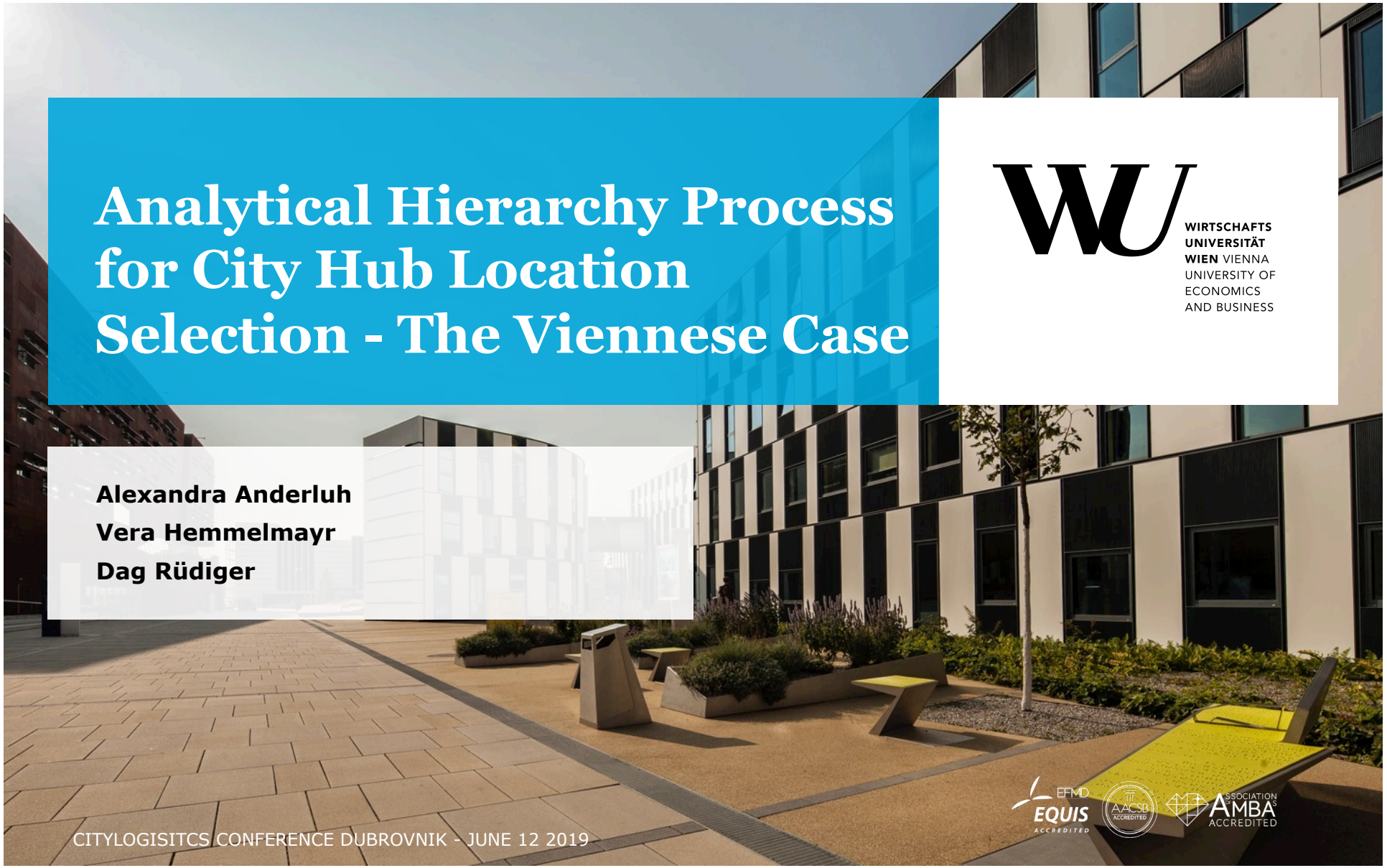

Analytical Hierarchy Process for City Hub Location Selection - The Viennese Case

WIRTSCHAFTS UNIVERSITÄT WIEN VIENNA UNIVERSITY OF ECONOMICS AND BUSINESS

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CITYLOGISITCS CONFERENCE DUBROVNIK - JUNE 12 2019

Agenda

- Introduction
- AHP for midi-hub location selection
- Survey results for selected criteria
- Indicators for location selection
- Preliminary results

