EURO PhD Summer School on MCDA/M Case Study
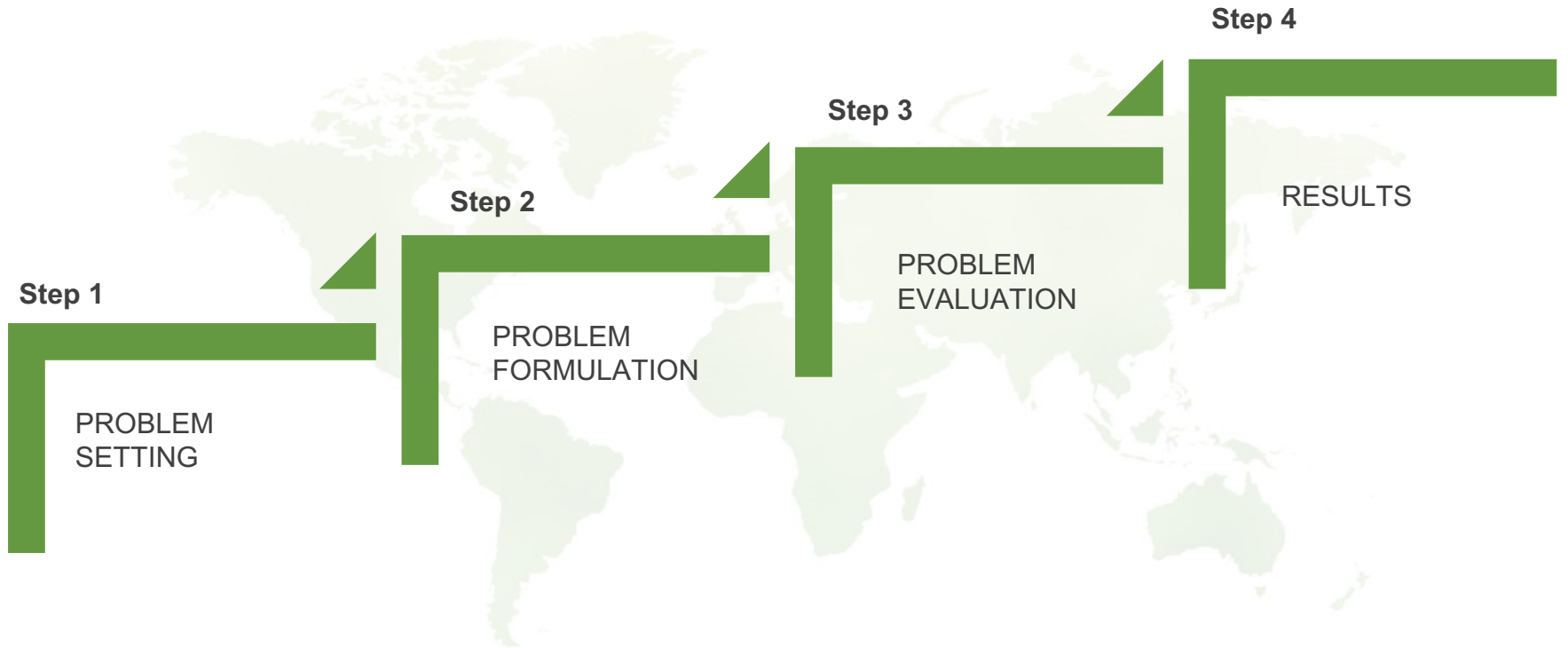# Urban Sustainability Assessment

Group 5:

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OUTLINE

1. **INTRODUCTION**

2. **DECISION PROBLEM**

3. **DECISION MODEL**

4. **RESULTS**

5. **CONCLUDING REMARKS**

Decision Analysis Process

Step 1

PROBLEM
SETTING

Step 2

PROBLEM
FORMULATION

Step 3

PROBLEM
EVALUATION

Step 4

RESULTS

Foundation 5

We believe that sustainability should be treated holistically and we strive to achieve the following objectives:

Environmental: To promote efficient use of resources and improve sanitation.

