



# Urban Sustainability Assessment

Group 3

**EURO PhD Summer School on MCDA/MCDM**

Chania, Greece

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# Identifying the Decision Maker



Decision Maker is private foundation concerned with cutting-edge technologies in green public transport



Aim:

- Categorization of cities using Multiple Criteria Decision Analysis (MCDA) tools
- Identify cities with low sustainability



Goal:

- Provide investments to relevant stakeholders (e.g. research centers, public transportation providers)
- Improve social, environmental and climate impacts of urban city logistics

# Solving MCDA problem using ELECTRE TRI-B method

- 1 Define a set of **alternatives** and ordered **categories**
- 2 Select a set of coherent family of **criteria**
- 3 Identify alternatives' **performances** with respect to criteria
- 4 Identify indifference, preference & veto **thresholds**
- 5 Determine **characteristic profiles** to define categories
- 6 Determine criteria **weights** using SRF method
- 7 **Sort** alternatives

# Alternatives & Categories of sustainability defined



## Alternatives

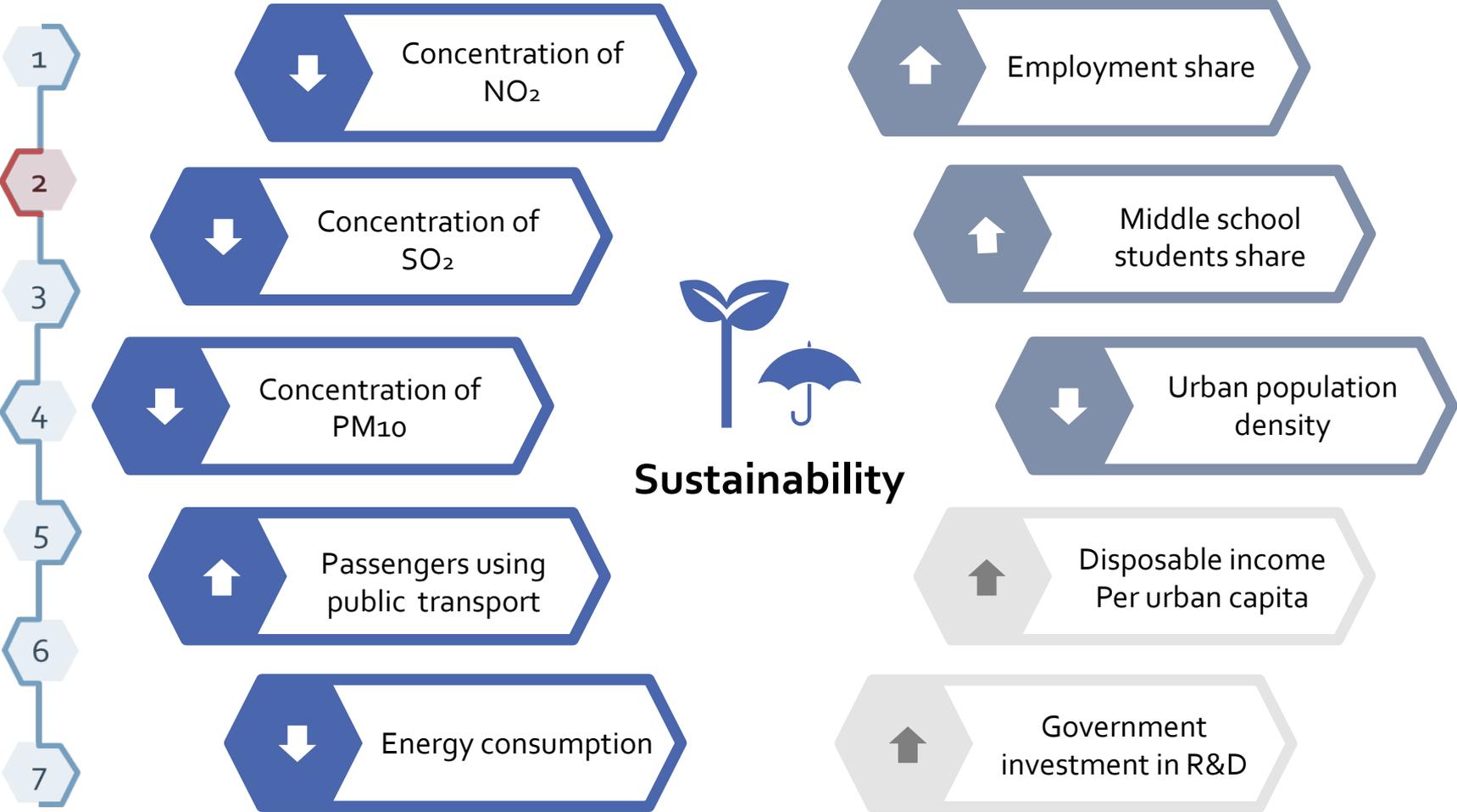


- Beijing
- Berlin
- Copenhagen
- Hong Kong
- Paris
- Prague
- Seoul
- Shanghai
- London
- New York
- Tokyo
- Stockholm

## Categories

-  High Sustainability
-  Moderate Sustainability
-  Low Sustainability

# Criteria considered in the three pillars of Sustainability (Environmental, Social & Economic)



# Performances of alternatives, thresholds & characteristic profiles



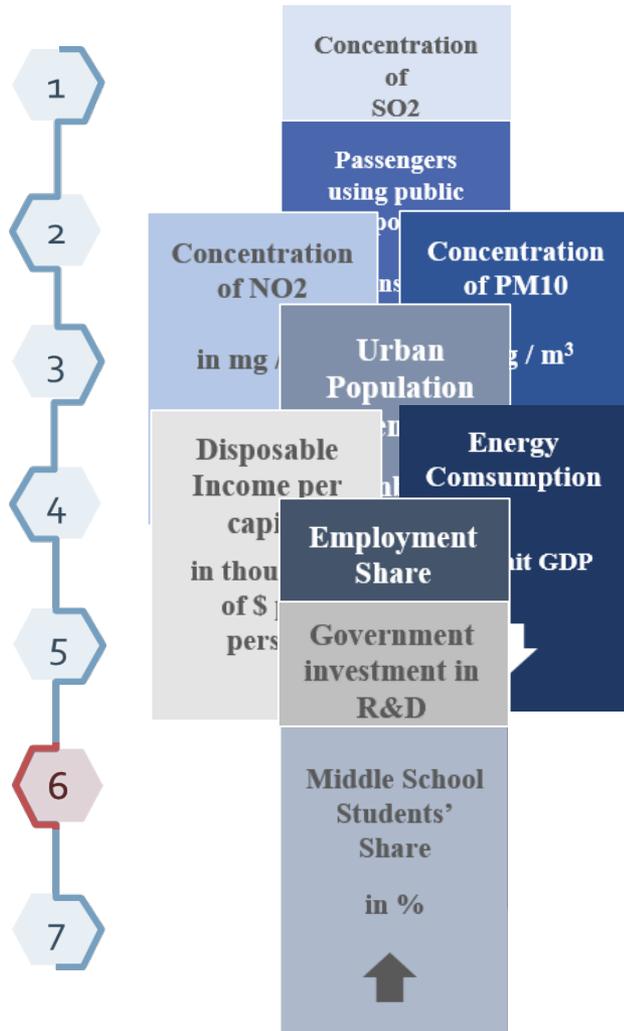
3 Performances → normalized to percentages

	Employment	Education	Urban density	NO <sub>2</sub>	SO <sub>2</sub>	PM <sub>10</sub>	Public transport	Energy consumption	Disposable income	R&D investment
Indifference	0.1	0.05	0.05	0.03	0.03	0.03	0.03	0.07	0.07	0.1
Preference	0.15	0.1	0.2	0.15	0.15	0.15	0.15	0.1	0.1	0.2
Veto	0	0	0	0	0	0	0	0	0	0

