Vrije Universiteit Brussel

Modal choice in freight transport: an MCDA simulation

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Introduction

- Expected transport growth worldwide

2050 Goals EC:

- 60% reduction in GHG emissions
- 50% modal shift to rail and IWT (+300km)

⇒ Modal choice and vehicle technology crucial

⇒ Need to understand and simulate modal choice decisions

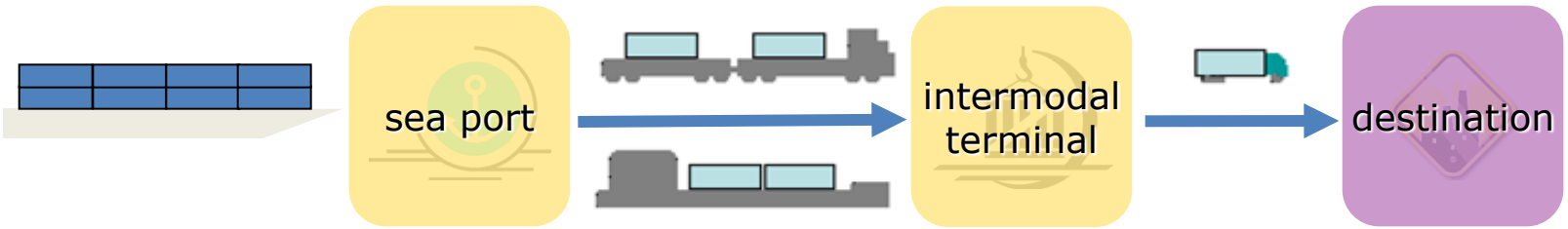
Outline

- Modal choice in container transport
- Societal concerns in modal choice
- Goal and approach
- Multi-criteria Decision analysis (MCDA)
- Geographic Information Systems (GIS)
- Combined approach
- Case study
- Conclusions

Modal choice in container transport

Unimodal road transport:

Intermodal transport:



Modal choice in container transport

Literature search:

- Review: Cullinane and Toy (2000)

	Word enumeration method	Appearance enumeration method	Latent analysis	Meta analysis
Cost/Price/Rate	1	1	3	3
Service	5	5	1	14
Transit time reliability	3	3	3	1
Speed	2	2	2	2
Loss/damage	6	8	12	4
Characteristics of the goods	4	4	6	9
Infrastructure availability	12	11	5	15
Capability	7	8	12	5

Modal choice in container transport

Literature search:

- Belgium: Vannieuwenhuyse et al. (2003)

Factor	Definition	Weight
Transportation cost	Direct cost of transportation, e.g. fuel, driver's wages, …	8.34
Reliability	Ability to respect the promised delivery date	7.82
Safety	Probability of avoiding damage and loss of quality of the goods	7.95
Transportation time	Duration of the overall transportation process (from door-to-door)	7.61
Flexibility	Ability to adapt to changing customer requirements and circumstances	7.05
Capacity	Remaining capacity available	5.02
Density of network	Availability of (alternative) links	4.87
Regulation and legislation	Set of rules, obligations, customs facilities, etc.	5.64
Impact	Impact and control potential on goods flow	5.68
Image	Company image with respect to environment, safety, etc.	5.34
Strategic elements	Considerations of strategic nature	5.13

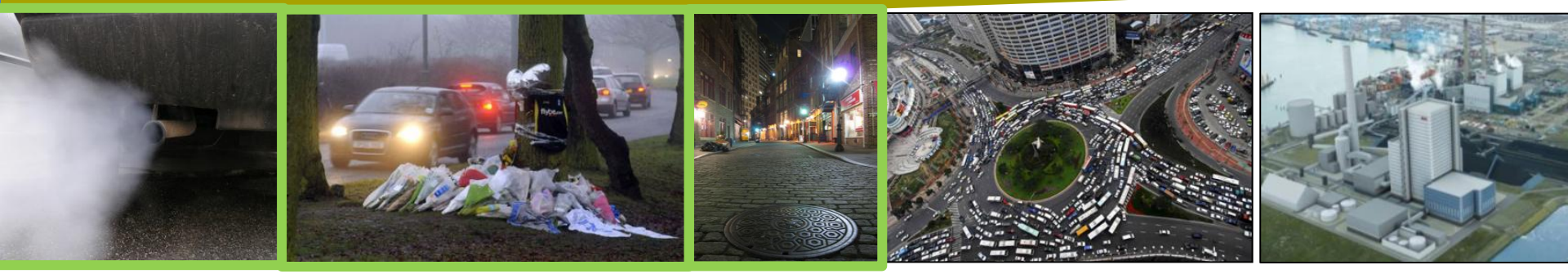
Modal choice in container transport

Literature search:

But:

- Decision maker?
- Characteristics of goods and supply chain
- Geographical differences
- Knowledge, experience and bias

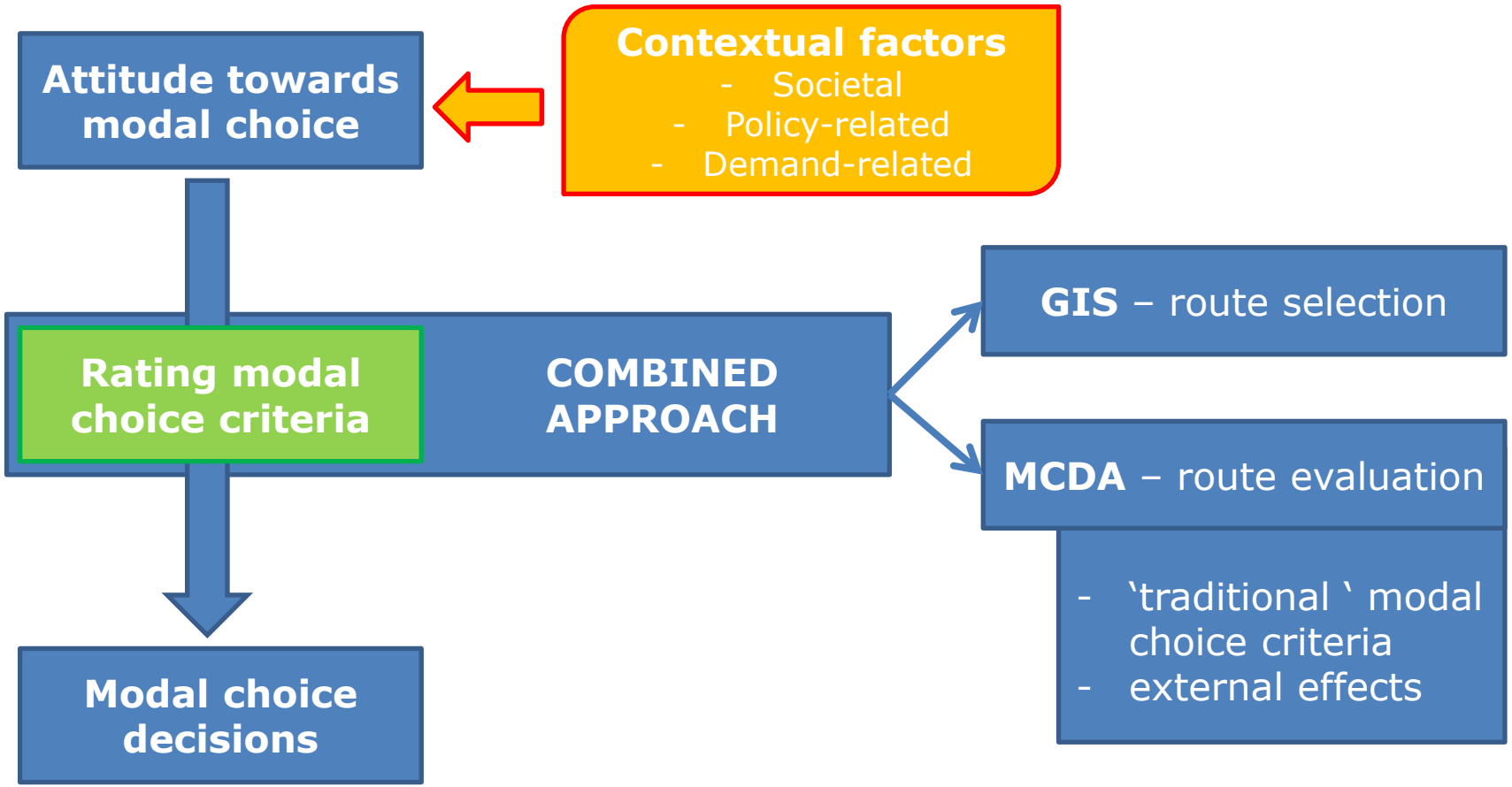
Societal concerns in modal choice



External effects freight transport:

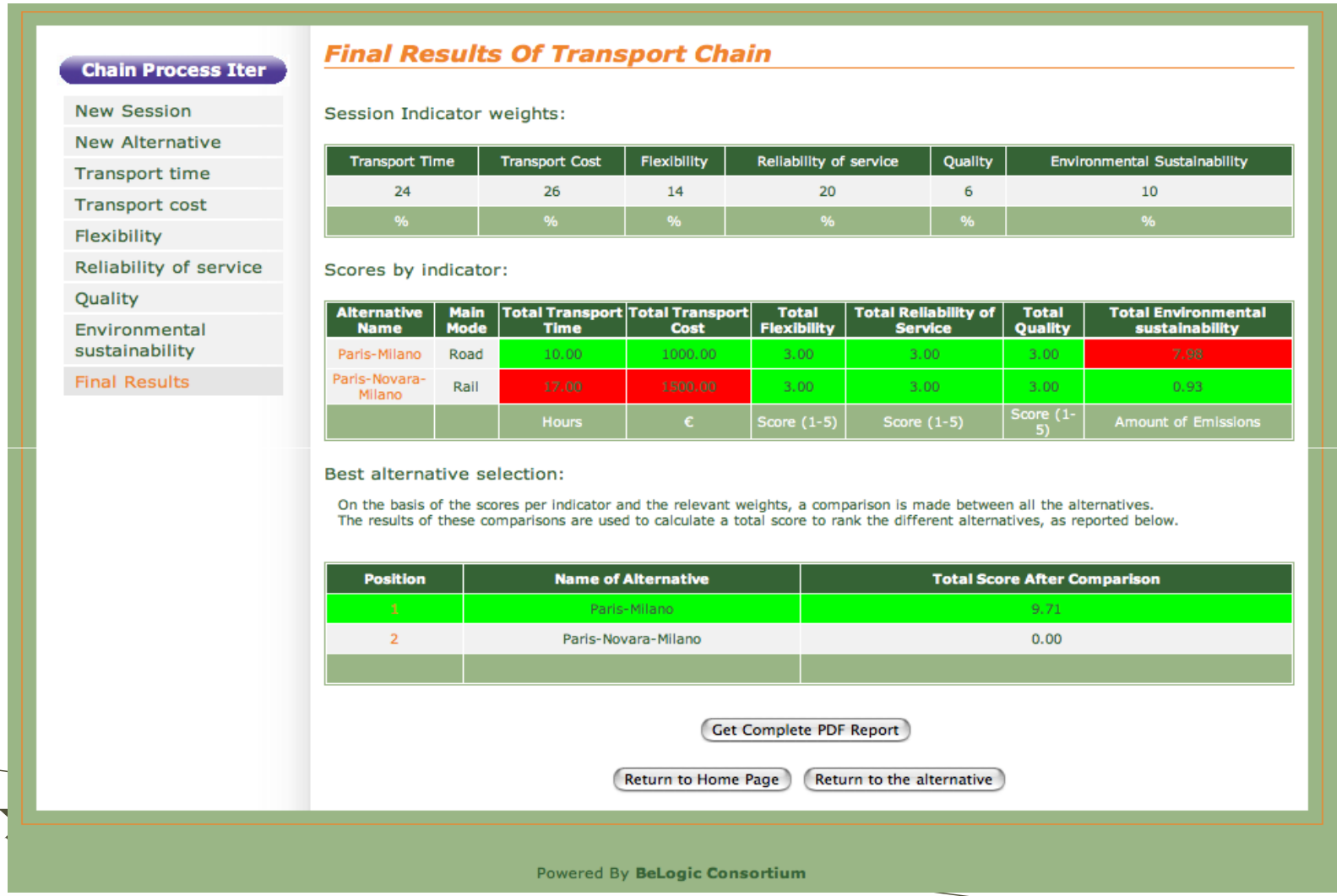
- Intermodal transport (in general) generates lower external costs
- Often neglected in modal choice studies (Lammgård, 2007)
- Growing awareness (CSR, sustainability awards, policy-incentives ...)