Social: To improve accessibility to healthcare and employment.

Economic: To support cities that are investing in sustainability practices.

*Our mission is to promote **sustainability** in cities across the globe. We have a vision of a **healthy** and **happy** world in which the needs of the present are met **without compromising** the needs of the future.*

Decision Criteria

Environmental
- g_1: minimise the concentration level of pollutants
- g_2: minimize consumption of resources
- g_3: maximise the treatment of waste

Social
- g_4: maximise healthcare security coverage
- g_5: maximise number of doctors per capita
- g_6: maximise the number of people in employment

Economic
- g_7: maximise investment in R&D.
- g_8: maximise income level.

Indicators

Environmental

- g_1: **Air pollution** (concentration N02, S02, PM10 mg per cubic meter), **Industrial pollution** (S0 2 per unit GDP – tons of S02 per billion dollars)
- g_2: **Power efficiency** (residential power consumption – kwh per capita), **Energy consumption** (TSCE^2 per thousands US dollars), **Water efficiency** (liters per unit GDP)
- g_3: **Household waste management** (domestic waste treatment %)

Social

- g_4: **Healthcare** (% of people with healthcare security to total urban population)
- g_5: **Doctor resources** (number of doctors per thousand urban population)
- g_6: **Employment** (ratio of the employed population to the total urban population - %)

Economic

- g_7: **Capacity investment** (government in R&D – US dollars per capita)
- g_8: **Income level** (disposable income per urban capita – thousands US dollard)

Problem statement: to *sort* the 12 cities to 5 ordered sustainability categories