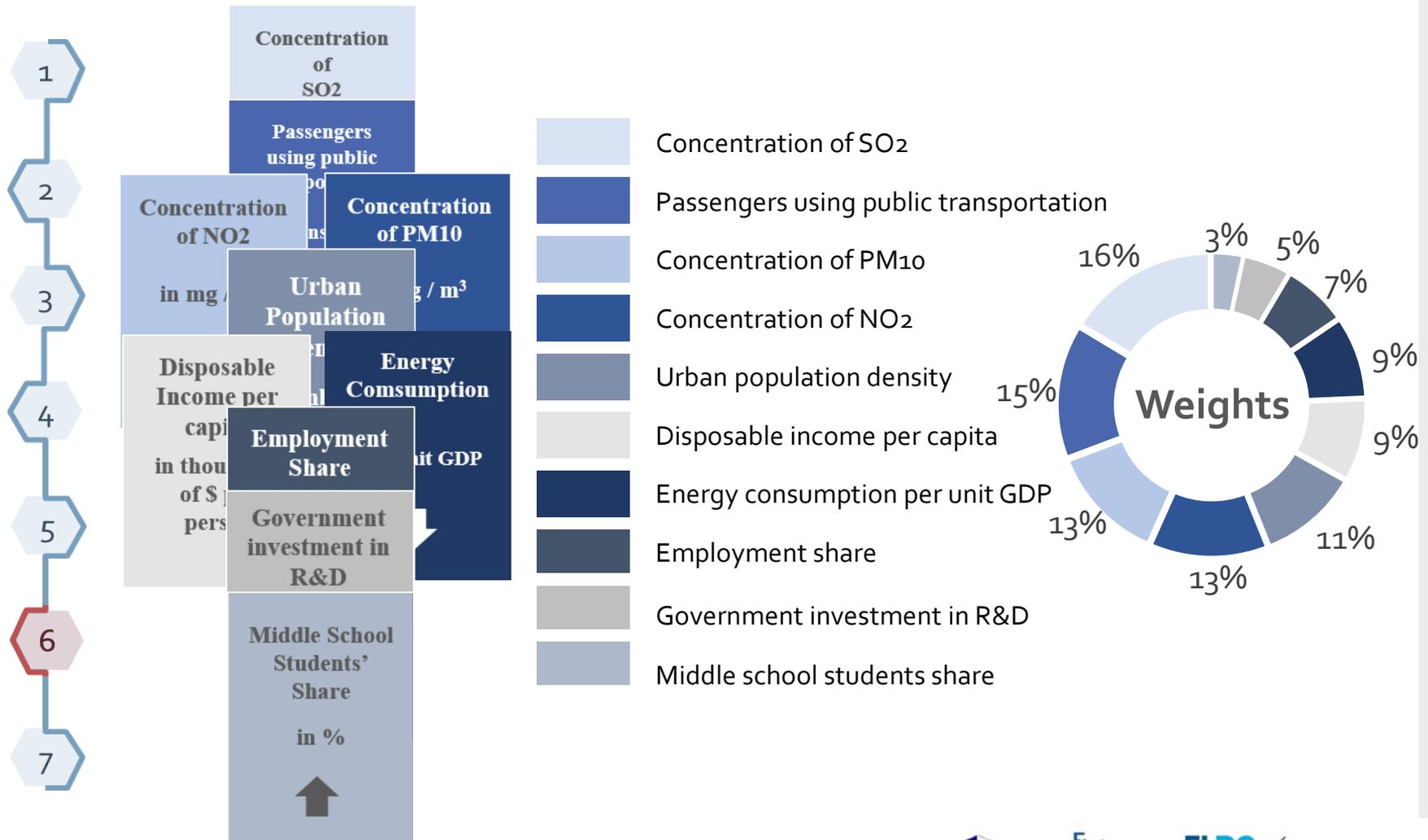
5 Limiting profiles for each criterion:

- Upper bound: 70 %
- Lower bound: 40 %

# Decision Maker's hierarchy of criteria (Deck of cards & revised Simos' Procedure)



# Decision Maker's hierarchy of criteria (Deck of cards & revised Simos' Procedure)



# Performance Matrix

- 1
- 2
- 3
- 4
- 5
- 6
- 7

Project : MCDA\_SS – Performance table : Performance\_table\_3.csv

[Alternative]	Employe...	Middle sch...	Urban Pop...	Concentrat...	Concentrat...	Concentrat...	Passenger ...	Energy con...	Disposabl...	Gouverne...
<b>Extent</b>	0.31	0.80	0.88	0.87	0.98	0.82	0.88	1.00	0.72	1.00
Beijing_1	0.78	0.26	0.36	0.16	0.46	0.00	0.24	0.26	0.64	1.00
Berlin_1	0.74	1.00	0.82	0.52	0.94	0.79	0.37	1.00	0.46	0.20
Copenh...	0.77	0.26	0.62	0.19	0.98	0.69	0.36	1.00	0.53	0.72
Hong Ko...	0.74	0.44	0.69	0.87	0.00	0.45	0.25	0.97	0.57	0.01
London_1	0.76	0.45	0.75	0.00	0.94	0.76	0.29	0.99	0.65	0.43
New Yor...	0.80	0.34	0.50	0.30	0.94	0.81	0.27	0.99	0.61	0.02
Paris_1	1.00	0.20	0.00	0.40	0.81	0.78	0.45	1.00	0.62	0.00
Prague_1	0.76	0.33	0.88	0.57	0.94	0.75	0.85	0.97	0.28	0.58
Seoul_1	0.92	0.41	0.19	0.55	0.90	0.64	0.28	0.99	0.64	0.00
Shangai	0.69	0.26	0.30	0.24	0.44	0.29	0.12	0.00	0.71	0.94
Stockhol...	0.77	0.39	0.83	0.36	0.98	0.78	0.80	0.99	0.60	0.51
Tokyo_1	0.74	0.48	0.32	0.63	0.96	0.82	1.00	1.00	1.00	0.00

# Decision Configuration

- 1
- 2
- 3
- 4
- 5
- 6
- 7

Project : MCDA\_SS – Decision configuration : Configuration\_6

### Criterion parameters

[Parameter]	Employe...	Middle sch...	Urban Pop...	Concentrat...	Concentrat...	Concentrat...	Passenger ...	Energy con...	Disposable...	Governme...
k	7.0	3.3	10.8	12.6	16.3	12.6	14.5	8.9	8.9	5.1
q <sup>α</sup>	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅
q <sup>β</sup>	0.1	0.05	0.05	0.03	0.03	0.03	0.03	0.07	0.07	0.1
p <sup>α</sup>	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅
p <sup>β</sup>	0.15	0.1	0.2	0.15	0.15	0.15	0.15	0.1	0.1	0.2
v <sup>α</sup>	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅
v <sup>β</sup>	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅
Direction	Maximize	Maximize	Maximize	Maximize	Maximize	Maximize	Maximize	Maximize	Maximize	Maximize
Thresho...	Constant	Constant	Constant	Constant	Constant	Constant	Constant	Constant	Constant	Constant

### Method parameters

Discrimination threshold  
 $\lambda$ : 0.7

### Categories

Add category

\* The best category is at the top, the worst at bottom.

Name	Description
High sustainable	
b2	
Moderative sustainable	
b1	
Least sustainable	

### Performance table of the reference alternatives

[Alternative]	Employe...	Middle sch...	Urban Pop...	Concentrat...	Concentrat...	Concentrat...	Passenger ...	Energy con...	Disposable...	Governme...
Extent	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
b1	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
b2	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

# Results



Project : MCDA\_SS – Result : <Configuration\_6, Performance\_table\_3.csv, Performance\_table\_3.csv, Ø>