Introduction

- Current trends with negative impact (congestion, noise and pollution) to cities
  - Increasing Urbanization
  - Growing freight transport volumes
  - Thriving industry of e-commerce

- Urban consolidation centers (city hubs, *midi-hubs*) with a two-stage delivery process as one promising solution
  1. Delivery to midi-hub located within the city area
  2. Consolidated last-mile distribution to end consumers by environmentally friendly vehicles

➡ Project ***MiHu*** funded by Bundesministerium Verkehr, Innovation und Technologie and FFG Forschung wirkt.

Aim of the project

- Generate model for midi-hub location selection problem considering
  - Qualitative and quantitative factors
  - Different stakeholder groups
    - Municipality (city administration)
    - Residents of Vienna (citizens)
    - Logistic service providers (logistic companies)
- Appropriate method: ***Analytical Hierarchy Process (AHP)***

Implementation of AHP

Step 0: Problem Definition
Step 1: Determine relevant criteria for location selection of midi-hub in Vienna
Step 2: Collect valuable data from each stakeholder group to determine priority weights (-> survey)
Step 3: Collect data and compare each potential location pairwise with respect to selected criteria at step 1
Step 4: Analyze pairwise comparison matrix results and check/fix inconsistencies
Step 5: Identify preferred midi-hub location(s)
Step 6: Before & after analysis for selected midi-hub location(s) and final recommendations

