U4SSC SMART SUSTAINABLE CITY INDEX (SSC INDEX) – FIRST DRAFT

THE GLOBAL CITY RANKING

PRESENTED BY:

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&

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CONTENT

- History why measuring, metrics and best practices
- Why we need better solutions than just static analysis
- Methodologies
- What can be implemented together e.g. Forms etc.
- Timeline

TWO PHENOMENA:

TWO PHENOMENA:

MEASURING UP…
THE TRADITIONAL WAY

The Economist Intelligence Unit's "Global Liveability Ranking"

Forbes: Ranking The World's 'Smartest' Cities

Mercer Quality of Living Survey

Monocle's "Most Liveable Cities Index"

UNDP Human Development Report

Environmental Performance Index (EPI)

World Bank International LPI Global Ranking

A.T. Kearney Global Cities Index and Global Cities Outlook

PWC Cities of Opportunity, The living city

ARCARDIS Sustainable Cities

Legatum Prosperity Index

IPRI Index of property rights

IMD World Competitive Index

World **Economic Forum**

WHY UNITED 4 SMART SUSTAINABLE CITY INDICATORS ARE NEEDED?

In general, city rankings offer leaders, urban stakeholders and businesses:

- Efficiency in urban operations and services
- Means to improve quality of life of the citizens
- Cultivation of economic, social and environmental sustainability

WHY A U4SSC INDEX? II

- There is a need to measure progress.
- There is a need to make different levels of economic integration, geographic location sizes of cities transparent.
- There is a need to evaluate and integrate different levels of quantitative and qualitative data.
- There is a need to make these data comparable and visible with state of the art scientific methods.
- There is a need to transform/translate scientific outcomes into easy understandable graphics and numbers.
- There is a need to make outcomes/results public for users (citizens, governments etc.).

BENEFITS FOR CITIESNG AND RANKING

The **overall rating** includes sub-ratings within the following categories with n - different parameters:

- Business/Micro-Economics
- Government/Public Economy and infrastructure/Macro-Economics,
- Quality of life for individuals and
- the future development potential of each Smart City concept.

➔ after all the outcomes of the U4SSC INDEX **determine policy decisions** of **investment** or **divestment**
➔ for industrial production sites, headquarters, service industries, **smart decisions on sustainability** and **green growth** etc.

- targeting existing gaps and deficiencies
  - identifying the top priority areas
  - make a prognosis on their future performance

➔ better access to financial means

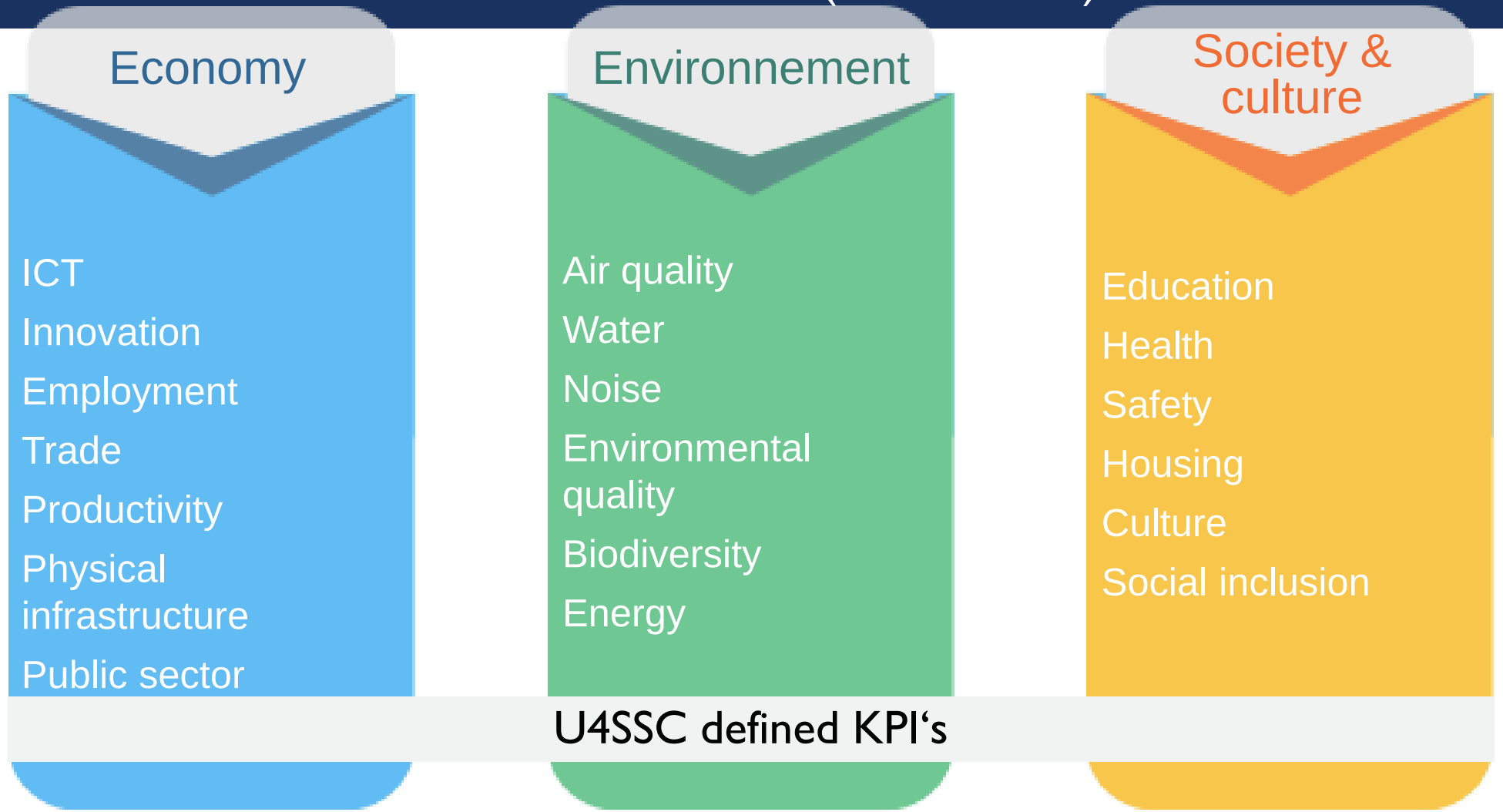
- targeting transparency
  - standardization
  - enabling better, consistent, evidence-based decision making

➔ better access to financial means

SO LETS CHECK THE BOXES – BENEFITS FOR ALL STEAKHOLDERS

- identify sources of funding and opportunities for financing to implement smart urban solutions
- bridge the gap between investors and cities
- discuss business models and good practices for financing cities
- determine the right standards and variables (key performance indicators KPIs) and SDGs to monitor success, economic growth and wellbeing
- Self-assessment

INDICATORS
OF SMART SUSTAINABLE CITIES (BY U4SSC)



POINTS TO BE TAKEN INTO CONSIDERATION FOR INDICES

- Differnet preferences
- No coherent set of metrics
- ... common understanding
- ... shared goals
- ... division of labor
- ... exchange

BASIS U4SSC INDEX?

- The classification "population size" may be defined as follows:
  - 0 – 10,000 citizens
  - 10,000 – 50,000 citizens
  - 50,000 – 100,000 citizens
  - 100,000 – 250,000 citizens
  - 250,000 – 500,000 citizens
  - 500,000 – 1,000,000 citizens
  - 1,000,000+ citizens

- The classification "economic integration" may be defined as follows (IMF):
  - < $2,000 GDP per Capita
  - $5,000 – 10,000 GDP per Capita
  - $10,000 – 20,000 GDP per Capita
  - $20,000 – 35,000 GDP per Capita
  - $35,000 – 50,000 GDP per Capita
  - > $50,000 GDP per Capita

GEOGRAPHIC LOCATION

WHO CAN PARTICIPATE IN THE U4SSC INDEX PROGRAM TIMELINE

- Any city, community, municipality that is part of the U4SSC program regardless its size or geographical location
- Any city that has uploaded the data on the ITU Form / U4SSC Index website
- Any city, whose data have been evaluated