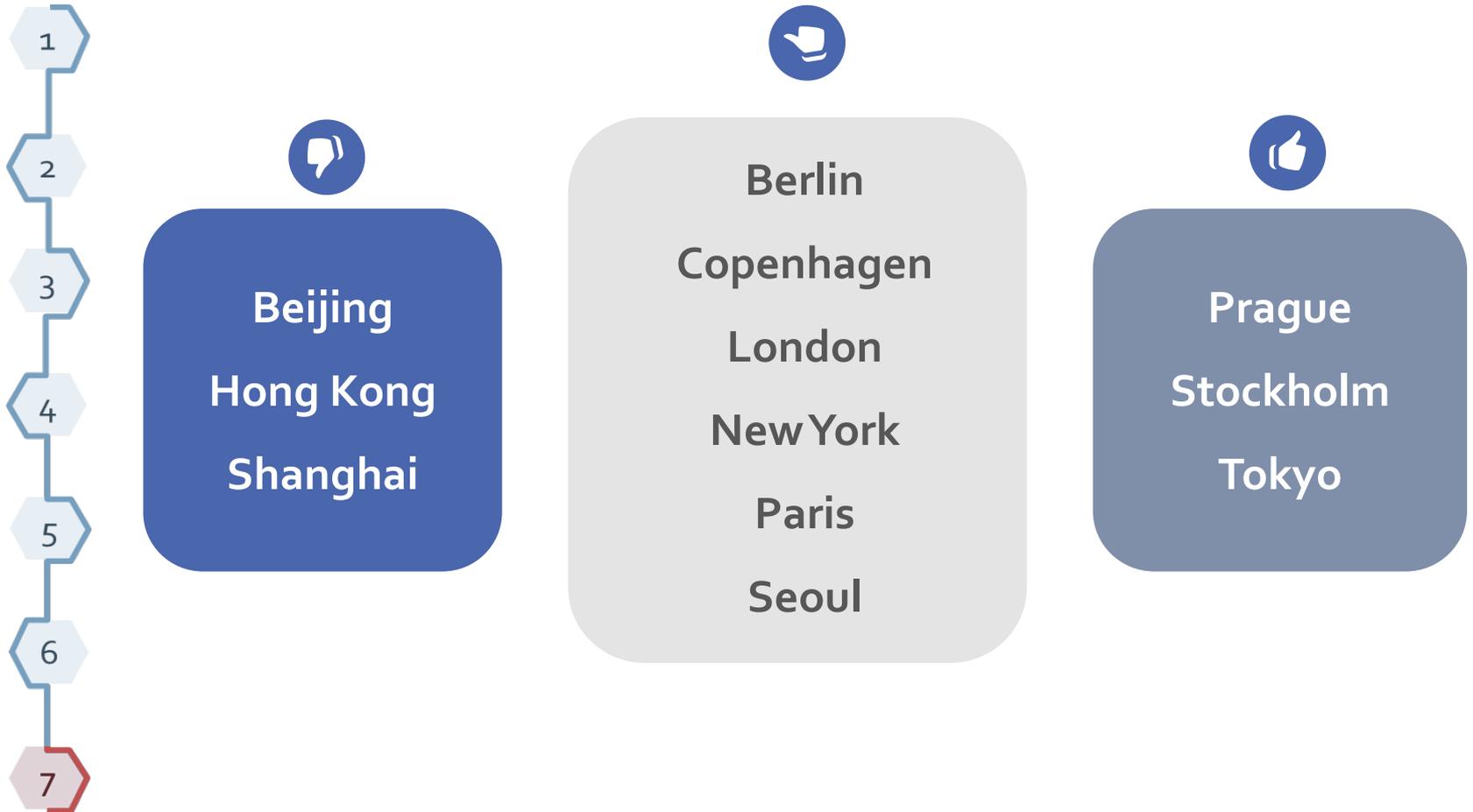
RESULT <Configuration\_6, Performance\_table\_3.csv, Performance\_table\_3.csv, Ø>

Statistics :

<min,max>	#	%
<1,1>	2	16.6667%
<1,2>	1	8.3333%
<2,2>	2	16.6667%
<2,3>	4	33.3333%
<3,3>	3	25.0000%