Pros and cons of AHP

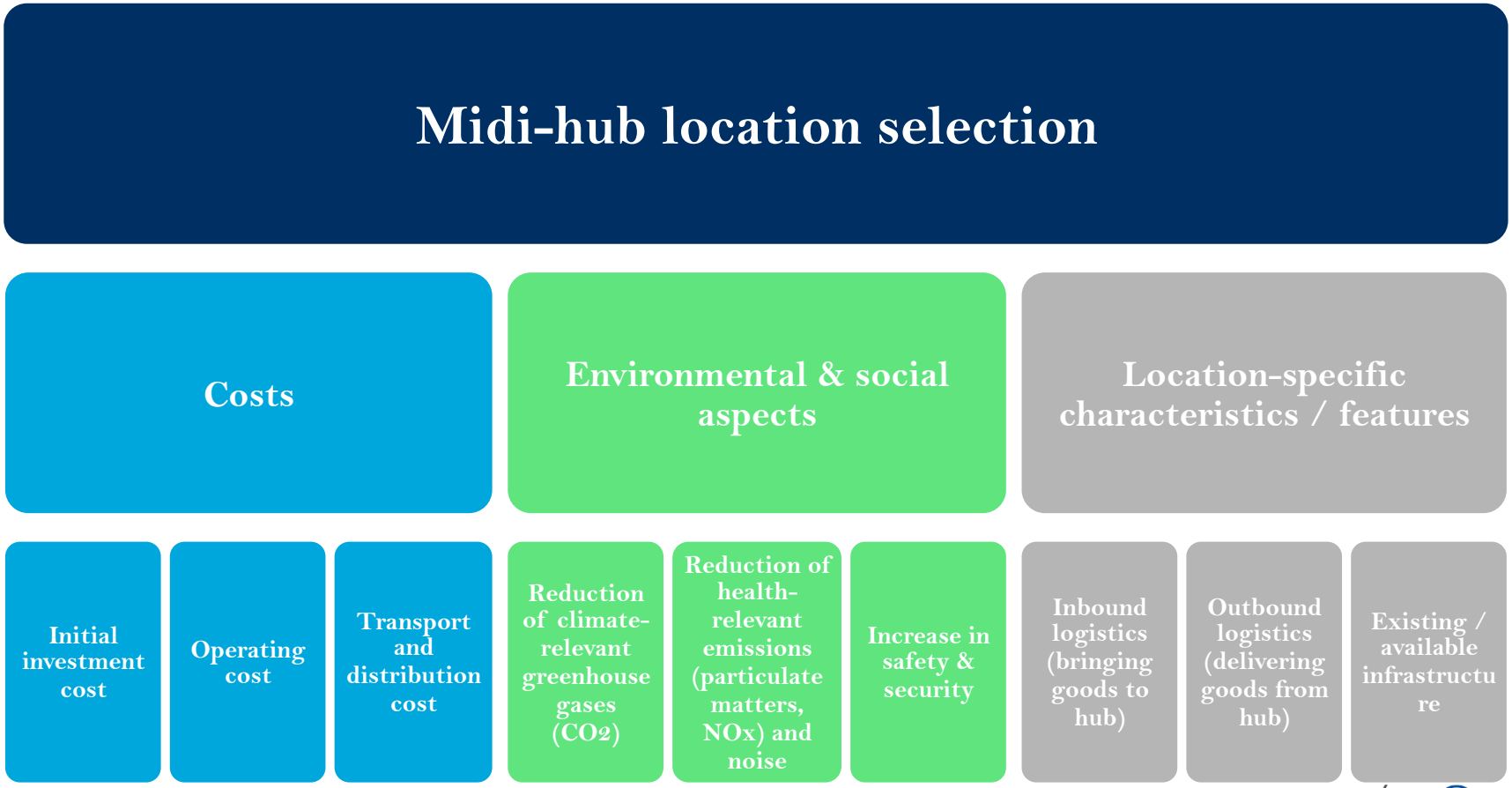
Pros

- Hierarchical structuring of a decision problem
- Combine multiple inputs from several participants and/or stakeholders to a consolidated outcome (comparison matrix)
- Desirable results would possibly occur since priorities are the main decision maker in the model
- Calculation is easy with help of some tools (e. g., MS Excel, online tools etc.)

Cons

- Pairwise comparison is a quite artificial way to compare a set of items
- If consistency index is more than 10%, reconsidering the inconsistent input and adjustments must be made

Criteria for midi-hub location selection



AHP Survey process

- Companies and municipilaty filled out online survey (sent via email)
- Citizens were invited to a workshop to conduct survey
- All survey questions involved comparing all critera and determining their degree of importance pairwise (slightly more important, significantly more important, etc...)
- Result were entered into a AHP online tool created by Goepel, K.D. (2018) which calculates the overall importance of the criteria based on all survey result

Survey: Screenshot 1

From which stakeholder perspective do you answer the following questions?

- ◯ City Administration
- ◯ Logistic Companies
- ◯ Citizens

*Aus Sicht welcher Stakeholdergruppe beantworten Sie folgende Fragen?

- Stadtgemeinde
- Unternehmen, die innerstädtische Lieferungen/Abholungen abwickeln
- BürgerInnen

Bitte wählen Sie "BürgerInnen", wenn Sie die nachfolgenden Fragen weder aus Sicht der Stadtgemeinde noch aus der Sicht eines Unternehmens beantworten.

Survey: Screenshot 2

Which criteria is relatively more important?

- ◯ X
- ◯ Y
- ◯ Equally important

*Welches Kriterium beurteilen Sie als wichtiger?

- Kosten
- Umwelt und Sozialer Aspekt
- Gleichermaßen wichtig

Kosten: *Ausgaben für Grundstücke, Gebäudeübernahme, Leasingkosten, Transport- und Distributionskosten*

Umwelt und Sozialer Aspekt: Bezogen auf den Schutz der Umwelt, nachhaltige Transportsysteme - Auswirkungen der Logistikaktivitäten auf die Umwelt und die Lebensqualität der StadtbewohnerInnen.