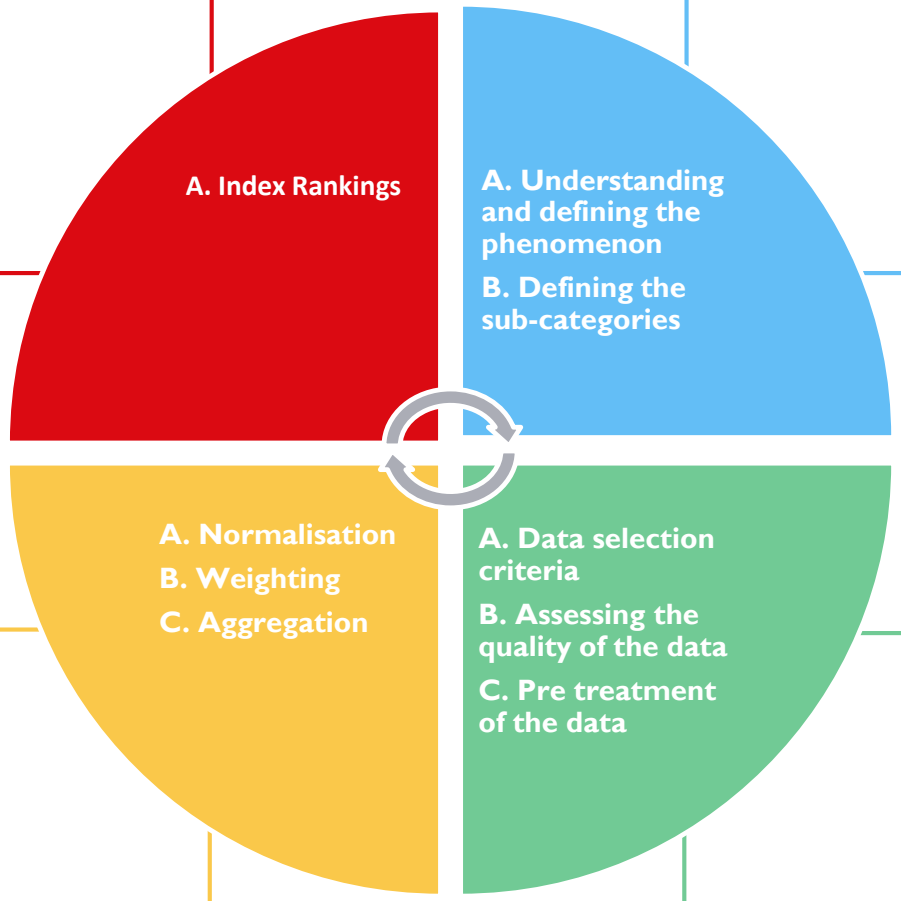
- Every year there will be a new edition with special focus of the U4SSC INDEX

PREPARATION OF THE U4SSC INDEX – FIRST DRAFT

- **This SSC INDEX is being developed under a cooperation agreement between ITU and Smart Dubai**
- **The SSC INDEX is based on the Key Performance Indicators (KPIs) for Smart Sustainable Cities (SSC) which were developed with the input from 16 UN Agencies, over 100 cities under the framework of the U4SSC Initiative.**
- **The U4SSC KPIs are based on Recommendation ITU-T Y.4903/L.1603: Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals.**
- **The development of the SSC INDEX, is based on feedback gathered from the pilot testing of the U4SSC KPIs which are being implemented in over 100 cities worldwide.**
- Input is being also gathered from other external researchers and scientists from Universities, Institutes and Think Tanks from different fields of research e.g. political and social science, economics, institutional economics, sociology, mathematics, statistics, computer science, philosophy, city planners, architects, environmentalists etc.
- In addition to the inputs from the experts in Dubai and experts from many UN Agencies, additional input is being gathered from other experts including: Maria Blanco (San Pablo CEU University), John Chisholm (MIT, Alumni President), Nobel Laureate Edmund Phelps (Columbia University), Peter Jungen (Institute for New Economic Thinking), Nobel Laureate Vernon Smith (Chapman University), Dambisa Moyo (Independent), Hartwig Schafer (World Bank), Razeen Sally (National University of Singapore), Robert Lawson (Southern Methodist University, Dallas), Enrico Colombatto (University of Torino), Hannes Gisruarson (University of Iceland), Richard Rahn (Institute for Global Economic Growth), Enrique Ghersi (University of Lima), Deirdre McCloskey (University of Illinois at Chicago), Krassen Stanchev (University of Sofia), Prince Michael of Liechtenstein (GIS, Geopolitical Intelligence Services, Liechtenstein); Christian Bjornskov (Aarhus University)…

PHASES AND POSSIBLE TIMELINE UNDERTAKEN TO CONSTRUCT THE U4SSC INDEX

- Phase 4
- **Result visualization**



- Phase 1
- **Theoretical Framework**

- Phase 3
- **Data treatment**

- Phase 2
- **Data selection**

U4SSC INDEX POSSIBLE OUTCOMES I

- The U4SSC Index sets new standards to compare cities.
- The U4SSC Index is the first international set of coherent metrics.
- TheU4 SSC Index uniquely coordinates data input from all international resources (e.g. UN Statistical Division, World Bank, OECD etc.) and the evaluated KPI city data with its state of the art scientific methods.
- TheU4SSC Index benchmarks the cities' contribution to sustainability and smartness as well as their ongoing efforts to implement SDGs.
- The U4SSC Index is a highly useful tool for any city to improve, advance and further develop its performance related to society, economy and environment.
- The U4SSC Index allows cities to learn from each other in a transparent way.

U4SSC

UNITED FOR SMART SUSTAINABLE CITIES INDEX

METHODOLOGY

BASIC CONSIDERATIONS

BASIC CONSIDERATIONS
(BASED ON RECOMMENDATIONS FROM IMF, EUROSTAT, OECD)

- **Relevance**

  The relevance of the selected range of basic data to the overall purpose of the indicators was determined by a group of experts.

- **Accuracy**

  Accuracy of data is an extremely important for the purpose of building composite indicators. Thus, special attention has been paid to the process of securing and validating data. It is in this context that a request was made to have data from a reliable source namely, the UN.

- **Accessibility**

  Accessibility to reliable data source can affect the cost of production and updating the indicators over time. In this respect having access to the data that is collected directly from the respective city authorities is extremely important.

- **Coherence**

  Coherence of data over time as well as over cities is another aspect that affects the data quality. A questionnaire with definitions and explanations were prepared in order to ensure the coherence of the data used for the model.

- **Timeliness**

  Considering that data collection timings vary between the variables as well the cities, special care will be taken to ensure that all data in question refer to the same time frame.

- **Interpretability**

  The interpretability of data is another important factor that influences the quality of the final product. In order to ensure adequate interpretability a table consisting of definitions and classifications was used for all stakeholders.

KEY PERFORMANCE INDICATORS (KPI)

Key Performance Indicators (KPI)

Dimension	Economy	Environment	Society and Culture
Sub-Dimension	ICT | Productivity | Infrastructure	Environment | Energy	Education Health, Culture | Saftey, Housing, Social Inclusion
CATEGORY	ICT Infrastructure Water and Sanitation Drainage Electricity Supply Transport Public Sector Innvoation Employment Water and Sanitation Waste Transport Electricity Supply Building Urban Planning	Air Quality Water and Sanitation Waste Environmental Quality Public Space and Nature Energy	Education Health Culture Housing Social Inclusion Safety Food Security

Each KPI is located in one of the Top-3 key performance indicators structure levels.
54 Core Indicators + 37 advanced Indicators; 20 Smart + 32 Structural + 39 Sustainable

KPI EXAMPLES

Variable Name	Average	Stdev	Max	Min
Household_Internet_Access	89,8%	1,7%	92,5%	86,9%
Fixed_Broadband_Subscriptions	79%	22%	117%	41%
Wireless_Broadband_Subscriptions	155.555	70.461	279.094	32.038
Availability_of_WIFI_in_Public_Areas	5.074	5.545	14.442	-4.705
Smart_Water_Meters	3%	4%	10%	-3%
Smart_Electricity_Meters	5%	5%	13%	-3%
R_D_expenditure	3%	1%	4%	2%
Patents	50,80	49,21	132,59	-39,87
Unemployment_Rate	2%	1%	4%	0%
Youth_Unemployment_Rate	4%	2%	7%	1%
Water_Supply_Loss	9%	2%	12%	5%
Electricity_System_Outage_Frequency	0,08	0,05	0,15	-0,02
Electricity_System_Outage_Time	229,54	291,09	724,91	-261,48
Public_Transit_Network	179,31	35,53	240,97	121,86
Bicycle_Network	10,96	8,41	25,98	-3,25

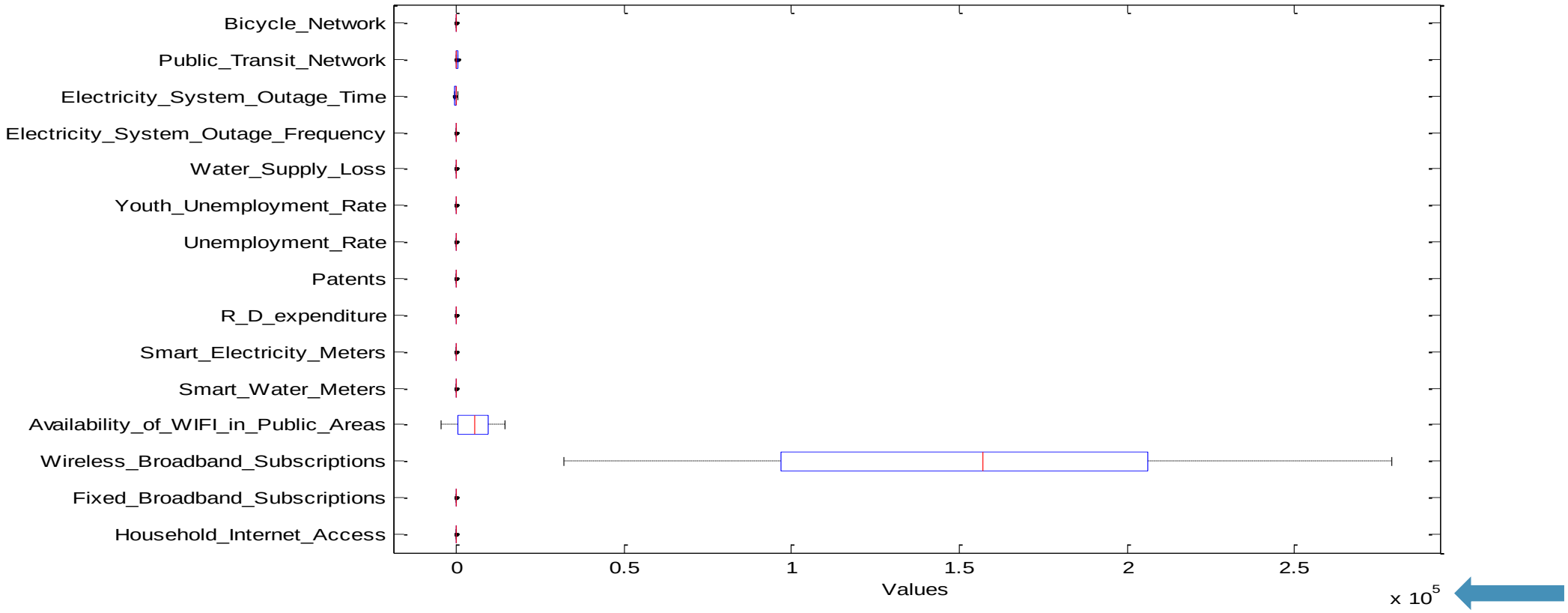
The KPI‘s are measured in different scales.