Berlin   Copenhagen   Shanghai   London

Beijing   Prague   Seoul   Tokyo
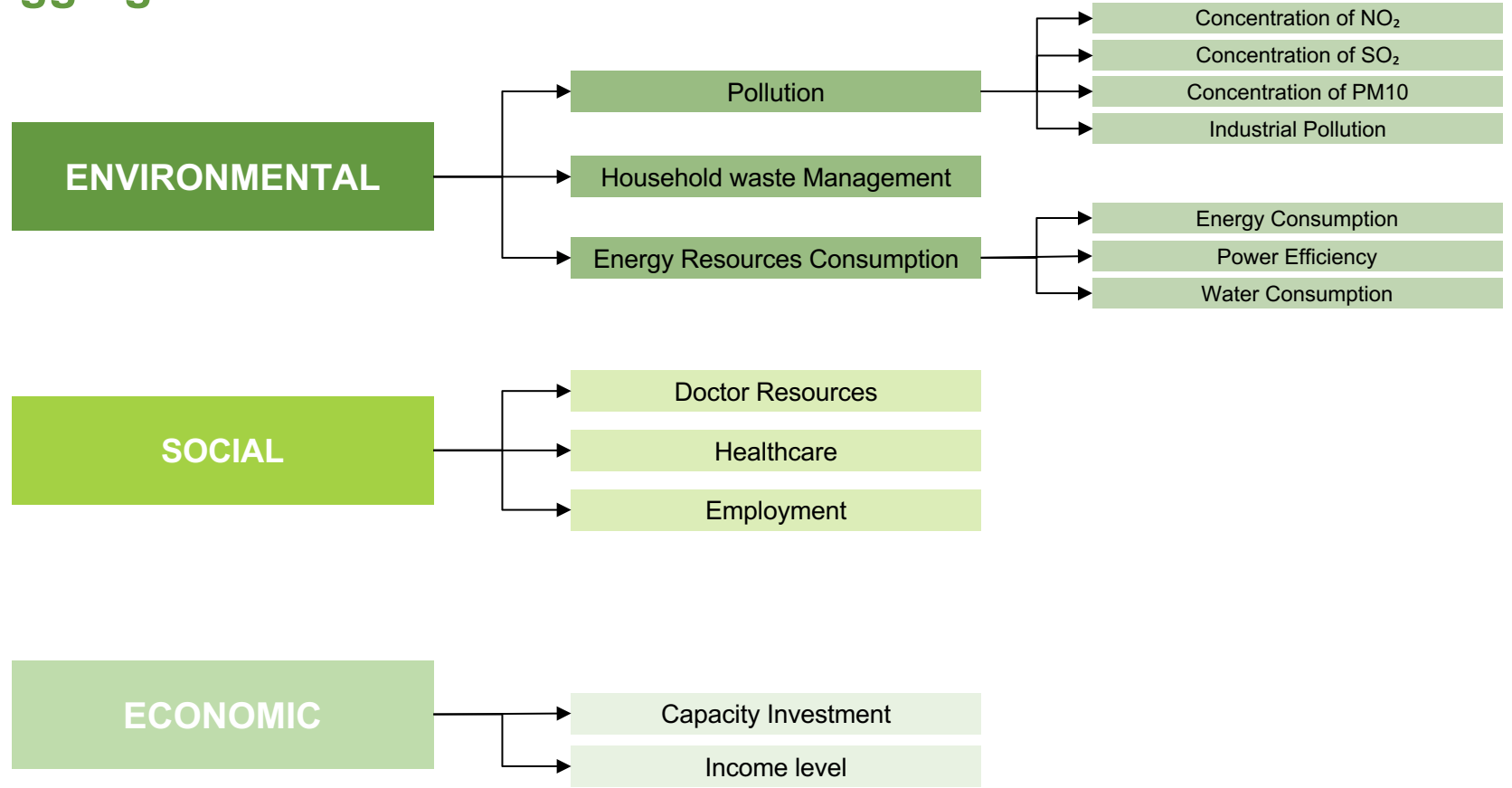
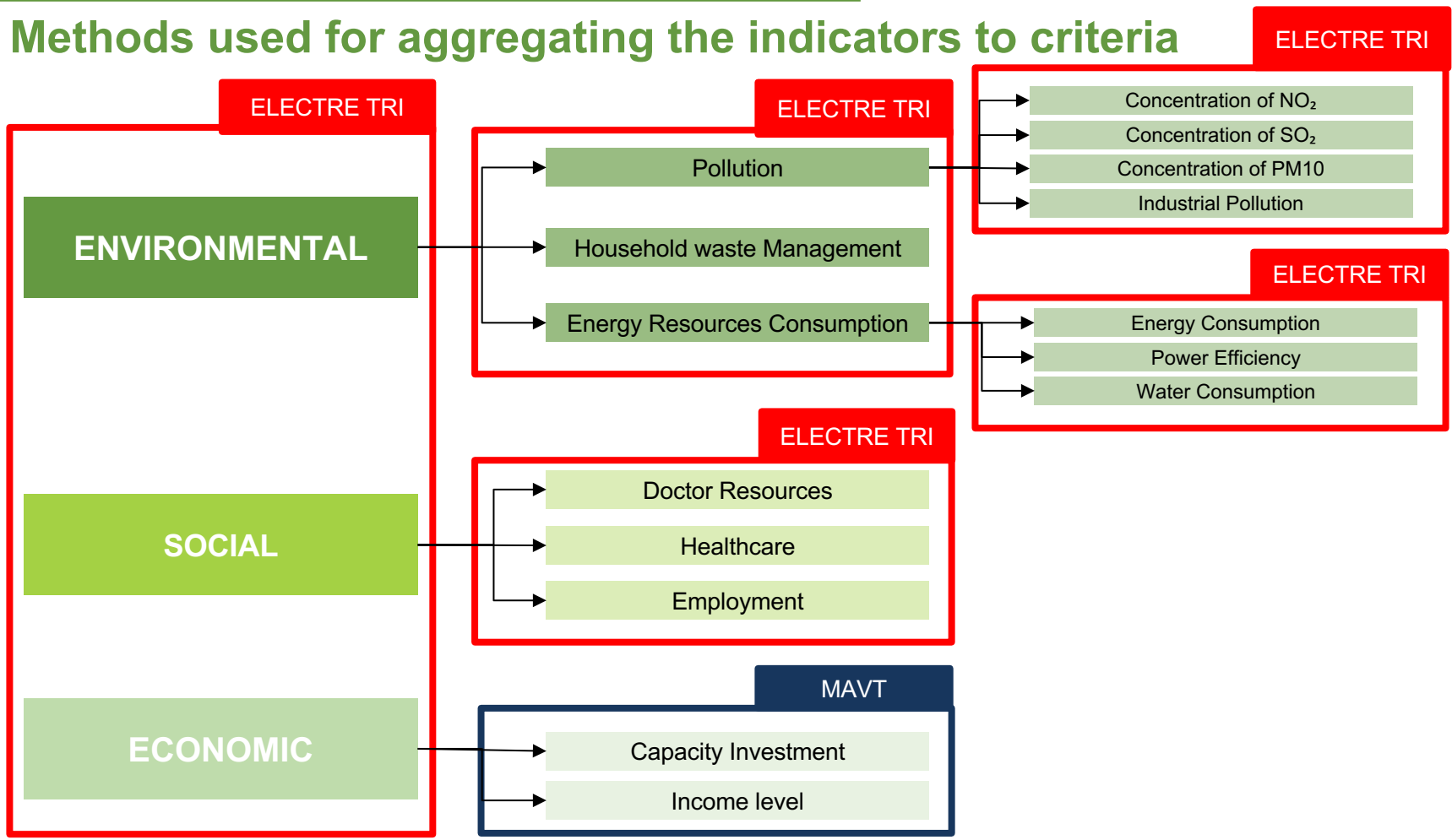Paris   Stockholm   Hong Kong   New York