Survey: Screenshot 3

How would you rate the relative importance of the selected criteria?

- ◯ 1 - Slightly more important
- ◯ 2 - Significantly more important
- ◯ 3 - Very strongly more important
- ◯ 4 - Extremely more important

*Wie viel wichtiger halten Sie Ihr ausgewähltes Kriterium gegenüber dem anderen?

Choose one of the following answers

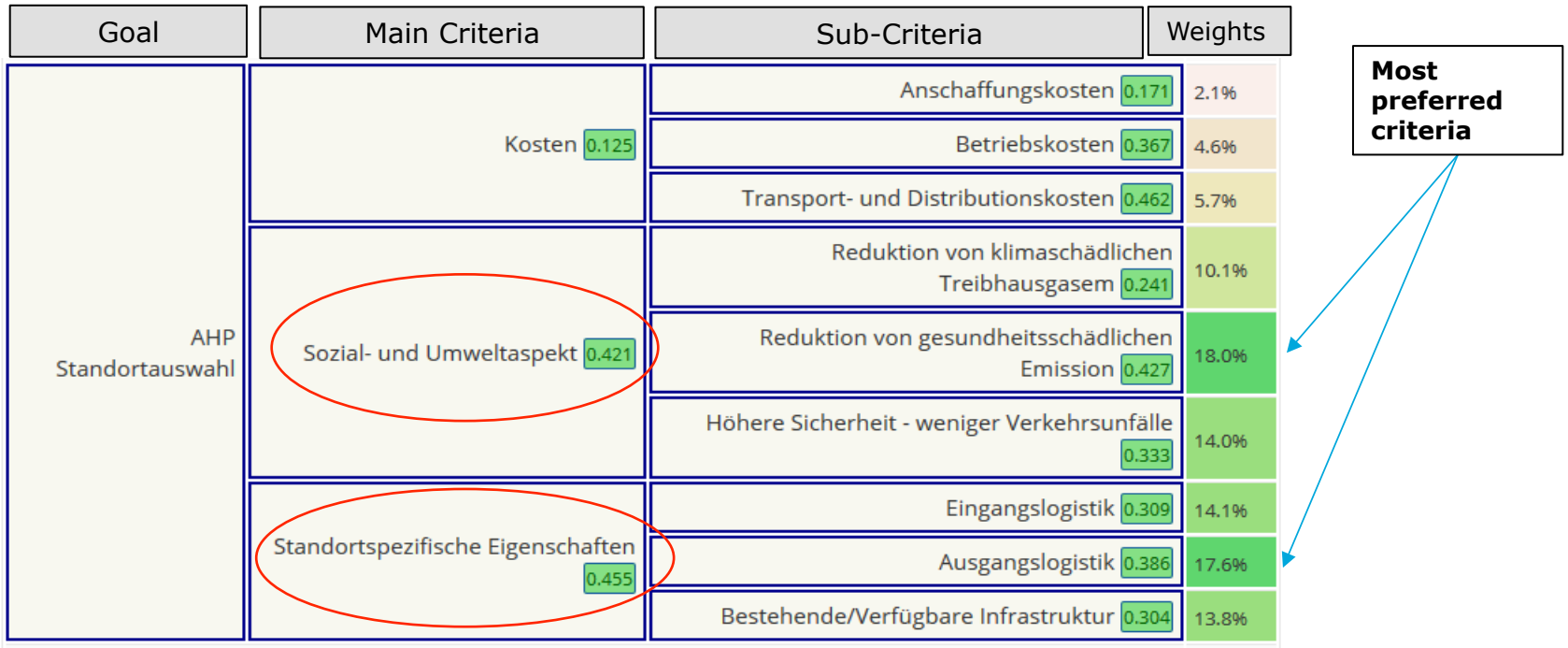
- 1- etwas höhere Bedeutung des bevorzugten Kriteriums
- 2 - deutlich höhere Bedeutung des bevorzugten Kriteriums
- 3 - sehr viel höhere Bedeutung des bevorzugten Kriteriums
- 4 - absolut höhere Bedeutung des bevorzugten Kriteriums

