Exploiting OpenData for 15MinCityIndex

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Co-developed with Enel X on the basis of the Solution that has been the Winner of Enel Open-Innovability Open Data Challenge 2020

"Computing 15MinCityIndexes on the basis of Open Data and Services",  
Proc. of the 2021 International Conference on Computational Science and Its Applications. Published on LNCS Springer.
Assessing in each point of the area (city or rural) the capability of providing services ad 15 Min walking distance for the city users

– Several different approaches from early Carlos Moreno concept
– Several different subindexes

<table>
<thead>
<tr>
<th>Carlos Moreno Functions</th>
<th>Li et al., 2019</th>
<th>15MinCityIndex subindexes</th>
</tr>
</thead>
<tbody>
<tr>
<td>living</td>
<td></td>
<td>Housing viability</td>
</tr>
<tr>
<td>Gov</td>
<td></td>
<td>Govern Services</td>
</tr>
<tr>
<td>Safety Services</td>
<td></td>
<td>Culture and Cults Services</td>
</tr>
<tr>
<td>Environment Quality</td>
<td></td>
<td>Slow Mobility Services</td>
</tr>
<tr>
<td>Roads</td>
<td></td>
<td>Fast Mobility Services</td>
</tr>
<tr>
<td>[Medical]</td>
<td></td>
<td>Economy/sustainability</td>
</tr>
<tr>
<td>working</td>
<td>pension</td>
<td>Food Services</td>
</tr>
<tr>
<td>commerce</td>
<td>commerce</td>
<td>Health Services</td>
</tr>
<tr>
<td>dining</td>
<td></td>
<td>Education Services</td>
</tr>
<tr>
<td>healthcare</td>
<td>medical</td>
<td>Entertainment Services</td>
</tr>
<tr>
<td>education</td>
<td>edu</td>
<td></td>
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<tr>
<td>entertainment</td>
<td>entertainment</td>
<td></td>
</tr>
</tbody>
</table>
Technical Challenges

• The main constraints:
  – use Open Data
  – maintain the concept of 15 Min distance

• Problems: conceptual, computational and technical such as
  – For Who: young, elders, impaired, etc.
    • If not walking: how moving...
    • Effective routing for walking? walkability
  – For Where, strong differences on: city, rural, industrial area
  – How:
    • Data collection processes and costs
    • Independency of the subindexes
    • Combining measures for computing subindexes
    • Combining subindexes for computing the 15MinCityIndex
    • Computational complexity of combining data from different sources and data density, availability, semantics, etc.
    • Definition of the acceptance level according to objective KPIs
The SubIndexes categories

A) environment quality:
   • quality of the environment in which one is going to live.

B) economy/sustainability:
   • assessing sustainability by matching the offer vs the demand of work, in first approximation.

C) housing viability:
   • assessing affordability of having a house of reasonable quality.

D) other: health services, food services, education services, govern services, safety services, culture and cults services, slow mobility services, fast mobility services, entertainment services, sport services.
   • assessing the availability of services, POI, etc.
Environment SubIndex

- **AIM:** assess the environmental **quality** of the area for living.
- **Good indicators can be:**
  - EAQI (European Air Quality Index), or others,
  - specific pollutants (NO2, CO2, O3, PM10, PM2.5, etc.). For most of them, recommended values are provided at the EC level. Please note that, most of the pollutants are also taken into account by the EAQI which is based on PM2.5, PM10, NO2, O2 and SO2, so that, the EAQI supersedes them.
  - quality of water,
  - presence of green areas/gardens (which can be recovered from municipality or from Copernicus Satellite data with some limitations and complexity),
  - noise level in most data set related to traffic,

SubIndex (env) = \( \frac{EAQI + K \cdot \text{GreenAreasSM} / \#\text{Inhabitants}}{2} \)

Economy SubIndex

- **AIM:** assess the economic **sustainability** of the area,
  - demand-vs-offer index,
  - self-sustainability: working places (commercial and industrial) wrt workforce in the area is satisfactory to ensure the economic well-being of the people.
- **Good Indicator can be:**
  - census data: people living in the area: ages, skill, etc.
  - commercial / economic data
    - POI as shops, services, industries, etc. as POI
    - capability in terms of personnel per POI
    - level of salary of the area (including retired people) for the sustainability of the whole population of the area.
European Air Quality Index **EAQI**


<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Index level (based on pollutant concentrations in µg/m³)</th>
<th>Good</th>
<th>Fair</th>
<th>Moderate</th>
<th>Poor</th>
<th>Very poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particles less than 2.5 µm (PM₂.₅)</td>
<td>0-10</td>
<td>10-20</td>
<td>20-25</td>
<td>25-50</td>
<td>50-800</td>
<td></td>
</tr>
<tr>
<td>Particles less than 10 µm (PM₁₀)</td>
<td>0-20</td>
<td>20-35</td>
<td>35-50</td>
<td>50-100</td>
<td>100-1200</td>
<td></td>
</tr>
<tr>
<td>Nitrogen dioxide (NO₂)</td>
<td>0-40</td>
<td>40-100</td>
<td>100-200</td>
<td>200-400</td>
<td>400-1000</td>
<td></td>
</tr>
<tr>
<td>Ozone (O₃)</td>
<td>0-80</td>
<td>80-120</td>
<td>120-180</td>
<td>180-240</td>
<td>240-300</td>
<td></td>
</tr>
<tr>
<td>Sulphur dioxide (SO₂)</td>
<td>0-100</td>
<td>100-200</td>
<td>200-350</td>
<td>350-500</td>
<td>500-1250</td>
<td></td>
</tr>
</tbody>
</table>

Measurements of up to five key pollutants supported by modelled data determine the index level that describes the current air quality situation at each monitoring station.

