CPI METHODOLOGY
What is different with the CPI framework

a) A flexible monitoring framework
b) A framework that promotes integration
c) An innovative tool based on spatial analysis
d) A multi-scale decision-making tool
CONTENTS

01. INTRODUCTION TO THE CPI METHODOLOGY
02. CLARIFICATION ON FEW INDICATORS
03. SPATIAL INDICATORS
04. PLANNING AND INTERPRETATION
MEASUREMENT OF CITY PROSPERITY
Methodology and Metadata

UN-HABITAT
FOR A BETTER URBAN FUTURE
3. METADATA

ICONS DESCRIPTION

Scope:
- Basic CPI
- Extended CPI
- Methodology CPI

Index number

Index code

CPI-M

Productivity

Index logo

Index name
# CPI-M

## Infrastructure and Development

01. Housing Infrastructure
   - 01. Improved Shelter ........................................... 80
   - 02. Access To Improved Water ................................. 84
   - 03. Access To Improved Sanitation .......................... 88
   - 04. Access To Electricity ........................................ 92
   - 05. Sufficient Living Area ........................................ 94
   - 06. Residential Density .......................................... 98

02. Social Infrastructure
   - 01. Physicians Density ............................................ 104
   - 02. Number of Public Libraries ............................... 108

03. ICT
   - 01. Internet Access ................................................ 112
   - 02. Home Computer Access ...................................... 114
   - 03. Average Broadband Speed ................................. 116

04. Urban Mobility
   - 01. Use Of Public Transport .................................... 122
   - 02. Average Daily Travel Time (reversed) ................... 126
   - 03. Length Of Mass Transport Network ....................... 130
   - 04. Traffic Fatalities (reversed) .............................. 132
   - 05. Affordability Of Transport (reversed) ................. 136

05. Street Connectivity
   - 01. Street Intersection Density ............................... 142
   - 02. Street Density ................................................ 146
   - 03. Land Allocated to streets ................................. 150

## Economic Equity

01. Economic Equity
   - 01. Gini Coefficient (reversed) ............................... 220
   - 02. Poverty Rate (reversed) .................................... 224

02. Social Inclusion
   - 01. Slum Households (reversed) ............................... 230
   - 02. Youth Unemployment (reversed) ......................... 234

03. Gender Inclusion
   - 01. Equitable Secondary School Enrolment .................. 240
   - 02. Women in Local Government ............................. 242
   - 03. Women in the Work Force .................................. 246

04. Urban Diversity
   - 01. Land Use Mix .................................................. 252

## Health

01. Life Expectancy at Birth ...................................... 158
02. Under-Five Mortality Rate (reversed) ....................... 162
03. Vaccination Coverage ......................................... 166
04. Maternal Mortality (reversed) .............................. 170

## Education

01. Literacy Rate .................................................... 176
02. Mean Years of Schooling ...................................... 180
03. Under-Six Participation on First Stage Development .... 184
04. Net Enrollment Rate in Higher Education .................. 188
05. Number of Top Universities .................................. 190

## Safety and Security

01. Homicide Rate (reversed) .................................... 196
02. Theft Rate (reversed) ......................................... 200

## Public Space

01. Green Area per Capita ......................................... 206
02. Accessibility to Open Public Area ............................ 210
**Indicator**

Accessibility of Open Public Areas

**Scope**

Extended CPI

**Rationale**

This indicator provides information about the open public areas in a city and whether this amount is sufficient for its population. Additionally, this indicator considers the accessibility of open public areas and the distribution of the total area across the city. In most countries, the concept of an open public area is related to green areas (where green areas are defined as public and private areas that have flora such as plants, trees, and grass). Nevertheless, the two principal roles of an open public area are to provide a space for healthy social interaction space and improve air quality (WHO, 2012).

Individuals residing in towns and cities should have access to natural green spaces or open public spaces less than 300 meters from home (Natural England; see also The Wildlife Trust & Natural England, 2009; Harrison et al., 1995; Barker, 1997; Handley et al., 2003; Wray et al., 2005; [1]).

A prosperous city has enough open public area for its residents, which is properly distributed and easy to access.

**Definition**

The percentage of the urban area located less than 300 meters away from an open public space.

