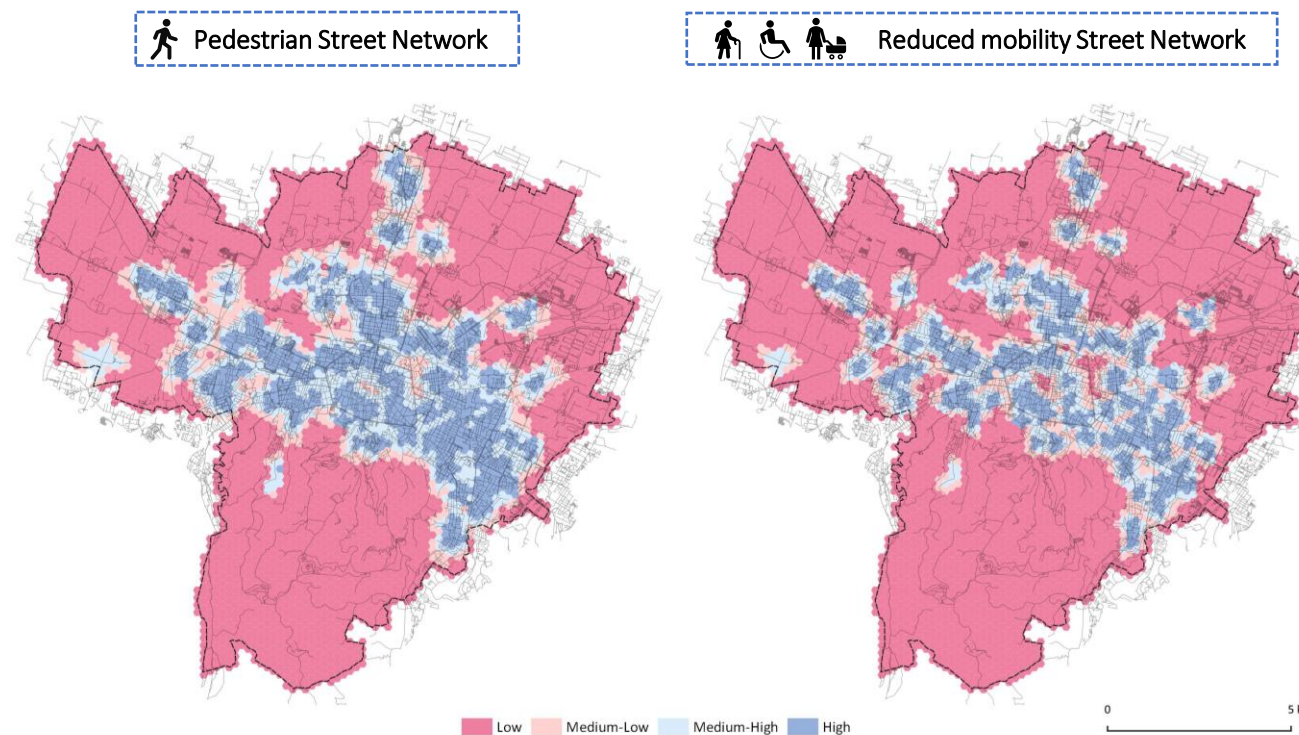
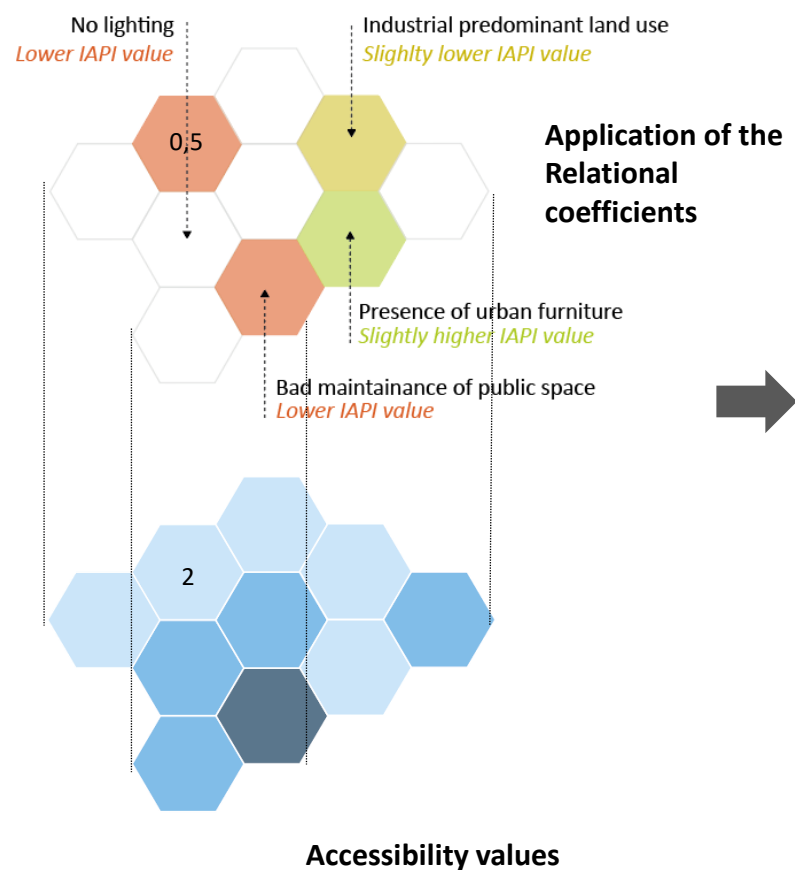
Create a hexagonal grid with an area equal to the area of the blocks (census tracts) in the study area