Goal and approach



Other example

BE LOGIC (Bozuwa et al., 2012)



Chain Process Iter

- New Session
- New Alternative
- Transport time
- Transport cost
- Flexibility
- Reliability of service
- Quality
- Environmental sustainability
- Final Results

Final Results Of Transport Chain

Session Indicator weights:

Transport Time	Transport Cost	Flexibility	Reliability of service	Quality	Environmental Sustainability
24	26	14	20	6	10
%	%	%	%	%	%

Scores by indicator:

Alternative Name	Main Mode	Total Transport Time	Total Transport Cost	Total Flexibility	Total Reliability of Service	Total Quality	Total Environmental sustainability
Paris-Milano	Road	10.00	1000.00	3.00	3.00	3.00	7.98
Paris-Novara-Milano	Rail	17.00	1500.00	3.00	3.00	3.00	0.93
		Hours	€	Score (1-5)	Score (1-5)	Score (1-5)	Amount of Emissions

Best alternative selection:

On the basis of the scores per indicator and the relevant weights, a comparison is made between all the alternatives.
The results of these comparisons are used to calculate a total score to rank the different alternatives, as reported below.

Position	Name of Alternative	Total Score After Comparison
1	Paris-Milano	9.71
2	Paris-Novara-Milano	0.00

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Return to Home Page | Return to the alternative

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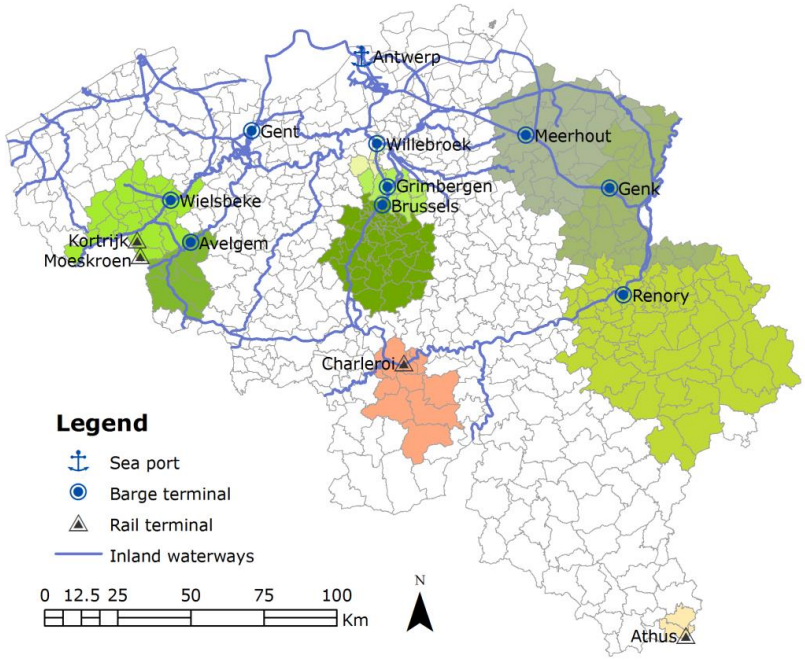
MCDA

- Pairwise comparison for weight determination
- PROMETHEE for overall MCDA
- Six steps:
  1. Analysis and definition of the problem: modal choice
  2. Generation of different alternatives: alternative routes: one road-only and two intermodal
  3. Formulation of criteria, weights and indicators
  4. Construction of the evaluation matrix
  5. Overall evaluation using an aggregation method (D-Sight software)
  6. Integration of MCDA results in decision making