TREATMENT OF MULTIDIMENSIONAL DATA

TREATMENT OF MULTIDIMENSIONAL DATA

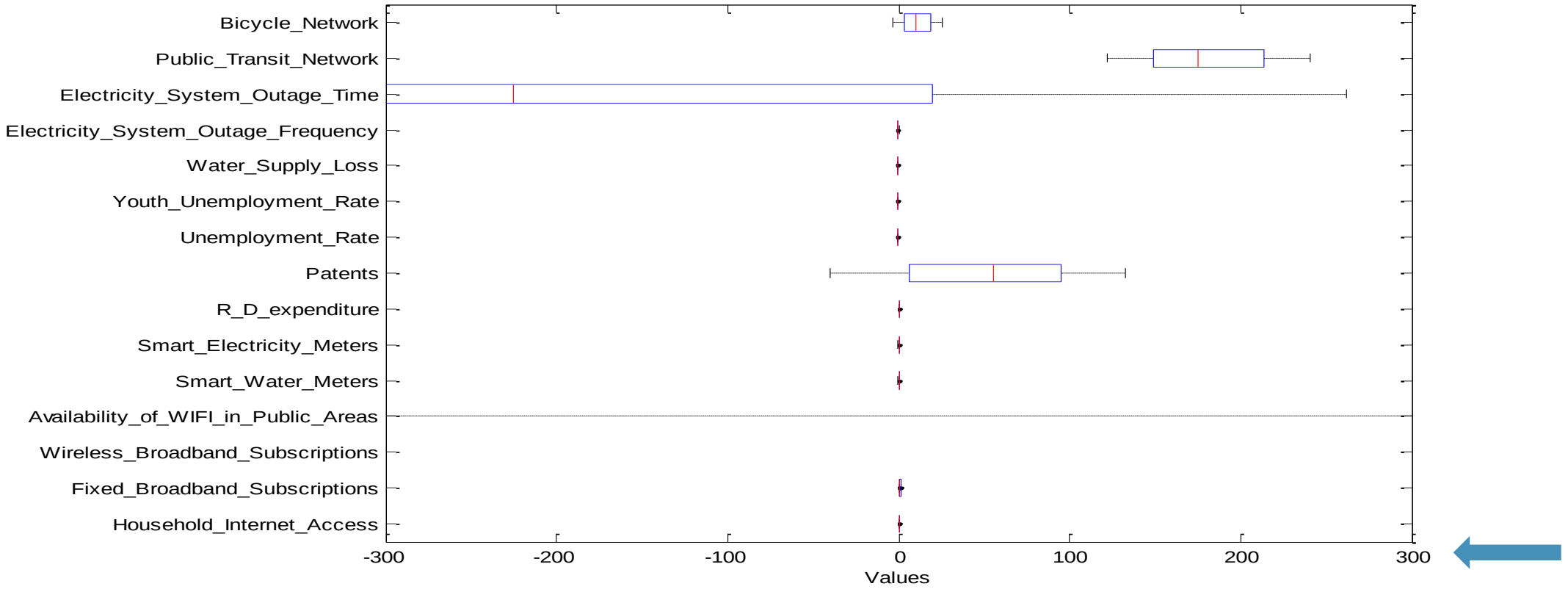
The individual KPIs are selected from a large set of variables which are appropriate to measure the distinct characteristics of cities in all relevant research dimensions. The next step involves **normalization** that enables comparisons between different indicators in a way that removes the impact of varying scales. Additionally, the indicators have to be **positively orientated**, which means that a higher (transformed) indicator value corresponds with better performance. (To this end, there are different methods available.)

BOX-PLOT VARIABLES (EXAMPLE ECONOMY) I



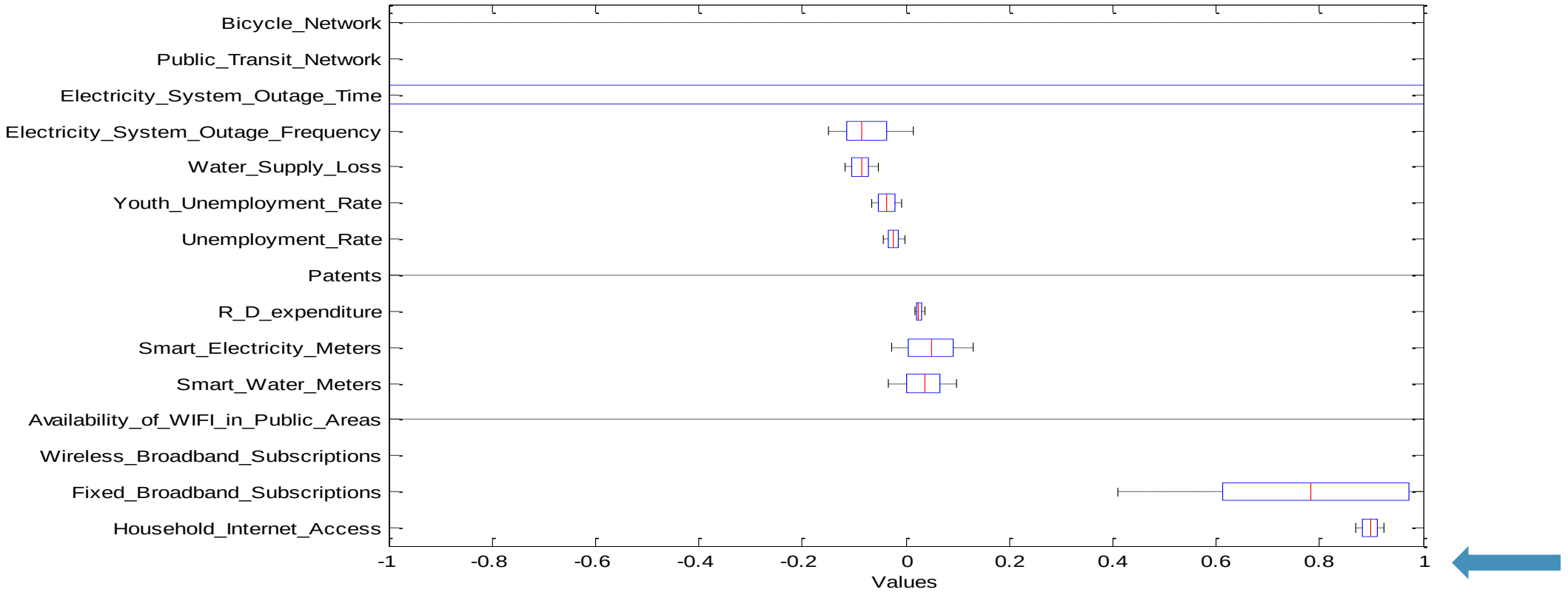
Different scales of variables (KPI) ….

BOX-PLOT VARIABLES (EXAMPLE ECONOMY) II



… require a …

BOX-PLOT VARIABLES (EXAMPLE ECONOMY) III



… standardization method.