Criteria preferences of city administration

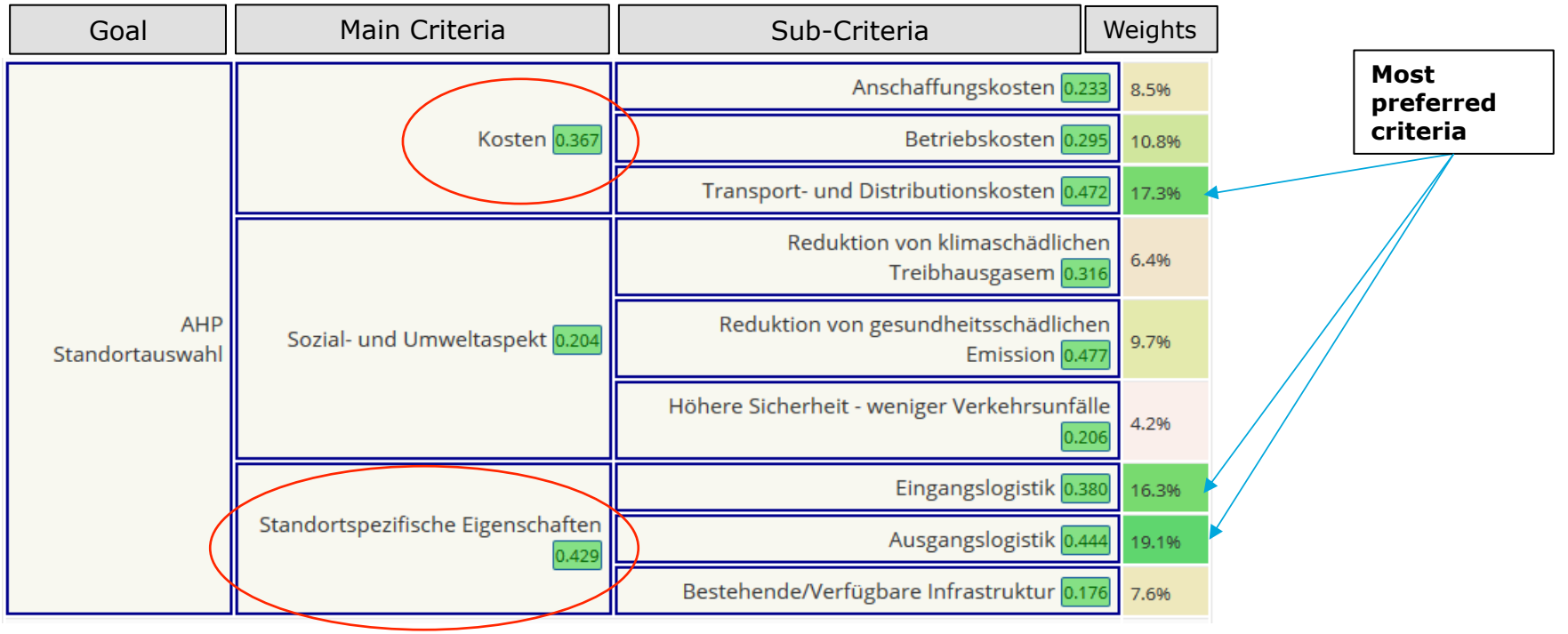
Goal	Main Criteria	Sub-Criteria	Weights
AHP Standortauswahl	Kosten 0.322	Anschaffungskosten 0.243	7.8%
		Betriebskosten 0.292	9.4%
		Transport- und Distributionskosten 0.465	15.0%
	Sozial- und Umweltaspekt 0.464	Reduktion von klimaschädlichen Treibhausgasem 0.392	18.2%
		Reduktion von gesundheitsschädlichen Emission 0.405	18.8%
		Höhere Sicherheit - weniger Verkehrsunfälle 0.202	9.4%
	Standortspezifische Eigenschaften 0.214	Eingangslogistik 0.312	6.7%
		Ausgangslogistik 0.571	12.2%
		Bestehende/Verfügbare Infrastruktur 0.116	2.5%