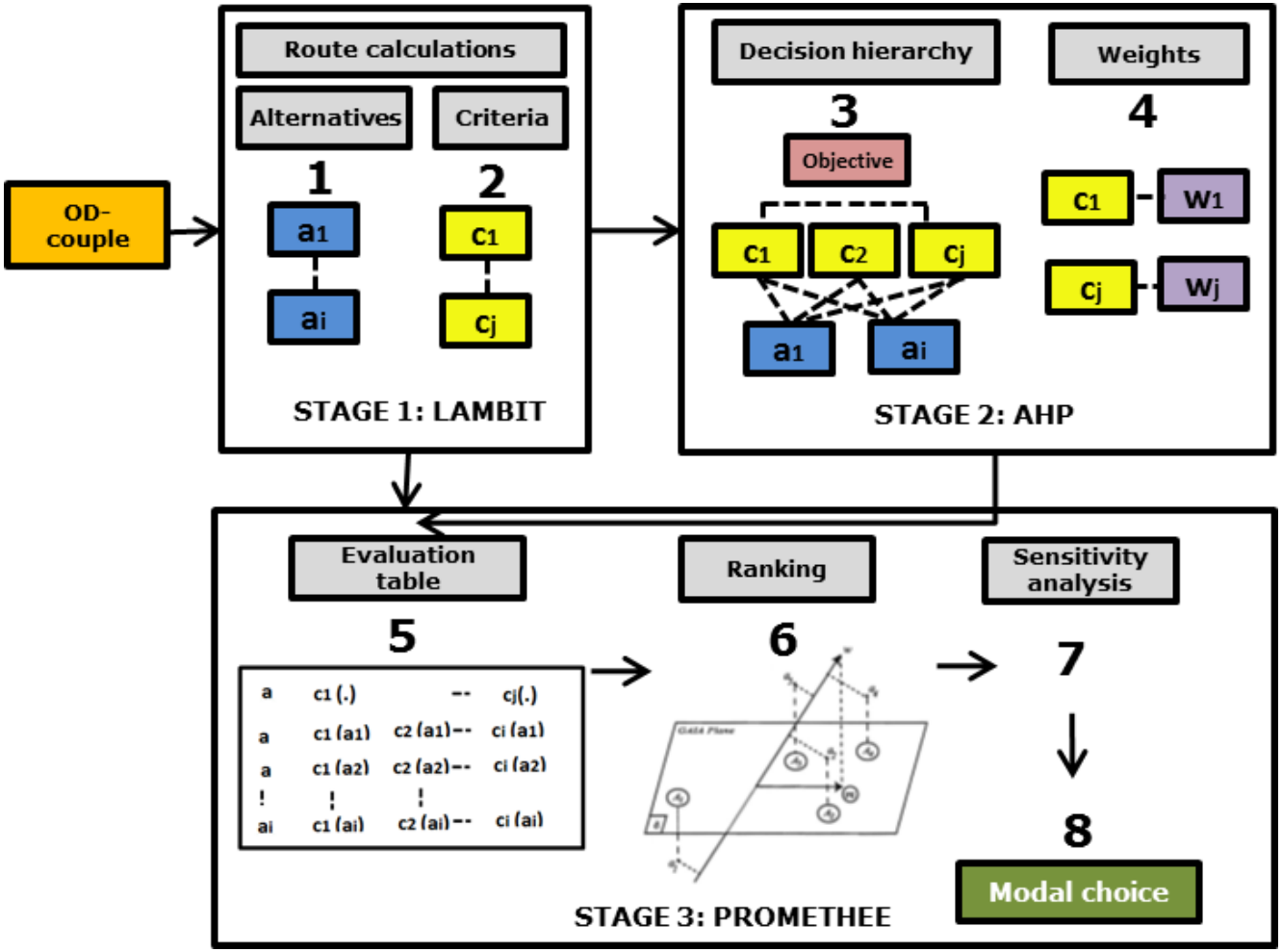
GIS

LAMBIT (Location Analysis Model for Belgian Intermodal Terminals)

- GIS-based model
- Mode/route comparison
- Model input
  - Transport networks
  - MC variables
  - Container flows