TERMINOLOGY: METHODOLOGY MIN-MAX / Z-SCORE

$$I_{i,j} = \frac{x_{i,j} - \min_{i}\left(x_{i,j}\right)}{\max_{i}\left(x_{i,j}\right) - \min_{i}\left(x_{i,j}\right)}$$

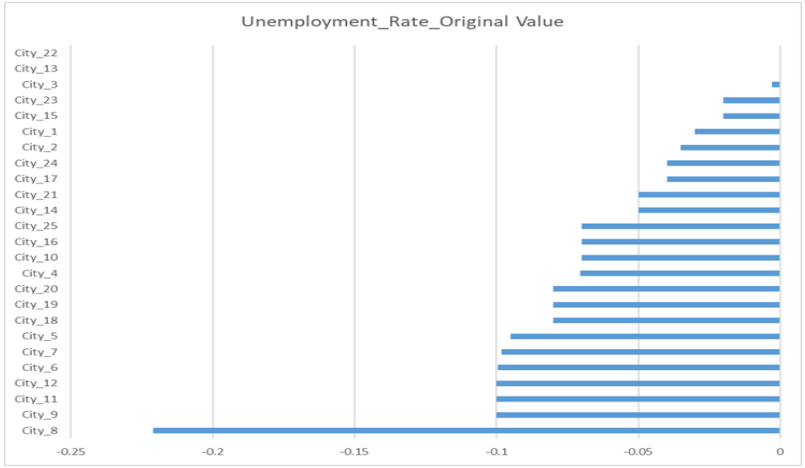
$j = 1 \ldots J$ J Number of Indicators

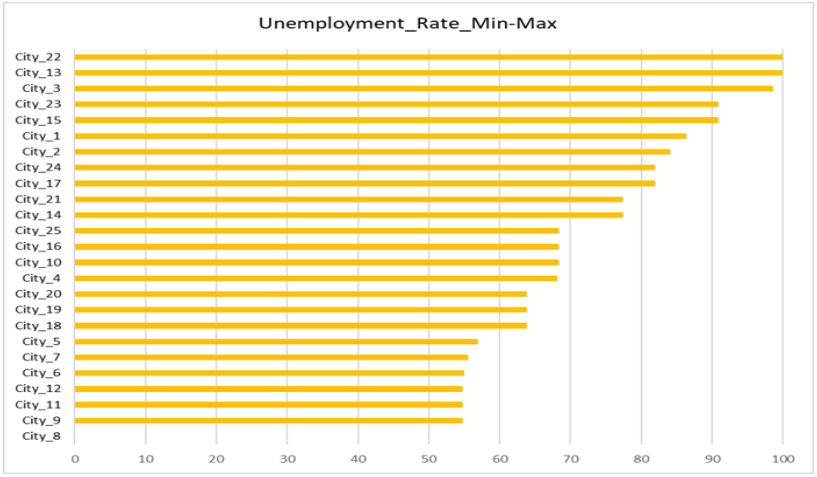
$i = 1 \ldots I$ I Number of cities

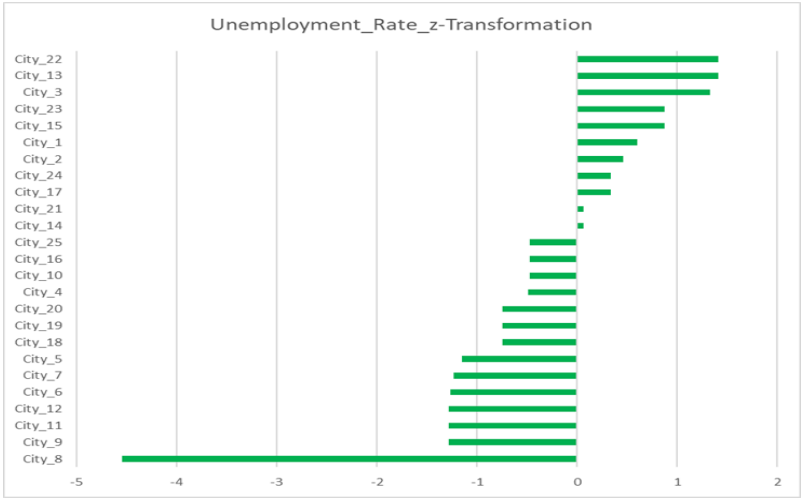
Since min-max-transformation is sensitive to extreme values, a z-transformation could be preferable in some cases. After standardization each transformed indicator variable has a mean of zero and a standard deviation of one E.g. an isolated and huge indicator value would shift all other transformed indicator values towards zero, and vice versa an isolated and tiny indicator value would shift all other transformed indicator values towards one.

$$I_{i,} = \frac{x_{i,j} - \underset{j}{mean}\left(x_{i,j}\right)}{\underset{j}{stdev}\left(x_{i,j}\right)}$$