Assigning a score to each area of the neighborhood (hexagon cell) based on the **accessibility levels** to services in the three isochrones






























Step3: Application of the relational coefficients
























Finally, **relational indicators coefficients** are multiplied by the isochrone values to obtain the final IAPI index.



In this example, the IAPI is calculated considering the accessibility to education-related facilities (kindergartens, primary schools and middle schools)

1) Re-defining coefficients based on respondents' stated preferences according to what they consider relevant to walking, reduced mobility, or cycling. The following information results from survey conducted in Bologna.

Category	Indicator			
1. Paths' technical performance	1.1 Pedestrian friendliness			
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	1.3 Sidewalk width			
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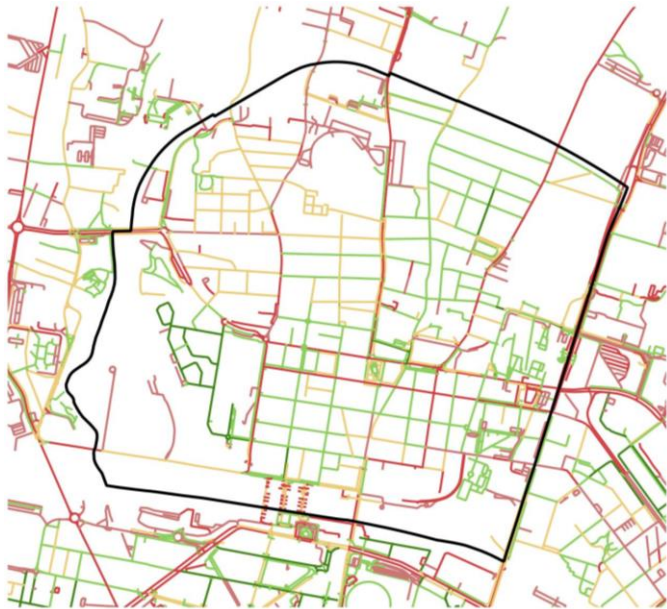
Category	Indicator			
3. Sense of safety	3.1 Population density Above city avg. → Below city avg. →			
	3.2 Poor maintenance of public spaces			
	3.3 Social hotspots Positive, high quality → No go areas →			
4. Design and diversity of the built environment	4.1 Urb. Furniture density Above city avg. → Below city avg. →			
	4.2 Predominant land use Favorable → Unfavorable →			
	4.3 POI density Above city avg. → Below city avg. →			
				



Example of a coefficient that was re-considered from low to medium impacting on walkability/cyclability following Commonplace results' analysis

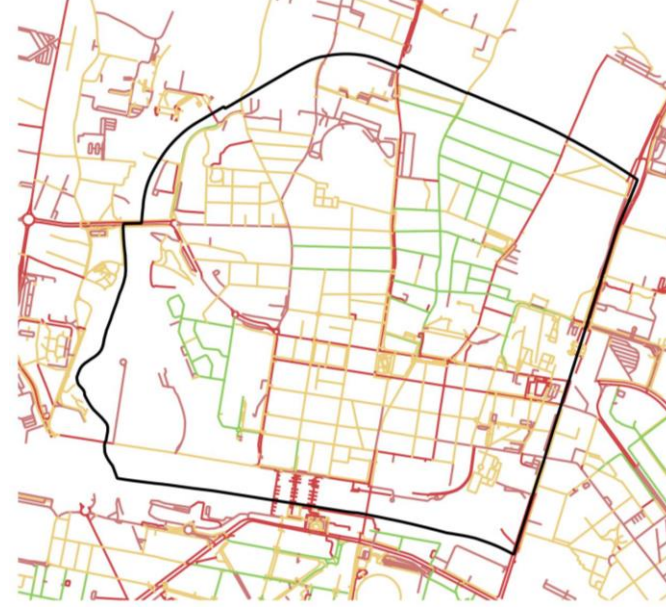
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IAPI Standard