VERY GOOD

GOOD

MEDIUM

BAD

VERY BAD

Aggregation of the indicators to criteria

ENVIRONMENTAL	Pollution	Concentration of NO_2
		Concentration of SO_2
		Concentration of PM10
		Industrial Pollution
	Household waste Management	
	Energy Resources Consumption	Energy Consumption
		Power Efficiency
		Water Consumption

SOCIAL	Doctor Resources
	Healthcare
	Employment

ECONOMIC	Capacity Investment
	Income level

Methods used for aggregating the indicators to criteria

Weights to criteria assigned with SIMOS method
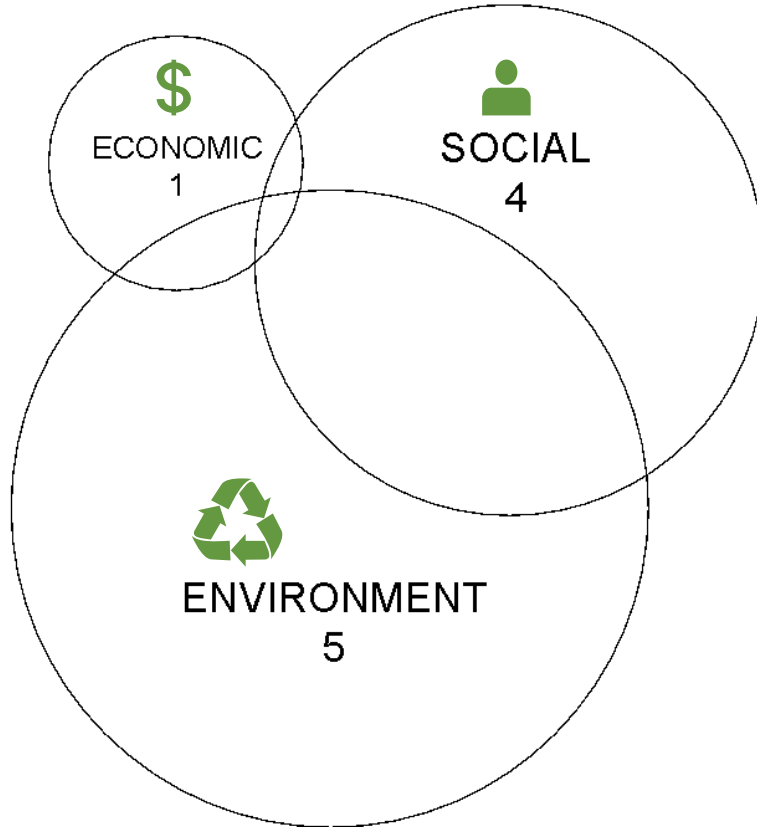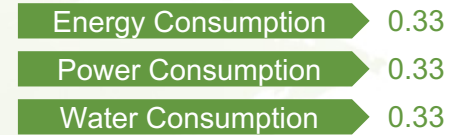
Environmental Indicator