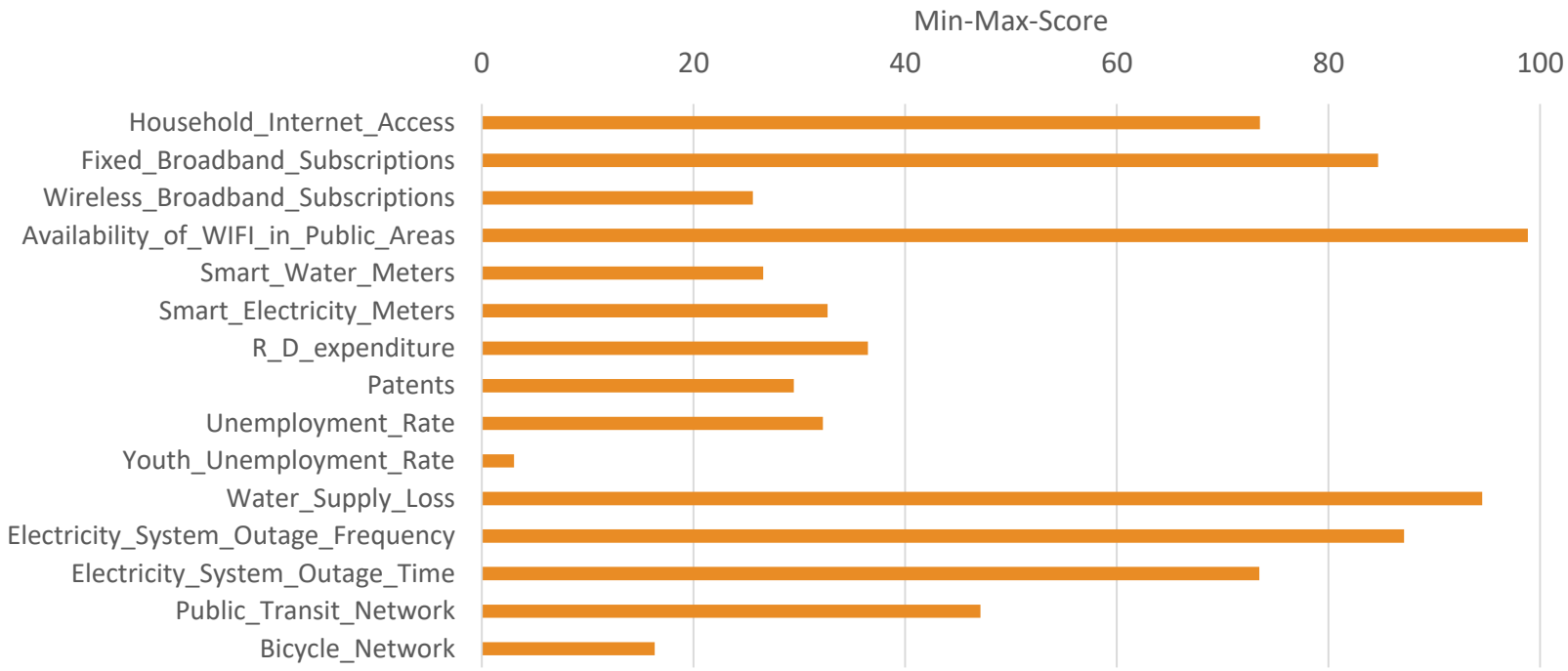
EXAMPLE WITH AN OUTLIER





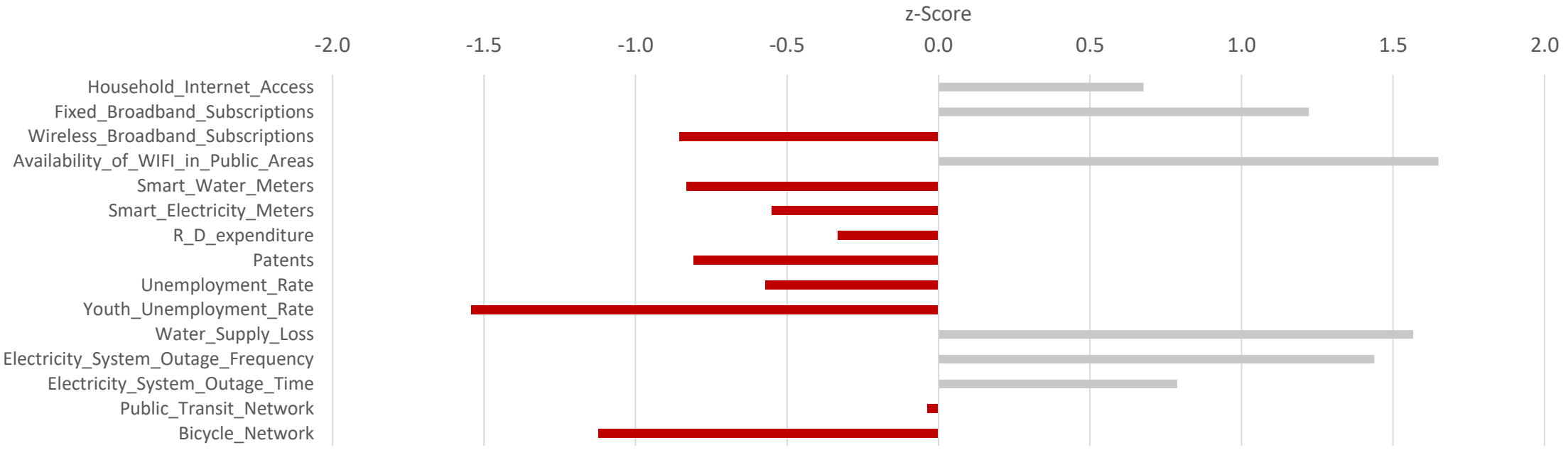


MIN-MAX-SCORE TO MAKE IT READABLE



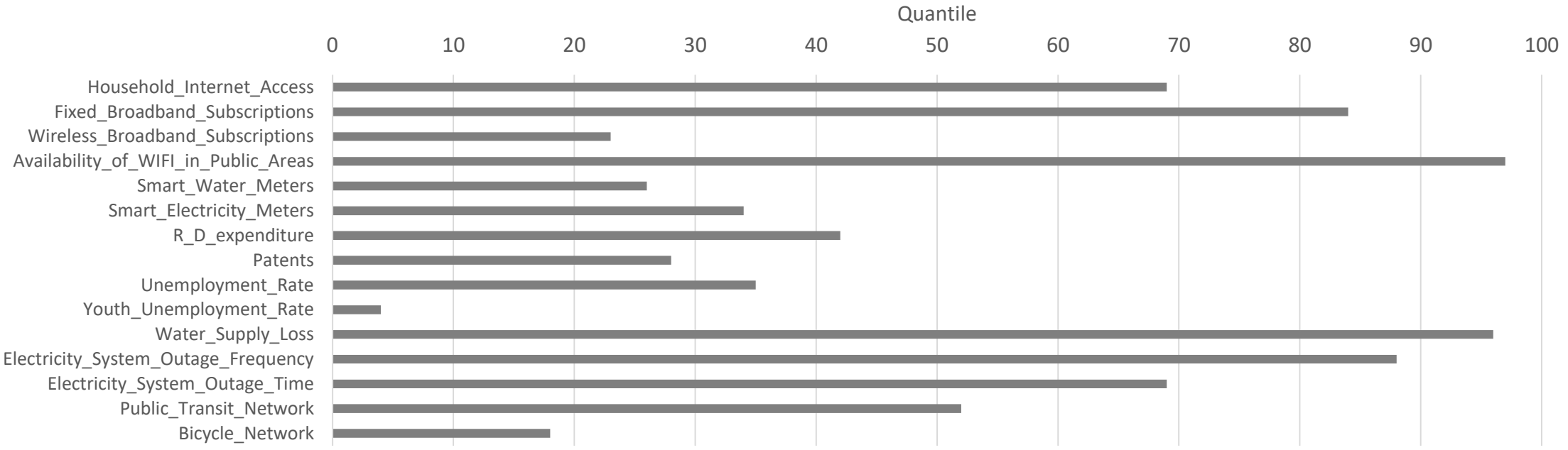
The performance of the city analysed in relation to the best (value 100) and worst performer (value 0) for each KPI can be shown.

Z-SCORE



Calculation of a z-score (each variable has an average of zero and a standard deviation of one). A positive (negative) values indicates a city performance above (below) the average.

QUANTILE



Show the performance of the analysed city in each KPI using the quantile of the rank position for the city and each dimension (KPI).

WEIGHTING AND AGGREGATION

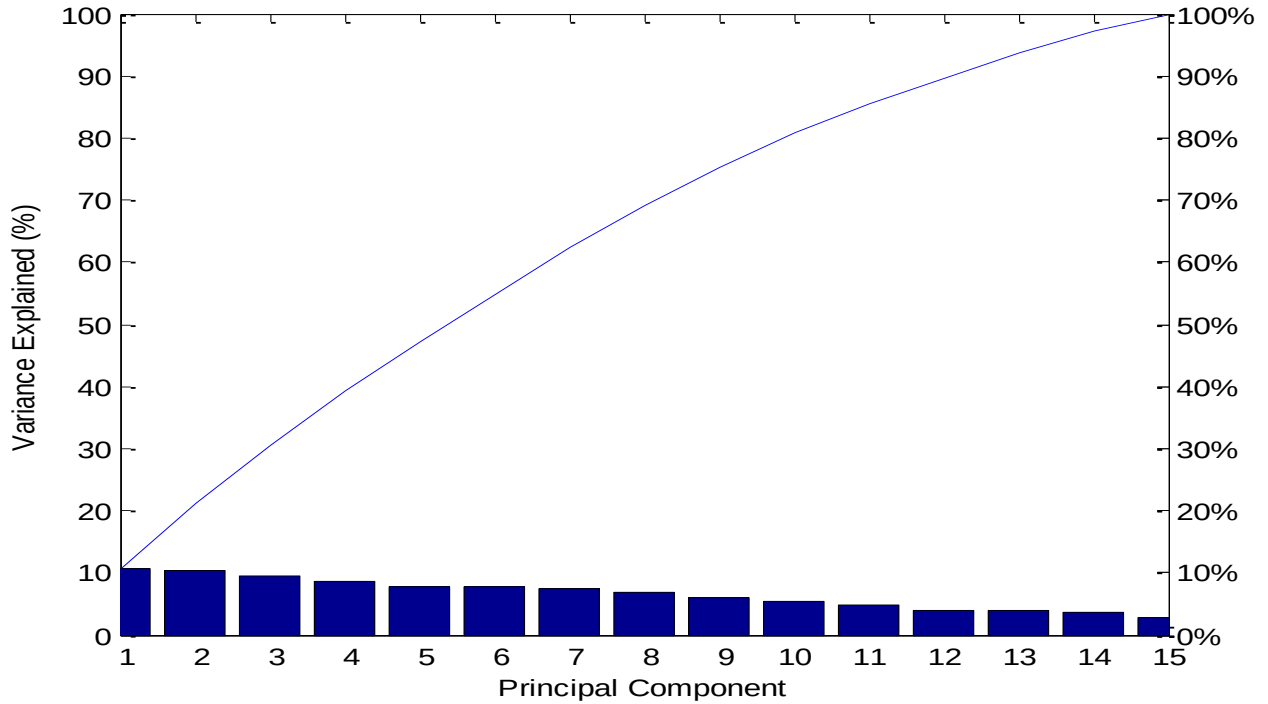
METHODOLOGY: AGGREGATION

- The next step is aggregation which involves determination of the vector of weights is based on a principal component analysis (PCA). This procedure rules out any ex-post influence on the weighting vector once the outcome of the benchmarking exercise is known since the weights are algorithmically and endogenously determined. This method contributes to a substantial objectification of the benchmarking process. The index for region *i* is thus calculated according to:

$$Index_i = \sum_{j=1}^{J} w_j \cdot I_{i,j}$$

- where the ***J*** weights are calculated using the standardized principal component coefficients $PC_{l,j}$ (also known as loadings) from a principal component analysis with variance represented by the corresponding principal component VE_l. Both dimensions are scaled to unity prior to the calculation of weights ($PC_{l,j}^*$, VE_l^*).

PRINCIPAL COMPONENT ANALYSIS



Explain the variance of the observed data throug a few linear combinations of the original data. The principal components are uncorrelated and preserve an amount of the cumulative variance of the original data.

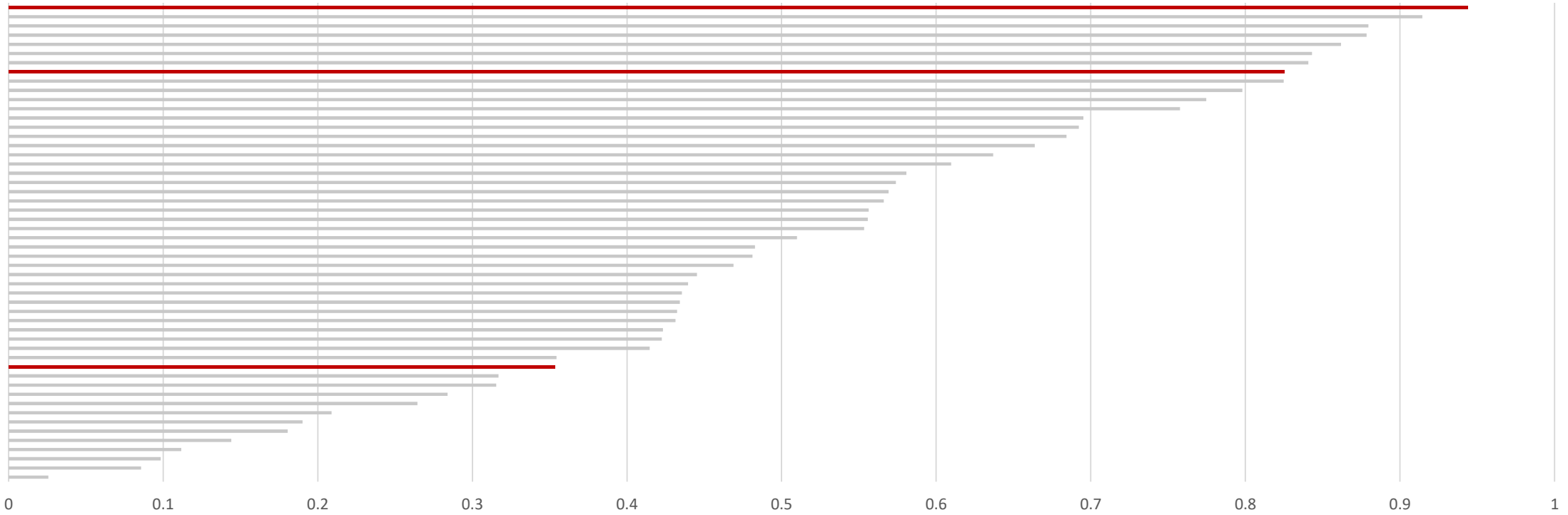
ENDOGENOUS DATA DRIVEN WEIGHTS

Using the principal component analysis it is possible to derive endogenously
weights for the KPI.