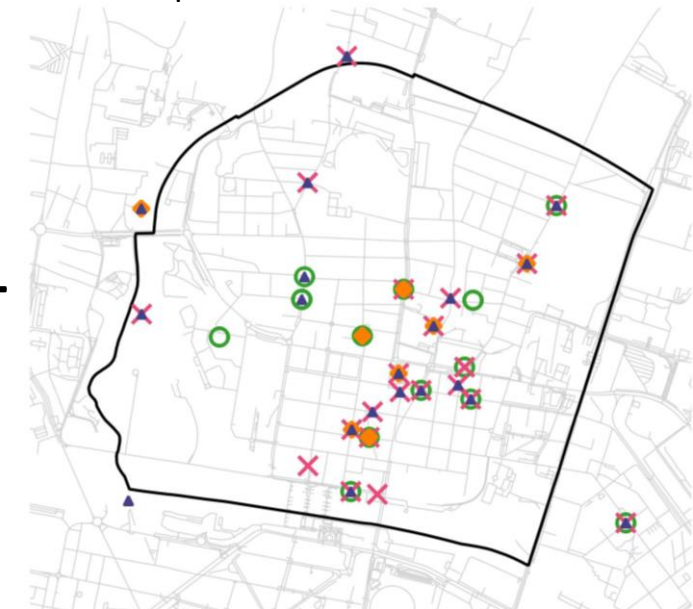


IAPI + Survey

Re-weighted indicators



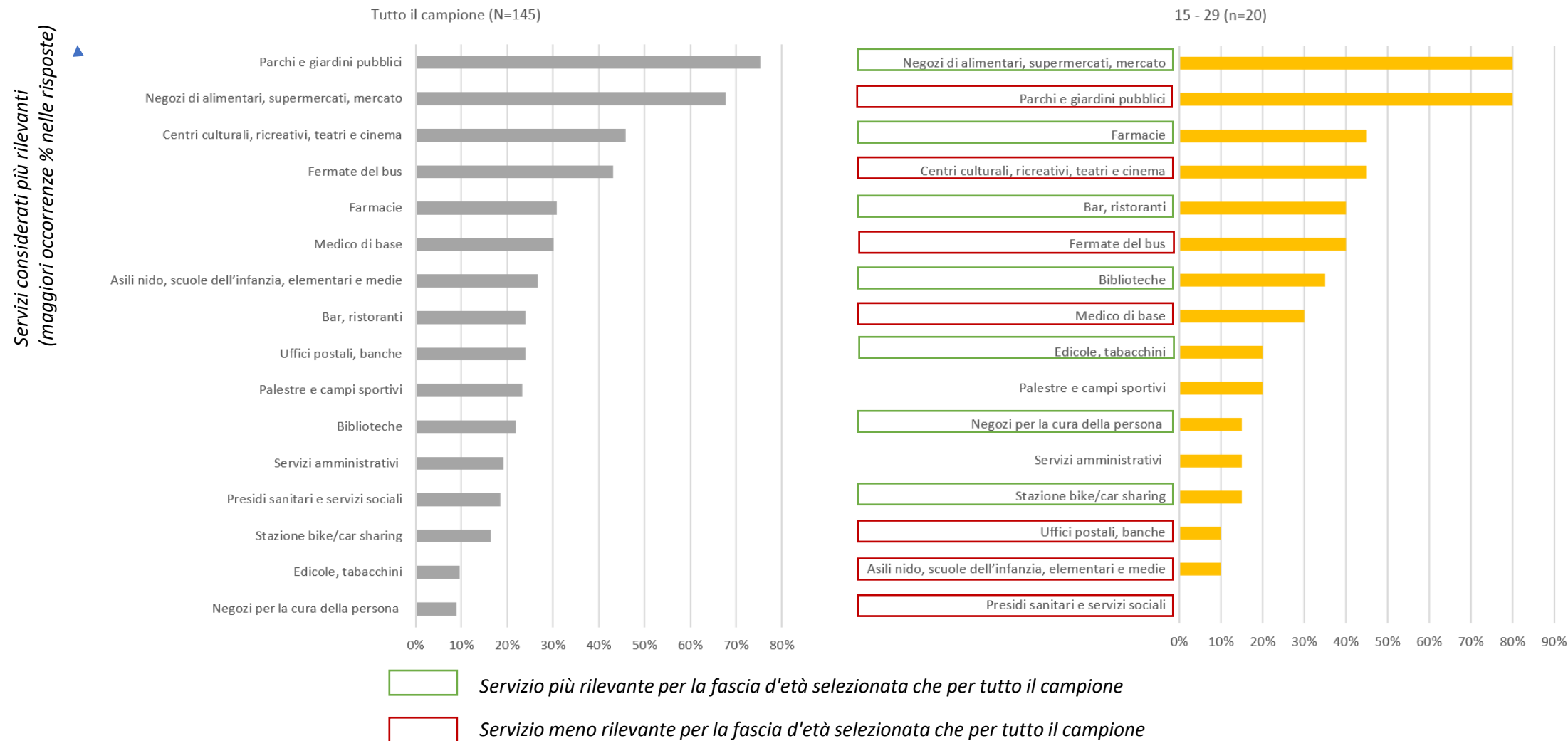
Direct input



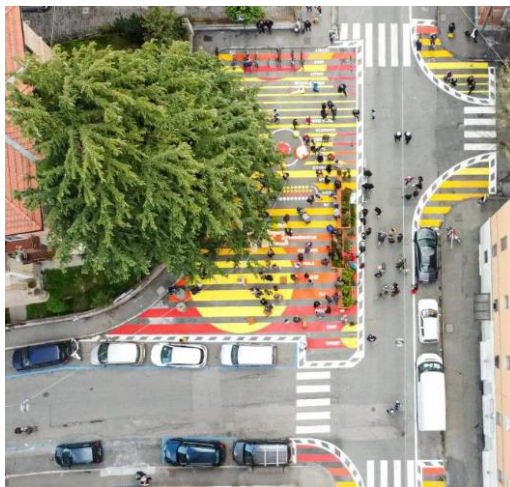
— Very high
— High
— Medium
— Low
— Very low

○ 1.Path technical performance
× 2.Traffi safety/road impacts
▲ 3.Security
◆ 4. Design and diversity of the built environment

2) Weight services and their relevancy according to the preferences of different social groups