Combined approach

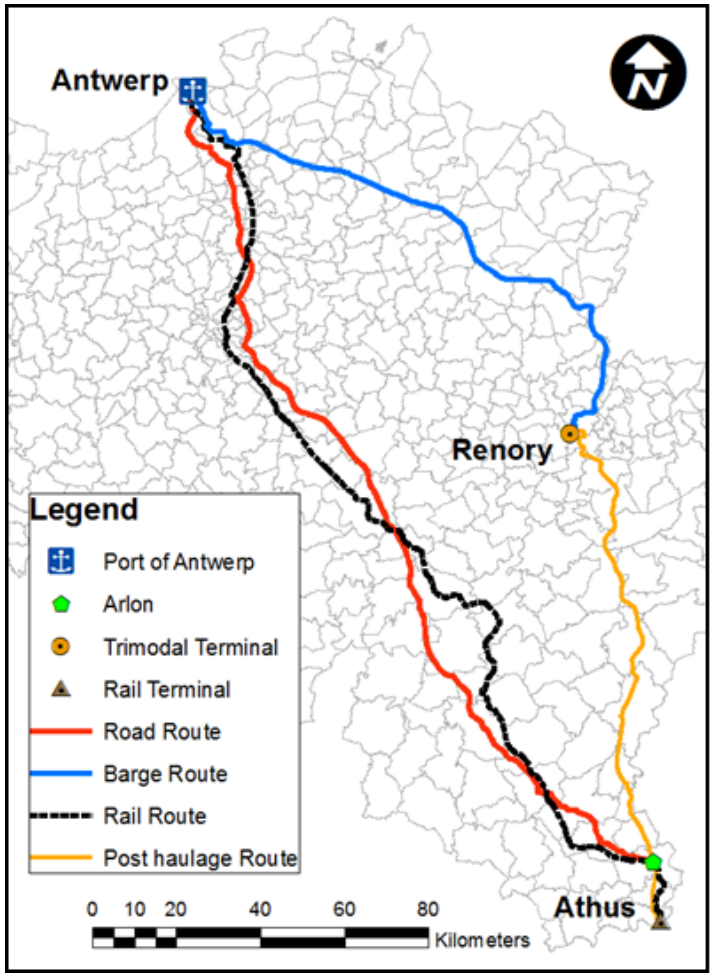


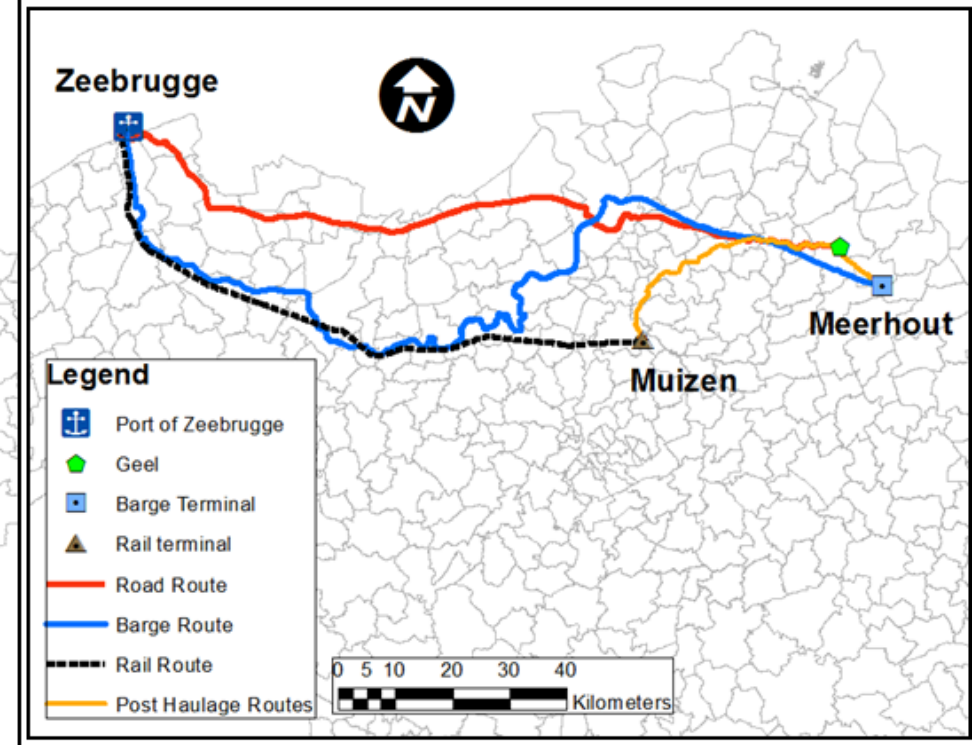
Case study Belgian-based shipper

Two cases

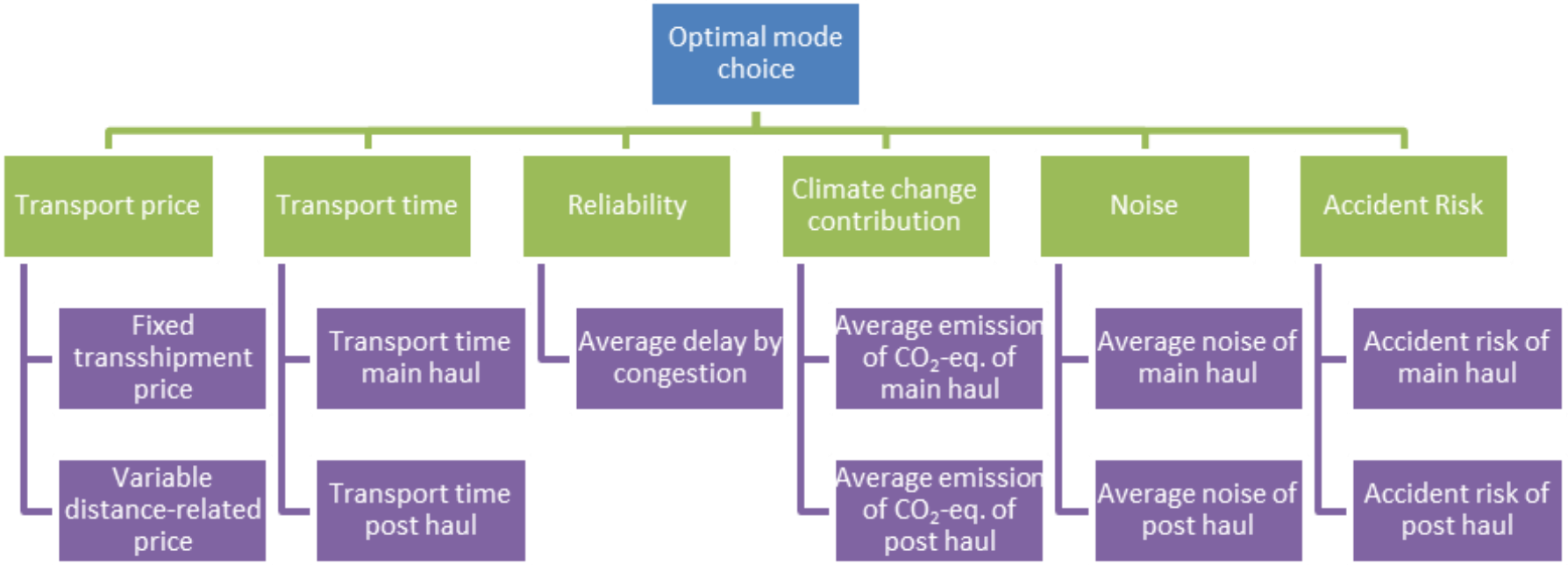
- Maritime-based container transport