SUM OF THE NORMALIZED KPIS

CONTRIBUTION OF THE INDIVIDUAL WEIGHTED KPIS

U4SSC INDEX EXAMPLE



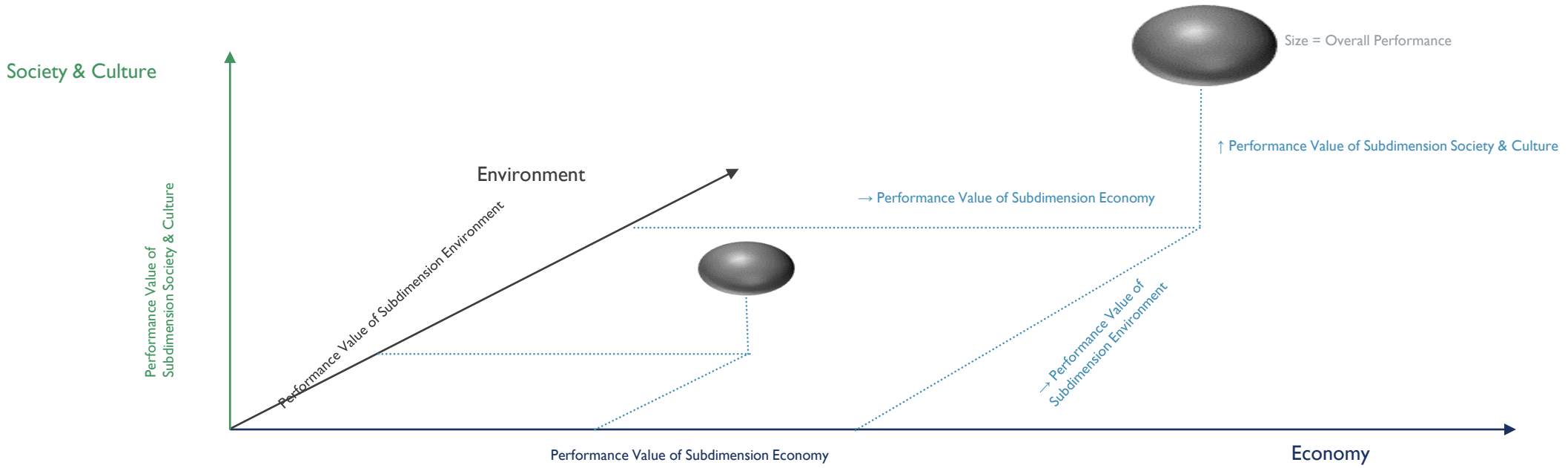
The overall index value is calculated by an additive aggregation of the standardized values and the endougenously derived weights using pca.

CLUSTERING

The Methodology used for U4SSC INDEX the variables such as size of population, level of GDP and geographical location of the cities play an important role, and thus can influence the ranking considerably. In order to avoid any bias that can arise from the inherent socio-economic characteristics of the cities and to be able to compare cities with similar socio-economic criteria, a clustering mechanism will classify cities according to the size, (both geographic and population), geographic location and Economic integration of the cities.

VISUALIZATION

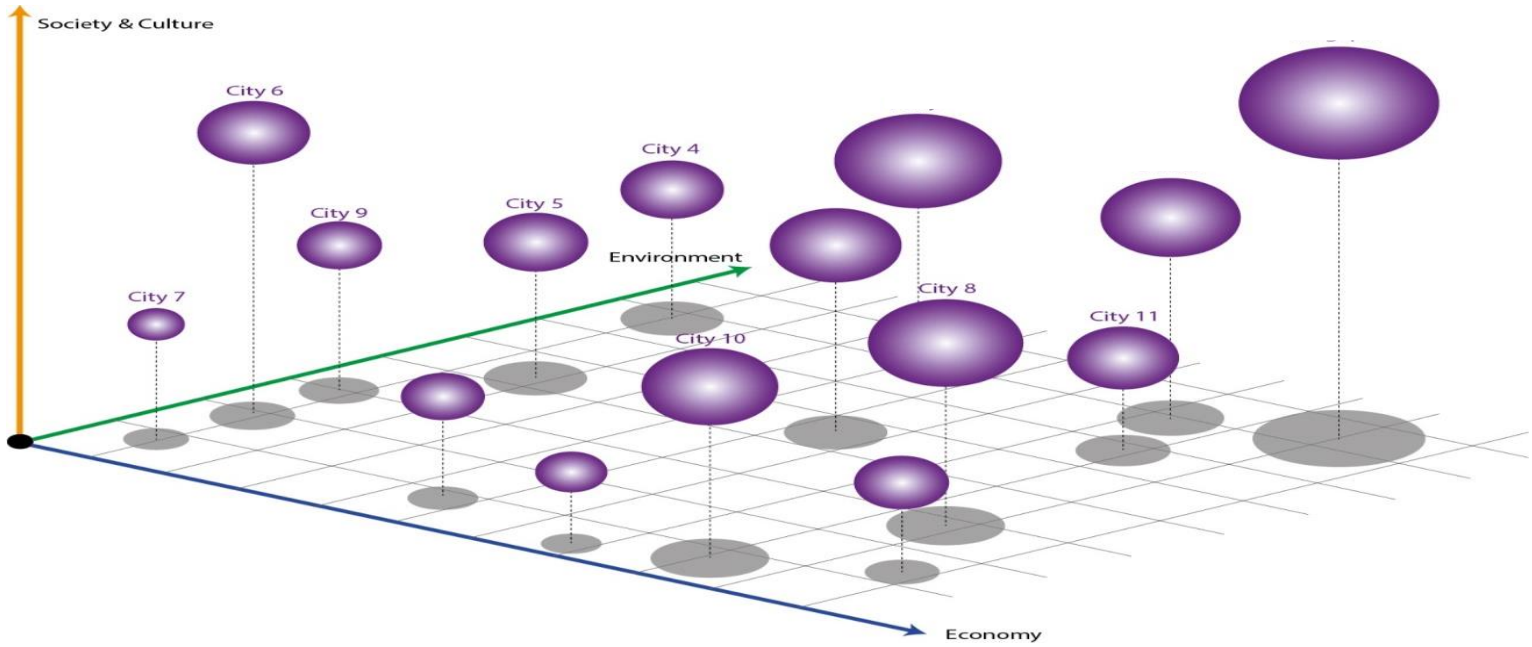
THE SMART AND SUSTAINABLE CITY UNIVERSE VISUALIZATION CONCEPT OF THE INDICATOR VALUES



The position of the individual cities is given by the performance in the three dimensions. The size is representing the overall performance.

THE SMART AND SUSTAINABLE CITY UNIVERSE VISUALIZATION OF THE INDICATOR RESULTS

Concrete overview



3-D visualization of the indicator results using example data.