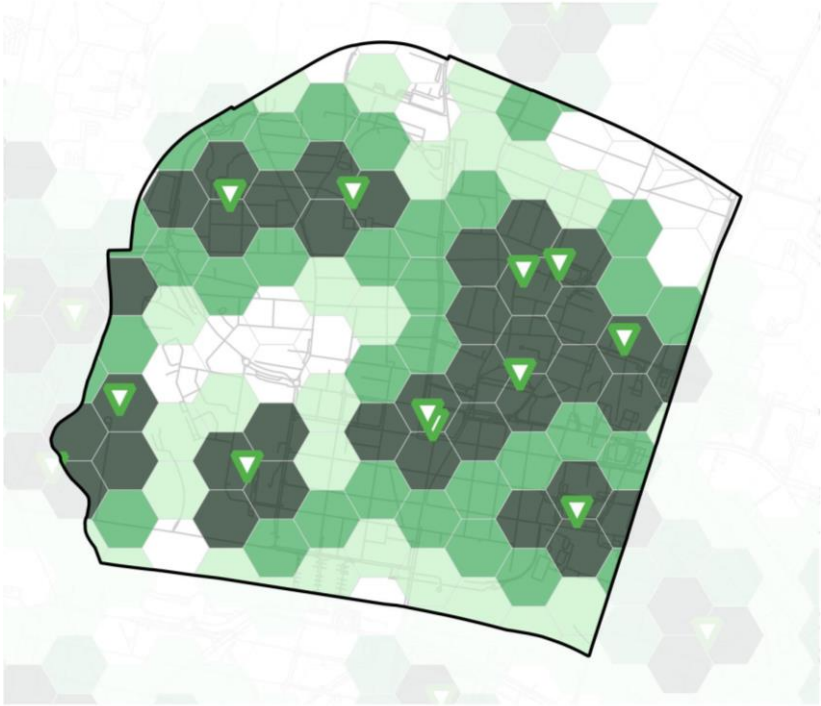


Procaccini Street Experiment



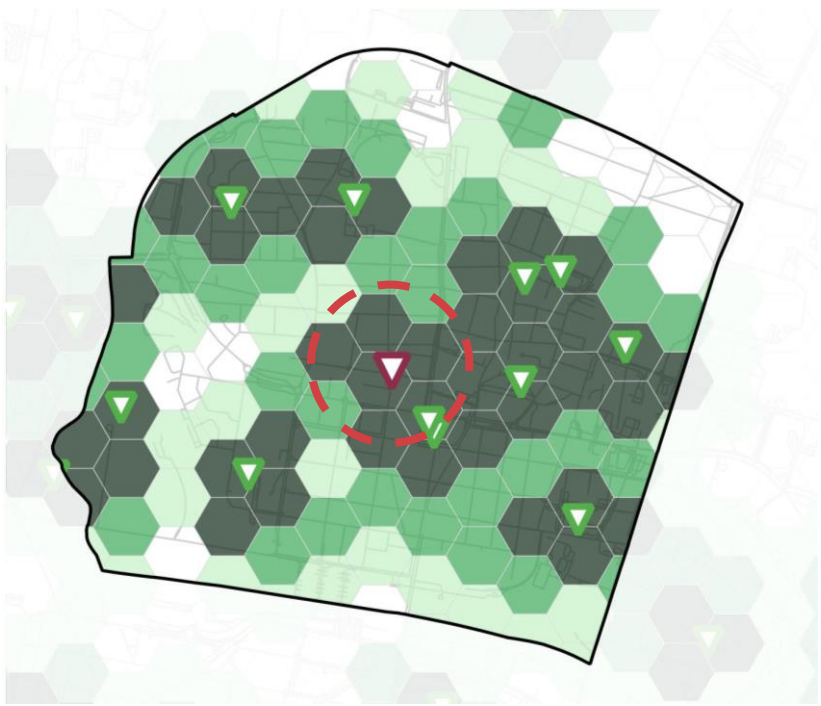
3) Assess the impact of a small intervention of public space redesign as a new playground

 Pedestrian Accessibility



Before

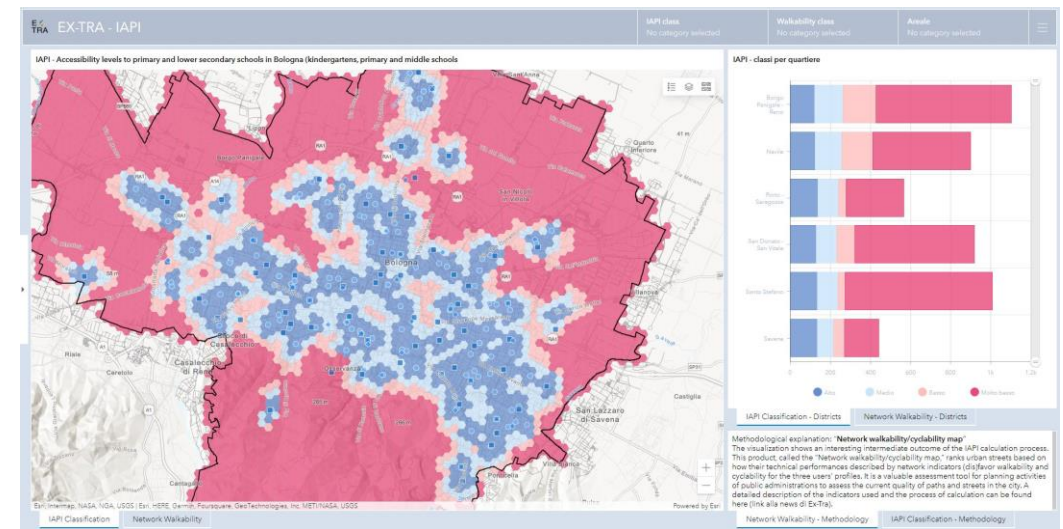
 Pedestrian Accessibility



After implementing the experiment

Due to the ease of calculation and the possibility of updating indicators, coefficients, and the ability to create new potential user profiles, the visualization of IAPI results contributes to:

- **Assess the current status** of the quality of paths and accessibility through active mobility in different neighborhoods of a city and for different profiles of inhabitants;
- **Stimulate the debate** within and outside the public administration through visualizations of the results;
- **Develop city-scale strategic plans** (e.g., pedestrian mobility plans; bicycle plans; PUMS);
- **Direct targeted interventions** to improve the quality of spaces and routes and to redistribute services and opportunities in the city;
- **Building scenarios** based on accessibility improvements.



Thank you!

Paola Pucci paola.pucci@polimi.it

Giovanni Lanza giovanni.lanza@polimi.it

Luigi Carboni luigi.carboni@polimi.it