Most preferred criteria

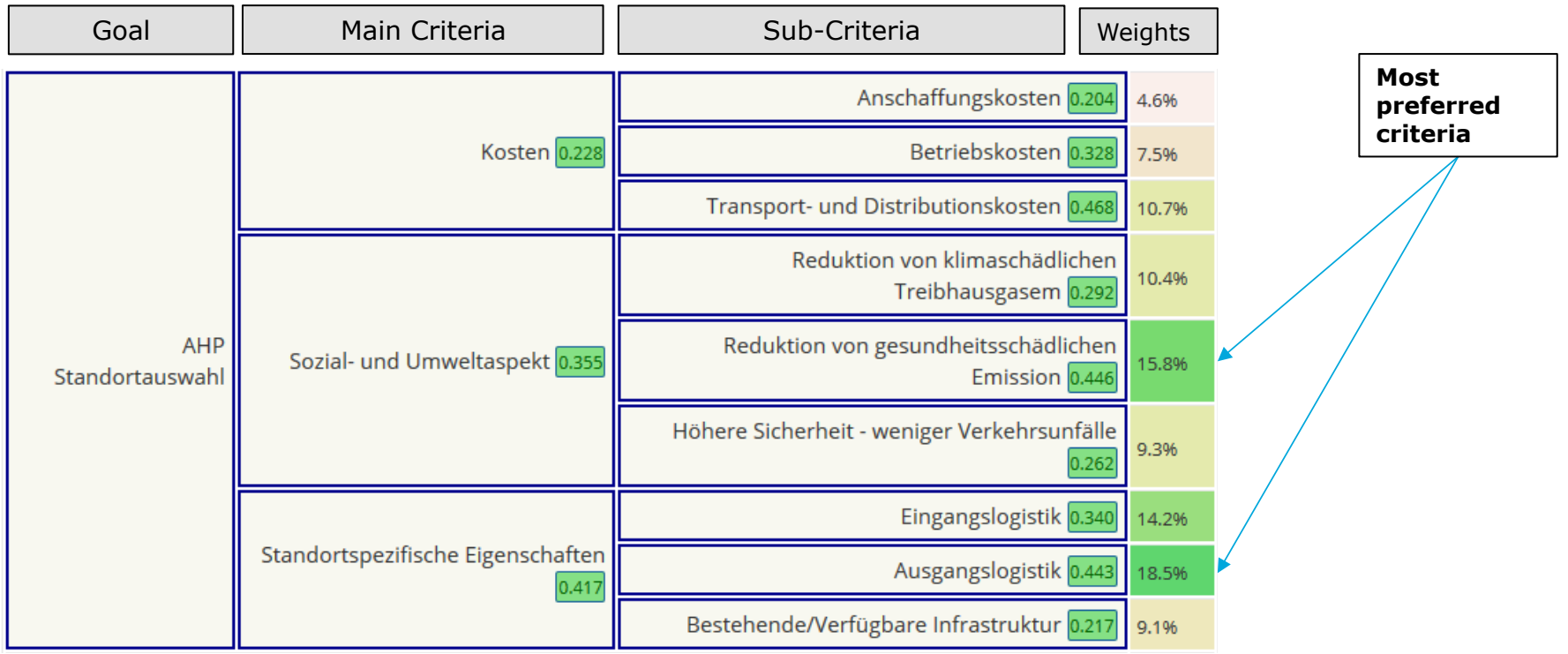
Criteria preferences of citizens



Criteria preferences of logistic companies



Overall survey results of all participants



Summary of survey results

Stakeholder	Costs	Social & Environmental aspect	Location specific characteristics
Municipality	32,2%	46,4%	21,4%
Citizens	12,5%	42,1%	45,5%
Companies (LSPs)	36,7%	20,4%	42,9%