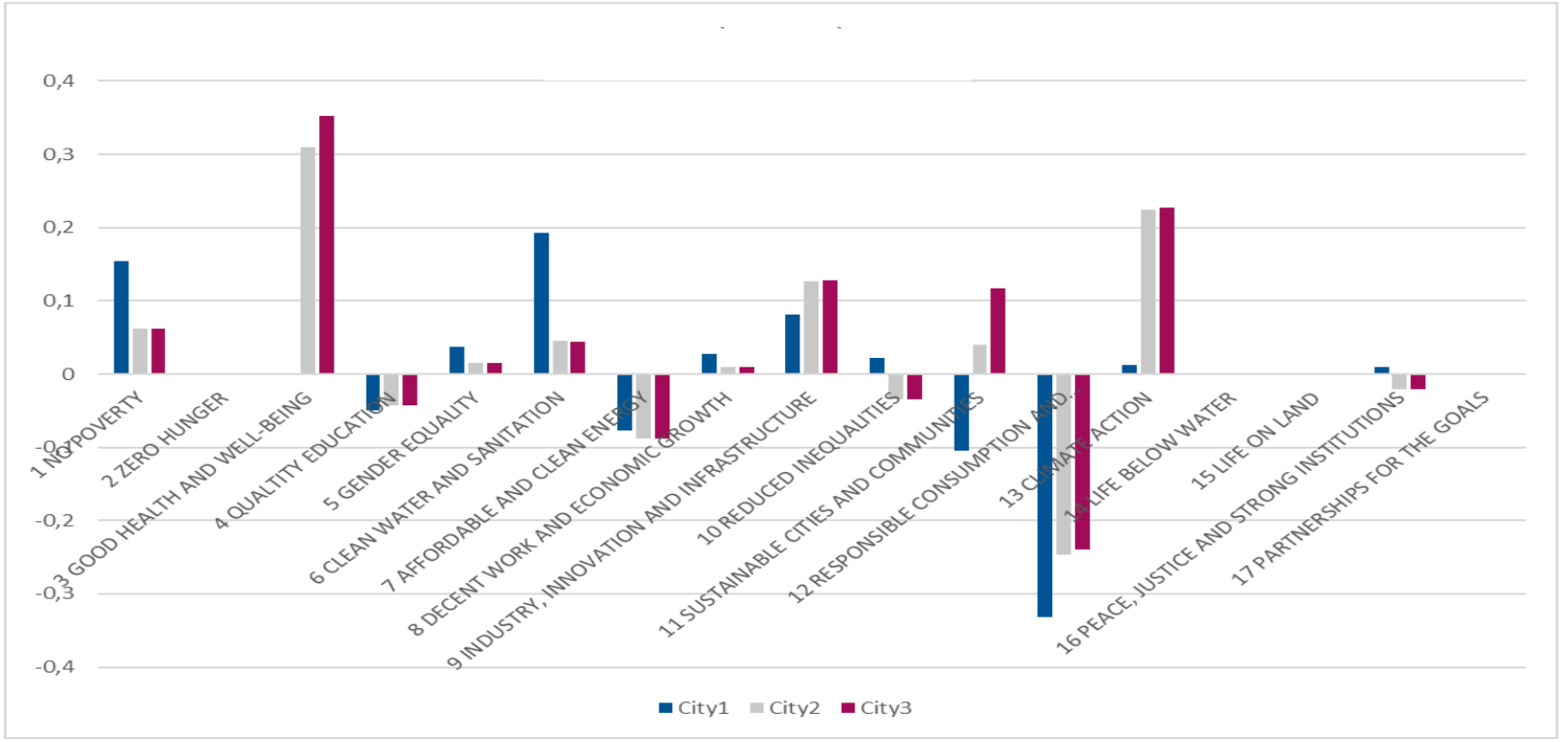
SUSTAINABLE DEVELOPMENT GOALS

SUSTAINABLE DEVELOPMENT GOALS

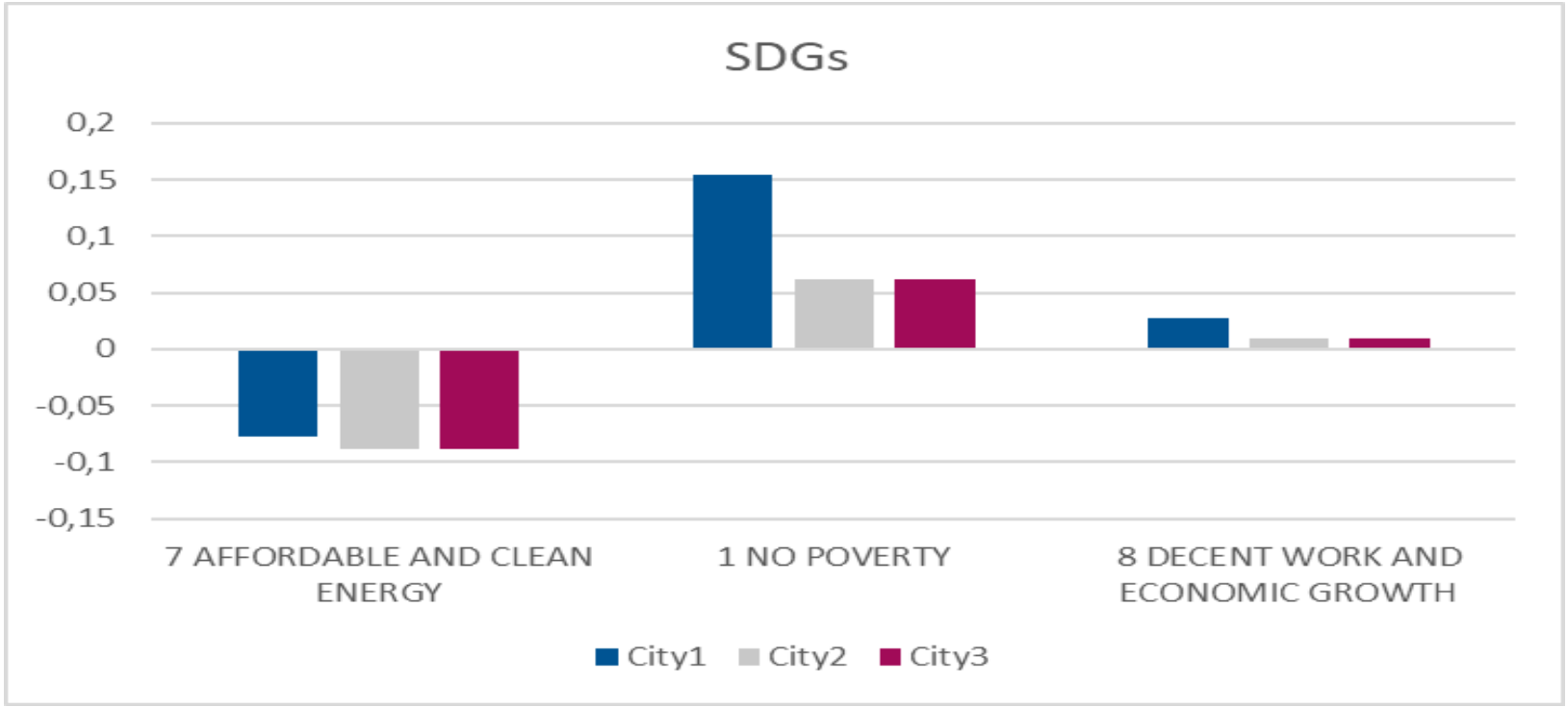
MAPPING
KPI → SDG

		SDG01	SDG02	SDG03	SDG04	SDG05	SDG06	SDG07	SDG08	SDG09	SDG10	SDG11	SDG12	SDG13	SDG14	SDG15	SDG16	SDG17
		1 NO POVERTY	2 ZERO HUNGER	3 GOOD HEALTH AND WELL-BEING	4 QUALITY EDUCATION	5 GENDER EQUALITY	6 CLEAN WATER AND SANITATION	7 AFFORDABLE AND CLEAN ENERGY	8 DECENT WORK AND ECONOMIC GROWTH	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	10 REDUCED INEQUALITIES	11 SUSTAINABLE CITIES AND COMMUNITIES	12 RESPONSIBLE CONSUMPTION AND PRODUCTION	13 CLIMATE ACTION	14 LIFE BELOW WATER	15 LIFE ON LAND	16 PEACE, JUSTICE AND STRONG INSTITUTIONS	17 PARTNERSHIPS FOR THE GOALS
of	23																	
of	31																	
Description																		
Percentage of households with Internet access	Percentage									■								
Percentage of households with fixed (wired) broadband.	Percentage									■								
Wireless broadband subscriptions per 100 000 inhabitants.	Number / 100 000 inhabitants									■								
Percentage of the city served by wireless broadband - 3G	Percentage									■								
Percentage of the city served by wireless broadband - 4G	Percentage									■								
Number of public WIFI hotspots in the city	Number									■								
Percentage implementation of smart water meters.	Percentage						■			■								
Percentage of the water distribution system monitored by I	Percentage																	
Percentage of drainage / storm water system monitored by	Percentage																	
Percentage implementation of smart electricity meters.	Percentage																	
Percentage of electricity supply system monitored by ICT	Percentage						■				■							
Percentage of electricity customers with demand response	Percentage							■				■						
Percentage of urban public transport stops with dynamicall	Percentage									■								
Percentage of major streets monitored by ICT	Percentage									■								
Percentage of road intersections using adaptive traffic cont	Percentage									■								
Percentage and number of inventoried datasets that are pu	Percentage and Number									■								
Number of public services delivered through electronic mea	Number									■								
Percentage of public sector procurement activities that are	Percentage									■								
Research and Development expenditure as a percentage o	Percentage									■								
Number of new patents granted per 100 000 inhabitants pe	Number /100 000 inhabitants									■								
Percentage of small and medium-sized enterprises (SMEs)	Percentage								■	■								
Percentage Unemployed	Percentage								■									
Percentage Youth Unemployed	Percentage								■									
Percentage of the labour force working in the tourism indus	Percentage											■						
Percentage of the labour force working in the ICT industry	Percentage									■								
Percentage of households with access to a basic water sup	Percentage						■											
Percentage of houesholds with potable water supply	Percentage						■											
Percentage of water loss in the water distribution system.	Percentage						■					■						
Percentage of households served by wastewater collection	Percentage						■					■						
Percentage of households with access to basic sanitation	Percentage						■					■						

PERFORMANCE INDICATORS ACCORDING TO INDIVIDUAL SDG



PERFORMANCE INDICATORS ACCORDING TO SELECTED SDG



SUMMARY

SUMMARY I:
ADVANTAGES OF KPI AND U4SSC INDEX
RATING AND RANKING

- U4SSC KPIs designed according to above methodology will help rank cities according to quality dimensions of living, working and producing in leading cities. By combining several concepts such as economy, environment culture and society, quality of life, and government, this index succeeds in capturing complex multidimensional realities with a view to supporting decision makers and stakeholders.
- This model can also assess progress over time and allows users to compare complex dimensions over time. The robustness tests that are built into the final calculations make it reliable for intertemporal analysis.
- Min-Max method assures that the indicators are normalized over an identical range. Even though the role of outliers in such a method can influence final ranking, a discussion among the involved experts can find appropriate ways to minimize the distortion, otherwise a z-transformation may become necessary.
- Since the cities are clustered prior to the application of the methodology to derive the indices, the interval of the indicators may become relatively small. In this case, the advantage of Min-Max method which leads to widening of the range of indicators that lie within a small interval increases the effect on composite indicator.