ELECTRE TRI Method

Household Waste Management

0.3

Air Pollution

Concentration of CO2	0.25
Concentration of SO2	0.25
Concentration of PM10	0.25
Industrial Air Pollution	0.25

0.5

Rescource Consumption

Energy Consumption	0.33
Power Consumption	0.33
Water Consumption	0.33

0.2
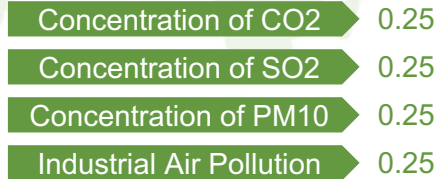
3. DECISION MODEL

Environmental Indicator
Air Pollution

	Beijing	Berlin	Copenhagen
Concentration of NO2	0.056	0.032	0.054
	4	3	4
Concentration of SO2	0.028	0.003	0.001
	3	1	1
Concentration of PM10	0.113	0.024	0.035
	5	1	3
Industrial air pollution SO2	8.018	1.919	1.305
	5	2	2
Air Pollution	5	2	3

	Conc NO2	Conc SO2	Conc PM10	Indus Pollut
Very Good (1)	0 - 0.01	0 - 0.005	0 - 0.025	0 - 1
Good (2)	0.01 - 0.03	0.005 - 0.01	0.025 - 0.03	1 - 2
Medium (3)	0.03 - 0.05	0.01 - 0.03	0.03 - 0.05	2 - 2.5
Bad (4)	0.05 - 0.06	0.03 - 0.05	0.05 - 0.1	2.5 - 3
Very Bad (5)	> 0.06	> 0.05	> 0.1	> 3

Copenhagen

Beijing

Berlin

Environmental Indicator
Resource Consumption

City	Energy consumption		Power consumption		Water consumption	
Beijing	4.59	4	0.699	1	0.029	1
Berlin	0.007	1	8.9	5	1.787	3
Copenhagen	0.015	1	5.95	4	0.552	2
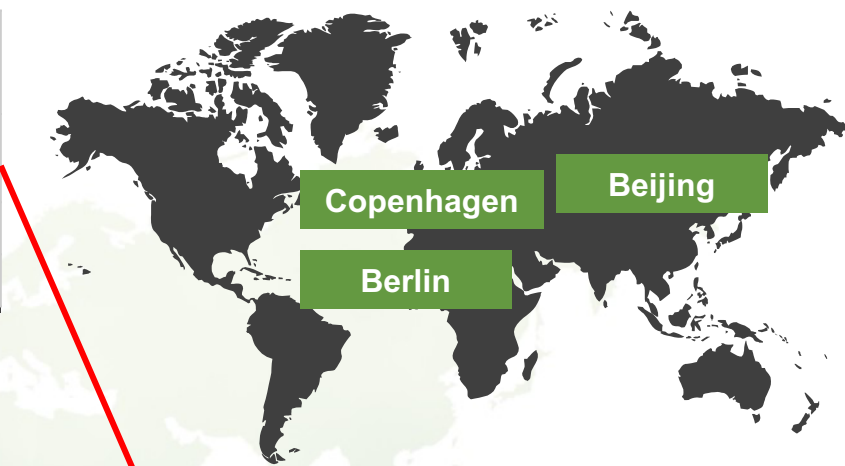
	Cutting levels		
Very Good (1)	0.05	1	0.5
Good (2)	0.1	2	1
Medium (3)	1	5	2
Bad (4)	5	7	3
Very Bad (5)	> 5	> 7	> 3