**Unit**

%  

**Methodology**

Methodology A:

- Accessibility of open public areas
- Parks: open spaces inside a city and contact with nature. Their proportion of green area.
- Civic parks: open spaces outside a city, which was later transferred.
- Squares: open spaces created by roads. Its main characteristics are transportation elements and interaction among activities. Usually public spaces that are a junction of political development, or cultural influences.
- Recreational green areas: environmental preservation. All recreational area and must be linked to urban, rural, and passive recreation.
- Facility public areas: open multi-use areas are part of city facilities (defined as public; e.g., public libraries, stadium, park, etc.). The following characteristics: provide both active and passive recreation.
Types of Standardization

• Not required
• Simple reversal
• Classic direct standardization
• Classic reversal standardization
• Standardization with the minimum target
• Standardization with the ultimate goal
• Standardization with single objective

Each indicator of the CPI has a specific way to be standardized
Example:

- The poverty rate, which is measured in percent.
- The variable moves from 0 to 100.
- The relationship with the CPI is reversed (a rise in the poverty rate will generate a decrease in the level of prosperity of the city).
Classic reversal standardization

Example:

- Higher values are worst
- CO₂ emissions (measured in metric tons of CO₂ per capita)
- WB (2008-2010)
  - Minimum 0.01
  - Maximum 44.20

- A city with 1.44 metric tons would have a standardized value of:

\[
X^{(S)} = 100 \left(1 - \frac{X - \text{Min}(X)}{\text{Max}(X) - \text{Min}(X)}\right)
\]

\[
X^{(S)} = 100 \left(1 - \frac{1.44 \text{ tonedalas métricas} - 0.01 \text{ tonedalas métricas}}{44.20 \text{ tonedalas métricas} - 0.01 \text{ tonedalas métricas}}\right) = 96.76
\]
Standardization with minimum target

Example:

- Number of intersection per square kilometer
- UN-Habitat (2014) recommends 100 sq. km
- A city with 50 intersections would have a standardized value of:

\[
X^{(S)} = 100 \left( 1 - \frac{50 \text{int/} \text{km}^2 - 100 \text{int/} \text{km}^2}{100 \text{int/} \text{km}^2} \right) = 50.00
\]
Example:

- PM10 concentration (measured in micrograms per cubic meter).
- EC (2013) has set a target value recommended maximum = 40.
- To exceed a certain threshold value decreases (40=100)
- A city with = 54.63, its normalized value is:

\[
X^{(s)} = 100 \left( 1 - \frac{X - X^*}{100} \right) \quad \text{for} \quad X^* < X < 2X^*
\]

\[
X^{(s)} = 0 \quad \text{for} \quad X \geq 2X^*
\]

\[
X^{(s)} = 100 \quad \text{for} \quad X \leq X^*
\]

\[
X^{(s)} = 100 \left( 1 - \frac{54.63 \, \mu g / m^3 - 40 \, \mu g / m^3}{40 \, \mu g / m^3} \right) = 63.43
\]
Standardization with single objective

Examples:
- Residential densities
- Women in Local Government (measured as a % target value)
- Mossuz-Lavau (2005) = 50%
- In a city with 31.22% of women in government, the standardized value would be:

\[
X^{(S)} = 100 \left(1 - \frac{31.32\% - 50\%}{50\%}\right) = 62.64
\]
Once the variables have been standardized, there is a need to define a methodology to add the information on these variables in a new variable. Need to define a weighting scheme for dimensions, sub-dimensions and variables.
Construction of a scheme of WEIGHTS

a) The dimensions have an equal weight in the indicator.

b) The sub-dimensions have equal weight within its dimension.

c) The variables have equal weight within its sub-dimension
Construction of a scheme of WEIGHTS

Equity and Social Inclusion Dimension

Economic Equity Subdimension

GINI COEFFICIENT

1/2

Poverty Rate

1/2

Social Inclusion Subdimension

Slum Household

1/2

Youth Unemployment

1/2

Gender Inclusion Subdimension

Equitable Secondary School Enrolment

1/18

Weights within the CPI

1/36

1/36

1/36

1/36

1/18
CLARIFICATION OF INDICATORS
PPP conversion factor, GDP (LCU per international $)

Purchasing power parity conversion factor is the number of units of a country's currency required to buy the same amounts of goods and services in the domestic market as U.S. dollar would buy in the United States.

This conversion factor is for GDP.