The index corresponds to the poorest level for any of five pollutants according to the following scheme.

**Legend of Environmental data:**

[https://www.snap4city.org/435](https://www.snap4city.org/435)
Road Graph (Tuscany region)
132,923 Roads, 389,711 Road Elements
318,160 Road Nodes, 1,508,207 Street Numbers
Info on: points, paths, areas, etc.
Services (20 cat., 512 cat.)
16 Public Transport Operators
21,280 Bus stops & 1081 bus lines
Housing SubIndex

• AIM: assess the affordability of houses in the area.

• Indicators can be:
  – services of the buildings, hard to get
  – age of the buildings, possible
  – prices for square meters of the real estate market, which is also related to the affordability of living.

• Consideration:
  – An affordable price with respect to the population living there could simplify the liveability.

Health SubIndex

• AIM: assessing the availability of health services

• Indicators:
  – Presence of: pharmacies, private and public hospitals, labs, studio of doctors, presence of defibrillators, etc. with respect to the number of users.

• Consideration
  – There are some KPI provided by the EC.
  – coverage of the pharmacies in terms of potential clients of the area.
    – a pharmacy every 3000 people for Italian govern,
    – 500 hospitals’ beds every 100,000 inhabitants,
    – 80 dentists per 100,000 inhabitants,
    – 1.6 hospitals per 100,000 inhabitants, etc.
Data Type Coverage

- POI, IOT, shapes,..
- maps, orthomaps, GTFS, GIS WFS/WMS, GeoTiff,..
- calibrated heatmaps,..
- traffic flow, typical trends,..
- trajectories, events,..
- 3D, BIM, Workflow,..
- Dynamic icons/pins,..
- OD Matrices, scenarios,..
- prediction models,..
- decision support,..
- Synoptics, animations,..
- social media, Routing,..
- Satellite data,..
- KPI, personal KPI,..
- etc.
Slow Mobility SubIdx

- AIM: assess presence of services to facilitate the local mobility.
- Indicators:
  - walkability, presence of sidewalks, number of Km of roads (that can be used for walking and biking), presence and number of cycling paths, availability of bike/cart sharing, number of sharing station for short range travel,
  - critical presence of barriers such as bridges, highways, etc., which can limit the walkability. Eventual usage of routing but computationally too complex.
- Consideration:
  - good services can facilitate the movements in the area and reduce the needs of taking less sustainable travel means.
  - having a good rank on most of the subindexes (taking into account of services in the area) it would reduce the needs of exiting from the local area by using a private or public travel means to access at the not accessible services.

Fast Mobility SubIdx

- AIM: assess the presence of services for moving out of the area.
- Indicators:
  - Presence of city busses, area busses and long distances (railways, airports, highway joint), with respect to the number of users of the authorized age to use them.
  - presence of fuel stations,
  - size of bus stops and railways stations,
  - long range recharging stations, etc.,
- Consideration:
  - Open Data, and POI.
  - Public transportation data (bus stops, bus lines, train stops, etc.) can be recovered from GTFS and/or Transmodel files which are accessible from the operators.
Prototype development: the process

• Creating a grid 700x700 mt
  – Computing number of inhabitants for grid area

• For each Subindex
  – Collecting: each sub-subindex data by using IoT App and saving them on Snap4City
  – Mapping data on the grid Analysing distribution,
    • scaling and centering the distribution according to KPI
  – Saving the Subindex

• Computing the 15MinCityIndex
  – Saving the 15MinCityIndex
15MinCityIndex

15MinCityIndex Dashboard

This Dashboard contains data estimated by the Snap4City 15Min index on the basis of Open Data accessible

• https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjkzOA==

iCities 2021, September 2021
15MinCityIndex

- Derived and extended from Carlos Moreno 15 Minute concept
  - But with 13 different subindexes
- Computable on the basis of Open Data
- Validated on major city area
- Extendable to whole national level or large regions
- Accessible as Dashboard to play with
Bologna Metropolitan Area Dashboard


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15MinCityIndex on Bologna

15 minuti index – Bologna Città Metropolitana (beta)


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From Prototype to Product: National Scale Up

Main Challenges

Validation, transparency & trust
Goal: support Public Administration in their sustainability transition with cross validated and transparent KPIs
Solution: Robustness check on each Sub-Indexes and Components, Internal and External Correlation analysis. University of Florence support in final validation path

Models, institutional benches and statistical approach
Goal: grant an objective evaluation of 15 min city readiness
Solution: Identification of Italian/European norms, guidelines and best practice to compute each KPIs and normalize open data values. Natural Breaks approach to assign Likert Scale.

Open Data, massive discovery & asseessment
- Goal: identify relevant source that can grant consistency and balance open data fragmentation among all 7,904 italian munis
- Solution: collection of Nation Wide Available open data with adequate granularity and update—leveraging Institutional Portals as well as Satellite Imagery and Open Source Community (ie. OSM)
15 minutes City Index – National Scale Up Preview
Soon available to registered PA in Enel X YoUrban Portal

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Conclusions

• **The 15MinCityIndex** has been
  – defined in terms of its subindexes, only using Open Data
  – developed taking into account the needs of local services as in the main Lockdown period in March 2020
  – validated in a large area of 800,000 inhabitants on Florence area

• **The Solution** in the presented form has been
  – the winner of the International Open Data Challenge 2020 of ENEL-X
  – Co-developed with Enel X on Bologna Metro Area exploiting data ingestion and computing capabilities of Snap4City infrastructure and tool, making it affordable.
  – Also using the IoT App for data ingestion and business intelligence on dashboard making them interactive
  – Scaled up by Enel X to address a Nation wide analysis