ACTION	Pessimist (pseudo-conjunctive)	Optimist (pseudo-disjunctive)
Beijing	C <sub>1</sub> Least sustainable	C <sub>1</sub> Least sustainable
Berlin	C <sub>2</sub> Moderate sustainable	C <sub>3</sub> High sustainable
Copenhagen	C <sub>2</sub> Moderate sustainable	C <sub>2</sub> Moderate sustainable
Hong Kong	C <sub>1</sub> Least sustainable	C <sub>2</sub> Moderate sustainable
London	C <sub>2</sub> Moderate sustainable	C <sub>2</sub> Moderate sustainable
New York	C <sub>2</sub> Moderate sustainable	C <sub>3</sub> High sustainable
Paris	C <sub>2</sub> Moderate sustainable	C <sub>3</sub> High sustainable
Prague	C <sub>3</sub> High sustainable	C <sub>3</sub> High sustainable
Seoul	C <sub>2</sub> Moderate sustainable	C <sub>3</sub> High sustainable
Shanghai	C <sub>1</sub> Least sustainable	C <sub>1</sub> Least sustainable
Stockholm	C <sub>3</sub> High sustainable	C <sub>3</sub> High sustainable
Tokyo	C <sub>3</sub> High sustainable	C <sub>3</sub> High sustainable

# ELECTRE TRI-B method outcome



# Discussion & Conclusions



- Employment share and Disposable income per capita – **Average**
- Government investment in R&D - **Good**
  
- Middle school student share and Energy consumption – **Average**
- Urban population density and Concentration of NO<sub>2</sub> - **Good**
  
- Disposable income and Government investment - **Good**

# Discussion & Conclusions



Beijing  
Hong Kong  
Shanghai

## Poor

- Concentration of SO<sub>2</sub>
- Passengers using public transportation
- Concentration of PM<sub>10</sub>
- Concentration of NO<sub>2</sub>

# References

FIGUIERA & ROY (2002) Determining the weights of criteria in the ELECTRE type methods with a revised Simos' procedure. *European Journal of Operational Research*, 139: 317-326.

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MUNDA (2005) Multiple Criteria Decision Analysis and Sustainable Development, in Figueira, J., Greco, S., Ehrgott, M. (eds), *Multiple Criteria Decision Analysis. State of the Art Survey*. New York: Springer.

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# Group Work

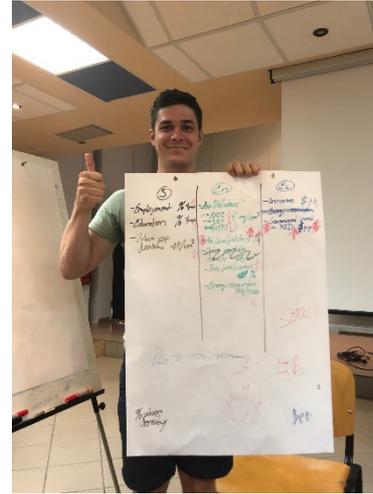
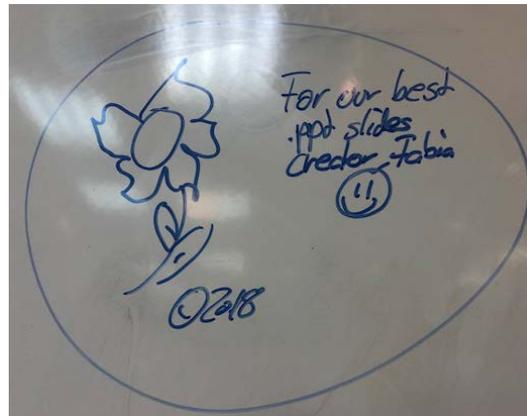


Tableau des Résultats

Indicateur	Unité	Objectif	Valeur	Poids	Poids non normalisé
1 - (g1) Media Internet d'entreprise	1	1	1	1	1
10 - (g10) Movement Investment I	2	0	3.07	5.1	15.6
1 - (c1) Employment Share	2	0	2.14	7	15.0
6 - (g6) Energy consumption per unit	4	0	2.11	11.9	25.1
6 - (g6) Intergovernmental income per unit	4	0	2.11	11.9	25.1
3 - (g3) Urban population density	5	0	3.29	10.8	35.6
4 - (c4) Consumption M02	6	0	3.86	12.6	48.7
4 - (c4) Consumption M01	6	0	2.98	12.6	37.5
7 - (g7) Passenger using public transport	7	0	4.43	14.6	64.6
5 - (g5) Consumption M02	8	0	5	16.3	81.6



# Thank you

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