<table>
<thead>
<tr>
<th>Country</th>
<th>Per Capita GDP (Nominal)</th>
<th>Per Capita GDP (PPP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>47,100</td>
<td>47,400</td>
</tr>
<tr>
<td>Germany</td>
<td>40,500</td>
<td>35,900</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>36,200</td>
<td>35,100</td>
</tr>
<tr>
<td>Japan</td>
<td>42,500</td>
<td>34,200</td>
</tr>
<tr>
<td>Mexico</td>
<td>8,900</td>
<td>13,800</td>
</tr>
<tr>
<td>Brazil</td>
<td>10,100</td>
<td>10,900</td>
</tr>
<tr>
<td>China</td>
<td>4,300</td>
<td>7,400</td>
</tr>
<tr>
<td>India</td>
<td>1,200</td>
<td>3,400</td>
</tr>
</tbody>
</table>
GINI COEFFICIENT

MEASURING INCOME INEQUALITY

Ideal and Actual Income Equality, by Household Quintiles, in 2008

Gini Coefficient:
Actual: 0.4272
Ideal: 0.0000
AVERAGE BROADBAND SPEED
MAKING USE OF BIG –REAL TIME- DATA
LENGTH OF MASS TRANSIT NETWORK
SPATIAL INDICATORS
DEFINING AREA OF INTERVENTION
An innovative tool based on spatial analysis

SPATIAL INDICATORS

- Residential Densities
- Economic Densities
- Land Use Mix
- Public Space
- Street Connectivity
- Length of Public Transport
PUBLIC SPACES

From motorway to Public Space. Cheonggyechon River, Seoul. © John Dolci
WHAT IS A PUBLIC SPACE?

“Public spaces are all places publicly owned or of public use, accessible and enjoyable by all for free and without a profit motive”

Charter on Public Spaces
Both publicly-and privately-owned public spaces are considered, although public ownership often guarantees more stable access and enjoyment over time.
WHY IS PUBLIC SPACE IMPORTANT?

- Reduce the impact of climate change and heat island effect
- Encourage people to walk and cycle
- Contribute to develop a sense of civic cohesion and citizenship
- Improve safety and reduces fear of crime
- Increases prosperity
It looks like PAC-MAN can't play here

There aren't enough roads in this area for PAC-MAN to get around. Move the map or try your luck at a random location.
A ratio of 50% of public space is common in successful cities. Manhattan, Barcelona, and Brussels have up to 35% of city area allocated to street space and an additional 15% for other public uses.
Water and sanitation provision is related to land allocated to street and to street density.
Required conditions for Public Transport
Disconnected, fragmented suburbs adjacent to well-connected city cores
A WELL PLANNED URBANIZATION: A KEY COMPONENT OF SUSTAINABLE DEVELOPMENT
### Saudi Arabia CPI – Jeddah

(Patterns at intra-city level)

<table>
<thead>
<tr>
<th></th>
<th>Atomistic areas</th>
<th>Residential areas</th>
<th>Informal areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land allocated to streets</td>
<td>25.99</td>
<td>34</td>
<td>33</td>
</tr>
<tr>
<td>Street density</td>
<td>46.4</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>Intersection Density</td>
<td>925</td>
<td>130</td>
<td>151</td>
</tr>
</tbody>
</table>
Land Allocated to Streets: 30%
Street Density: 20 km /km²
Intersection Density: 100 / km²

UN-Habitat recommendation:

Land Allocated to Streets: 30%
Street Density: 20 km /km²
Intersection Density: 100 / km²

Average street width: 15 m
Street-to-street distance: 100 m
Distance between intersection: 85 m
Neiva, Colombia:

Land Allocated to Streets: 22.5%
Street Density: 25.75 km /km2
Intersection Density: 243 / km2

Average street width: 9.1 m
Street-to-street distance: 80.8 m
Distance between intersection: 71.7 m
Dammam, Saudi Arabia:

- Land Allocated to Streets: 23 %
- Street Density: 17 km/km²
- Intersection Density: 72 / km²
- Average street width: 17.9 m
- Street-to-street distance: 149.5 m
- Average block size: 131.6 m
Correlation between street density and intersection density

Relationship between street density and intersection density.
Cities of Saudi Arabia

Street density
Intersection density

All city

R² = 0.8776
**SD:ID ratio**
Measures the **skewness** of the urban pattern
CPI

CLASIFICATION OF CITIES:

CLIMATIC CONDITIONS
CPI

CLASIFICATION OF CITIES:
CLIMATIC CONDITIONS
CPI
CLASIFICATION OF CITIES:
URBAN BOUNDARIES
CPI
CLASIFICATION OF CITIES:
URBAN TOPOGRAPHY
<table>
<thead>
<tr>
<th>City</th>
<th>Land / streets</th>
<th>Street density</th>
<th>Intersection D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riyadh</td>
<td>27.87</td>
<td>15.21</td>
<td>109.6</td>
</tr>
<tr>
<td>Makkah</td>
<td>23.12</td>
<td>14.98</td>
<td>111.11</td>
</tr>
<tr>
<td>Jeddah</td>
<td>22.83</td>
<td>14.08</td>
<td>125.71</td>
</tr>
<tr>
<td>Taif</td>
<td>22.65</td>
<td>16.7</td>
<td>146.13</td>
</tr>
<tr>
<td>Medina</td>
<td>27.19</td>
<td>15.85</td>
<td>153.83</td>
</tr>
<tr>
<td>Tabuk</td>
<td>26.65</td>
<td>14.21</td>
<td>86.67</td>
</tr>
<tr>
<td>Khamis Mushait</td>
<td>20.98</td>
<td>15.45</td>
<td>123.04</td>
</tr>
<tr>
<td>Najran</td>
<td>15</td>
<td>10.06</td>
<td>53.21</td>
</tr>
<tr>
<td>Jizan (Jazan)</td>
<td>22.72</td>
<td>13.71</td>
<td>105.45</td>
</tr>
<tr>
<td>Ha'il (Haiel)</td>
<td>24.49</td>
<td>14.75</td>
<td>110.91</td>
</tr>
<tr>
<td>Arar (Araar)</td>
<td>29.27</td>
<td>16.03</td>
<td>115.42</td>
</tr>
<tr>
<td>Al Bahah</td>
<td>13.98</td>
<td>10.34</td>
<td>59.35</td>
</tr>
<tr>
<td>Sakaka</td>
<td>21.43</td>
<td>12.57</td>
<td>90.67</td>
</tr>
</tbody>
</table>
LAS:SD ratio

Measures the **scale** of the urban grain
City prosperity is made possible by its **spatial capital** - the density, streets and public open space.
Identifying Thresholds

Poverty Rate

Intersection Density

$y = 132.97x^{0.1243}$

$R^2 = 0.3411$
IDENTIFYING FACTORS WITH LARGER INFLUENCE

<table>
<thead>
<tr>
<th>Gini Coefficient</th>
<th>Land Allocated to Street</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.028</td>
</tr>
</tbody>
</table>

**Land Allocated to Street**

<table>
<thead>
<tr>
<th>Gini Coefficient</th>
<th>Intersection Density</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.405</td>
</tr>
</tbody>
</table>

**Intersection Density**
### Deviation from City Core values in Colombian cities

<table>
<thead>
<tr>
<th></th>
<th>Land Allocated to Streets</th>
<th>Street Density</th>
<th>Intersection Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass Housing Projects</td>
<td>-16 %</td>
<td>15 %</td>
<td>82 %</td>
</tr>
<tr>
<td>Informal Areas</td>
<td>-34 %</td>
<td>34 %</td>
<td>130 %</td>
</tr>
<tr>
<td>Industrial Areas</td>
<td>-31 %</td>
<td>-40 %</td>
<td>-38 %</td>
</tr>
</tbody>
</table>
Typologies in Colombian cities:

- Average All Regions
- Colombian Average
- Historic Center
- Consolidated Areas
- Mass Housing
- Informal Areas
- Industrial
- UN-Habitat

Urban Pattern Quadrants:

1. Atomistic pattern
2. Theoretical grid pattern
3. Industrial pattern
4. SD:ID ratio

50 300
30 10
Accessibility to Public Space

1. Green Area per Capita

2. Accessibility to Open Public Space

- % urban AREA within 400m from open public space
- % urban AREA within 1000m from major open public space

Dammam, Saudi Arabia
Accessibility to Public Space

1. Green Area per Capita

2. Accessibility to Open Public Space

• % urban AREA within 400m from open public space

• % urban AREA within 1000m from major open public space

Guayaquil, Ecuador
Accessibility to Public Space

1. Green Area per Capita

2. Accessibility to Open Public Space

- % urban AREA within 400m from open public space
- % urban AREA within 1000m from major open public space

Lima, Peru