SUMMARY II:
ADVANTAGES OF KPI AND U4SSC INDEX
RATING AND RANKING

- In case of environmental indicators, distance to the theoretical values set as optimal by international agencies will be used to assign scores for the cities. For example, using the internationally agreed values as reference points, one can assign a value of 1 for the city that meets the criteria exactly and assign values higher than 1 to the cities who have better scores and less than one to cities with worse records.
- Most composite indicators use methods where all variables are given same weight. However, in a benchmarking framework such as U4SSC weights can play an important role in the final ranking. The model that will be used here will be assigning weights bases on several factors that will be decided among the experts. One of the methods that can be used to assign weights is principal component analysis (PCA). This procedure rules out any ex-post influence on the weighting vector once the outcome of the benchmarking exercise is known since the weights are algorithmically and endogenously determined. A stability check will be carried out using a Monte Carlo simulation.
- Another advantage in this model is that the composite indicator that can be used as a summary indicator to guide policy makers, can also be decomposed to provide insight into various sub-components which can help in depth understanding the characteristics of a city.

U4SSC AROUND THE WORLD

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ECONOMY INDICATORS / ADDITIONAL SUBCATEGORIES

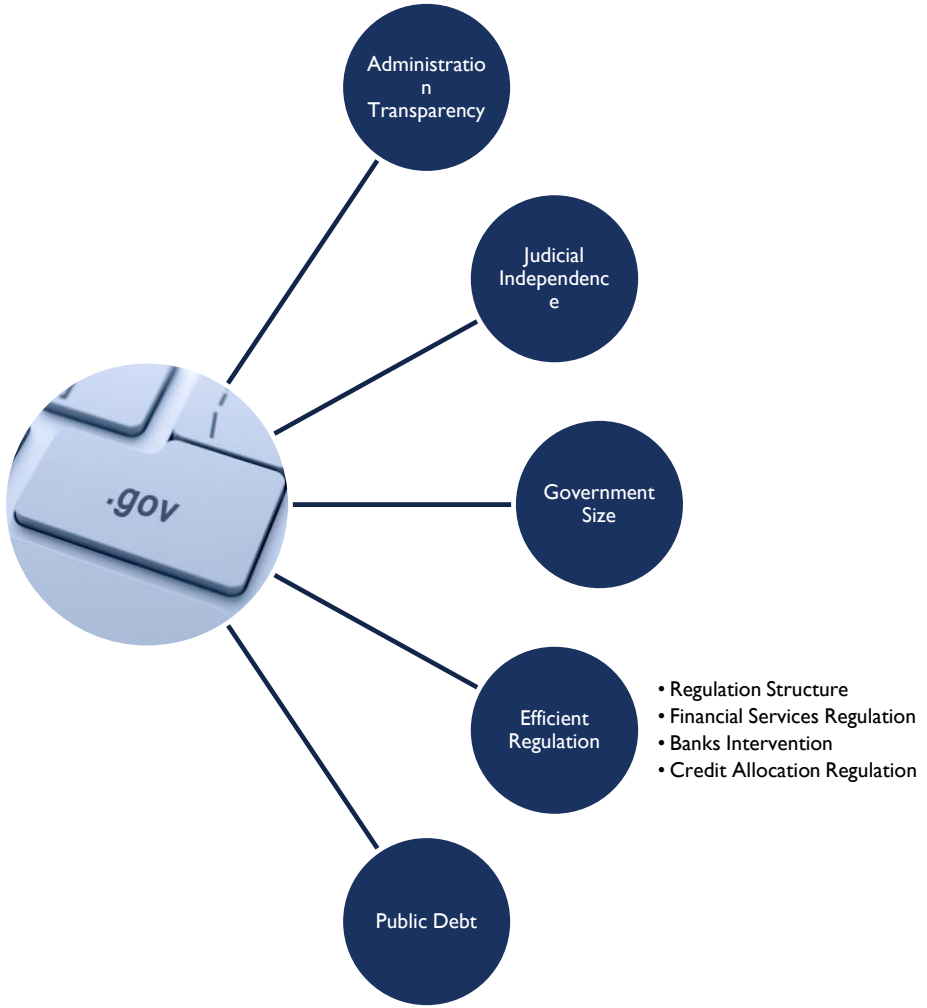
Additional KPIs have been added to create additional added value for the useres and allow to constantly improve, adapt and advance the U4SSC INDEX.

"QUALITY OF LIFE" INDICATORS / ADDITIONAL SUBCATEGORIES

The U4SSC INDEX, in addition to the overall results focuses on a new sub topic each year:
e.g. sustainable use of energy (in the housing sector) or smart public transport solutions

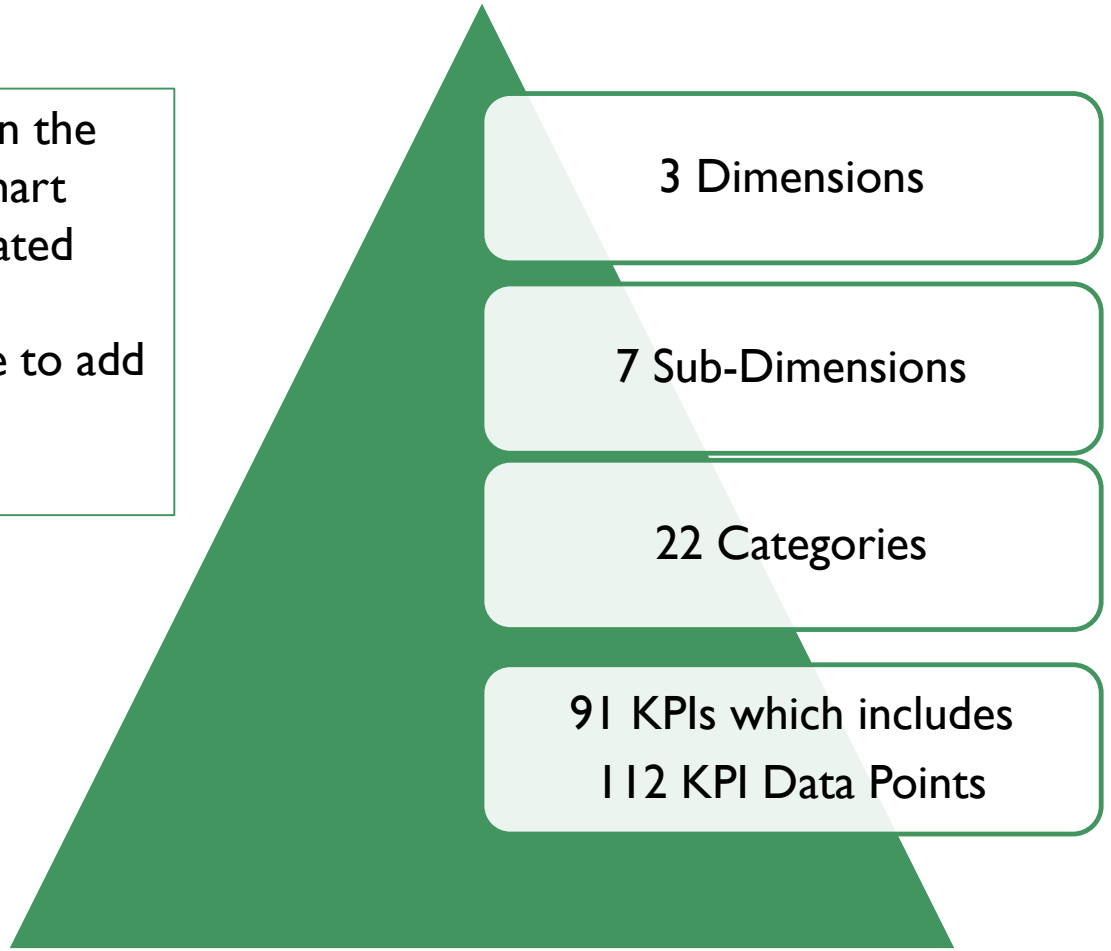
“CITY GOVERNMENT” INDICATORS / ADDITIONAL SUBCATEGORIES

The U4SSC INDEX presents differnt winners in all segments every year and provides comparisons and explanations



Variable Selection
Smart Sustainable City Key Performance Indicators

The variables are selected based on the Key Performance Indicators for Smart Sustainable Cities and fed/interpolated into the System.
For cities there will be an interface to add data.



Each KPI is located in one of the Top-3 key performance indicators structure levels.54 Core Indicators + 37 advanced Indicators;[58]
20 Smart + 32 Structural + 39 Sustainable

ADVANTAGES OF KPI AND U4SSC INDEX

- SSC KPIs are designed according to a methodology will help rank cities according to quality dimensions of living, working and producing in leading cities.
- Proposed combining of several concepts such as economy, environment culture and society, quality of life, and government succeeds in capturing complex multidimensional realities with a view to supporting decision makers and stakeholders.
- The proposed SSC INDEX model can also assess progress over time and allows users to compare complex dimensions over time. The robustness tests that are built into the final calculations make it reliable for intertemporal analysis.
- SSC INDEX methods that are proposed can assure that the indicators are normalized over an identical range.
- Cities would be clustered and compared against similar cities