Copenhagen   Beijing

Berlin

City	Resource Consumption
Beijing	2
Berlin	3
Copenhagen	2

Environmental Indicator

Data & Rating (ELECTRE TRI) : (1-5); Cd_Thresh=0.51

	Air Pollution	Waste Management	Resource Consumption
Beijing	5	1	2
Berlin	2	1	3
Copenhagen	3	1	2
Hong Kong	4	5	3
London	4	2	3
New York	3	1	2
Paris	3	2	3
Prague	3	3	3
Seoul	2	1	3
Shanghai	4	4	3
Stockholm	2	1	3
Tokyo	1	1	3

	Results
Beijing	4
Berlin	2
Copenhagen	3
Hong Kong	4
London	3
New York	2
Paris	3
Prague	3
Seoul	2
Shanghai	4
Stockholm	2
Tokyo	2

	Air Pollution	Waste Management	Resource Consumption
Crit_impor	0.5	0.3	0.2

Social Indicator

Data & Rating (ELECTRE TRI) : (1-5); v=3

	Employment share	Number of doctors per capita	Healthcare security coverage
Beijing	0,53	3,45	0,59
Berlin	0,5	8,15	0,99
Copenhagen	0,52	4,84	1
Hong Kong	0,502	1,8	1
London	0,514	2,77	1
New York	0,54	2,77	0,88
Paris	0,678	7,42	0,99
Prague	0,515	7,5	1
Seoul	0,623	2,72	0,96
Shanghai	0,47	1,84	0,41
Stockholm	0,52	3,75	1
Tokyo	0,501	3,15	1

	Employment share	Number of doctors per capita	Healthcare security coverage
Beijing	4	3	5
Berlin	4	1	2
Copenhagen	4	2	1
Hong Kong	4	4	1
London	4	4	1
New York	4	4	3
Paris	1	1	2
Prague	4	1	1
Seoul	2	4	2
Shanghai	5	4	5
Stockholm	4	3	1
Tokyo	4	4	1

THRESHOLDS_EmpSh		
	0,65	1
	0,6	2
	0,55	3
	0,5	4
	0	5

THRESHOLDS_DOC		
	6,52	1
	4,89	2
	3,26	3
	1,63	4
	0	5

THRESHOLDS_HCSC		
	1	1
	0,95	2
	0,9	3
	0,75	4
	0	5

	Result
Beijing	4
Berlin	2
Copenhagen	2
Hong Kong	4
London	4
New York	4
Paris	1
Prague	2
Seoul	2
Shanghai	5
Stockholm	3
Tokyo	4
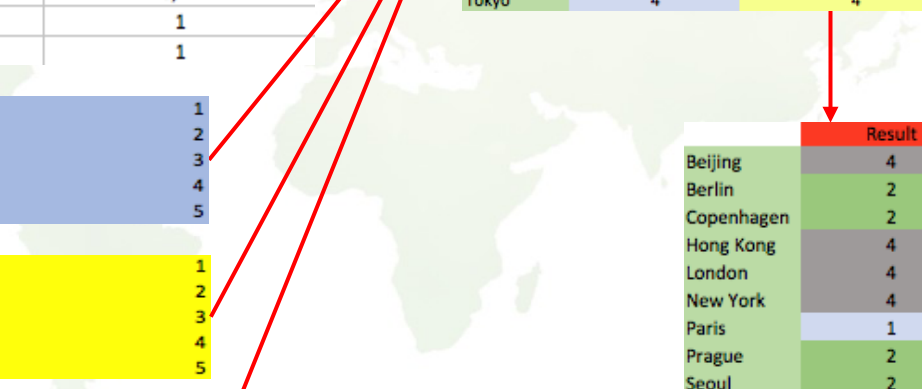
Economic Indicator

Data & Assessment of marginal utilities (MAVT)