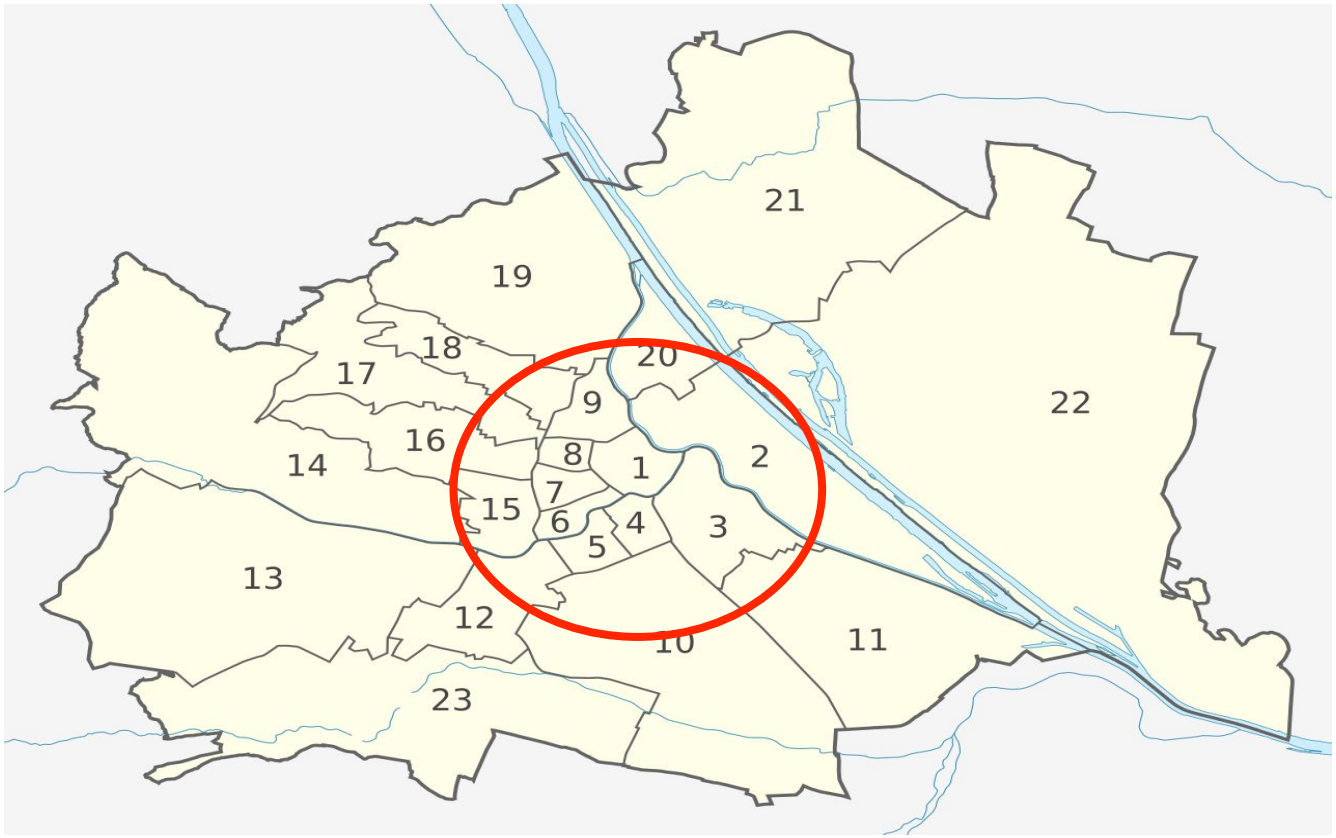
Most relevant sub-criteria by stakeholder group:

- **Municipality**:
  1. Reduction of GHG emissions
  2. Reduction of particular matter & noise
- **Citizens**:
  1. Reduction of particular matter & noise
  2. Outbound accessibility
- **Companies**:
  1. Transport & distribution costs
  2. Inbound & Outbound accessibility

Indicators for location evaluation

- Several potential locations preselected within Vienna
- Locations are evaluated based selected criteria
- To compare the alternatives, data has to be gathered from
  - Industry experts (cost estimations)
  - Municipality (Emission rates, noise levels, congestion data, etc.)
  - Investigation of the sites (infrastructure, connectivity, proximity to e-charging stations and bike lanes etc.)
- Based on the collected information ranking of the alternatives is created with pairwise comparison method

Possible Midi-Hub Area



https://de.wikipedia.org/wiki/Datei:Vienna,_administrative_divisions_-_Nmbrs.svg

AHP Tool for evaluation of alternatives

Alternatives										
No	Node	Criterion	Glb Priorities	Compare	Location -1	Location -2	Location -3	Location -4	Location -5	Location -6
1.	Kosten	Anschaffungskosten	4.6%	AHP	0.167	0.167	0.167	0.167	0.167	0.167
2.		Betriebskosten	7.5%	AHP	0.167	0.167	0.167	0.167	0.167	0.167
3.		Transport- und Distributionskosten	10.7%	AHP	0.167	0.167	0.167	0.167	0.167	0.167
4.	Sozial- und Umweltaspekt	Reduktion von klimaschädlichen Treibhausgasem	10.4%	AHP	0.167	0.167	0.167	0.167	0.167	0.167
5.		Reduktion von gesundheitsschädlichen Emission	15.8%	AHP	0.167	0.167	0.167	0.167	0.167	0.167
6.		Höhere Sicherheit - weniger Verkehrsunfälle	9.3%	AHP	0.167	0.167	0.167	0.167	0.167	0.167
7.	Standortspezifische Eigenschaften	Eingangslogistik	14.2%	AHP	0.167	0.167	0.167	0.167	0.167	0.167
8.		Ausgangslogistik	18.5%	AHP	0.167	0.167	0.167	0.167	0.167	0.167
9.		Bestehende/Verfügbare Infrastruktur	9.1%	AHP	0.167	0.167	0.167	0.167	0.167	0.167
			Total weight of alternatives:		0.167	0.167	0.167	0.167	0.167	0.167

	A - wrt *Anschaffungskosten* - or B?	Equal	How much more?
1	◉ Location-1 or ○ Location-2	◉1	○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
2	◉ Location-1 or ○ Location-3	◉1	○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
3	◉ Location-1 or ○ Location-4	◉1	○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
4	◉ Location-1 or ○ Location-5	◉1	○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
5	◉ Location-1 or ○ Location-6	◉1	○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
6	◉ Location-2 or ○ Location-3	◉1	○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
7	◉ Location-2 or ○ Location-4	◉1	○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
8	◉ Location-2 or ○ Location-5	◉1	○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
9	◉ Location-2 or ○ Location-6	◉1	○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
10	◉ Location-3 or ○ Location-4	◉1	○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
11	◉ Location-3 or ○ Location-5	◉1	○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
12	◉ Location-3 or ○ Location-6	◉1	○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
13	◉ Location-4 or ○ Location-5	◉1	○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
14	◉ Location-4 or ○ Location-6	◉1	○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
15	◉ Location-5 or ○ Location-6	◉1	○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9

Preliminary results

Municipality	Citizens	Companies
A	A	B
B	D	A
D	B	D
C	C	C
E	F	F
F	E	E

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