Economic Indicator

Results

	u(DI/UC)	u(GIR&D)	U(econ)
Beijing	0,548	0,922	0,725412281
Berlin	0,393	0,101	0,254552632
Copenhagen	0,449	0,558	0,500780702
Hong Kong	0,488	0,006	0,259751754
London	0,551	0,241	0,403964912
New York	0,524	0,012	0,28135614
Paris	0,528	0,000	0,27772807
Prague	0,237	0,426	0,326322537
Seoul	0,547	0,000	0,287640351
Shanghai	0,604	0,564	0,585096491
Stockholm	0,508	0,376	0,445681511
Tokyo	0,852	0,000	0,448219298

Crit_Importances	0,526315789	0,473684211

cutting thresholds	u(DI/UC)	u(GIR&D)	U(econ)
u_1	0,833	1,056	0,938596491
u_2	0,667	0,478	0,577192982
u_3	0,500	0,237	0,375438596
u_4	0,333	0,056	0,201754386

	RESULT
Beijing	2
Berlin	4
Copenhagen	3
Hong Kong	4
London	3
New York	4
Paris	4
Prague	4
Seoul	4
Shanghai	2
Stockholm	3
Tokyo	3

Overall performance

Software utilization: Diviz
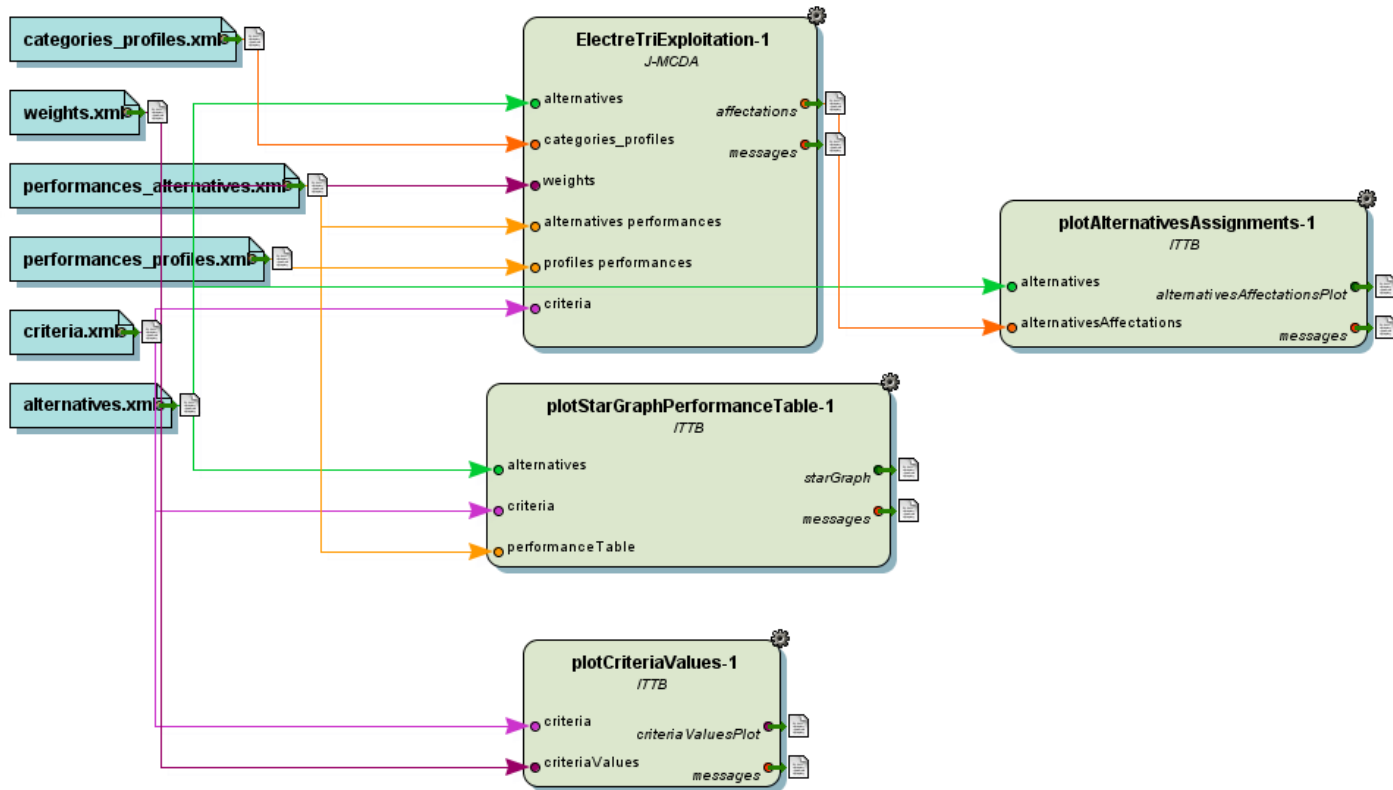
Results

City	Environmental	Social	Economic	Overall
Beijing	BAD	BAD	GOOD	BAD
Berlin	GOOD	GOOD	BAD	GOOD
Copenhagen	MEDIUM	GOOD	MEDIUM	MEDIUM
Hong Kong	BAD	BAD	BAD	BAD
London	MEDIUM	BAD	MEDIUM	MEDIUM
New York	GOOD	BAD	BAD	MEDIUM
Paris	MEDIUM	VERY GOOD	BAD	MEDIUM
Prague	MEDIUM	GOOD	BAD	MEDIUM
Seoul	GOOD	GOOD	BAD	GOOD
Shanghai	BAD	VERY BAD	GOOD	BAD
Stockholm	GOOD	MEDIUM	MEDIUM	MEDIUM
Tokyo	GOOD	BAD	MEDIUM	MEDIUM

VERY GOOD	GOOD	MEDIUM	BAD	VERY BAD
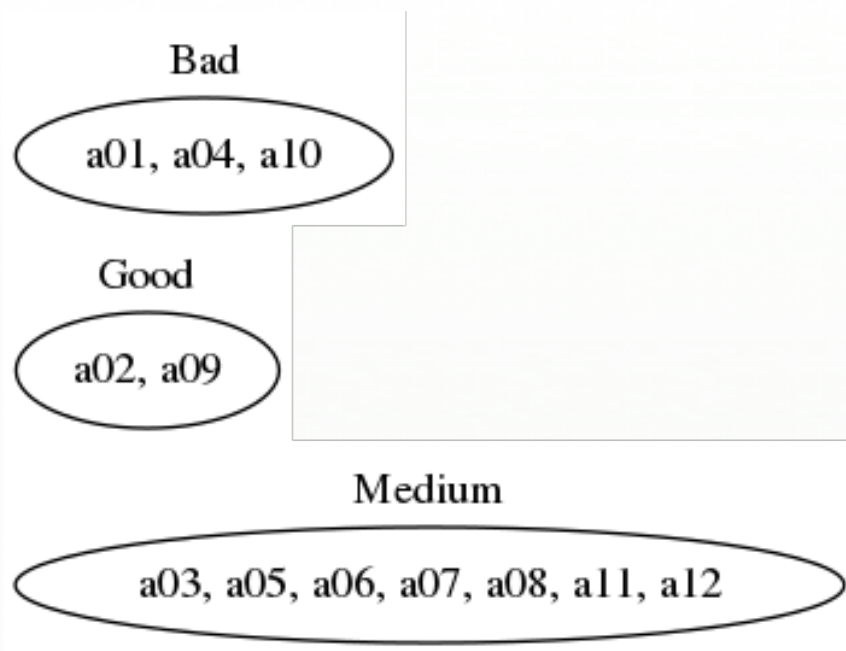
Results

Results

a01	Beijing
a02	Berlin
a03	Copenhagen
a04	Hong Kong
a05	London
a06	New York
a07	Paris
a08	Prague
a09	Seoul
a10	Shanghai
a11	Stockholm
a12	Tokyo

BERLIN
SEOUL

COPENHAGEN
LONDON
NEW YORK
PARIS
PRAGUE
STOCKHOLM
TOKYO

BEJING
HONG KONG
SHANGAI

Thank you