- Belgian hinterland transport
- One unimodal alternative vs two intermodal (rail and IWT)

Route-mode alternatives





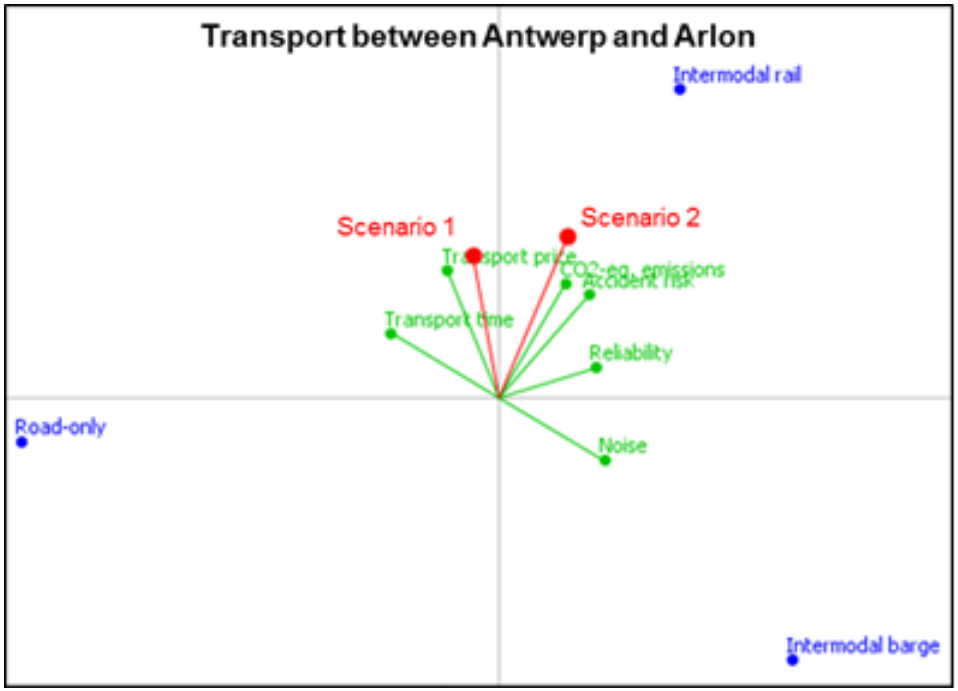
Criteria, weights and indicators

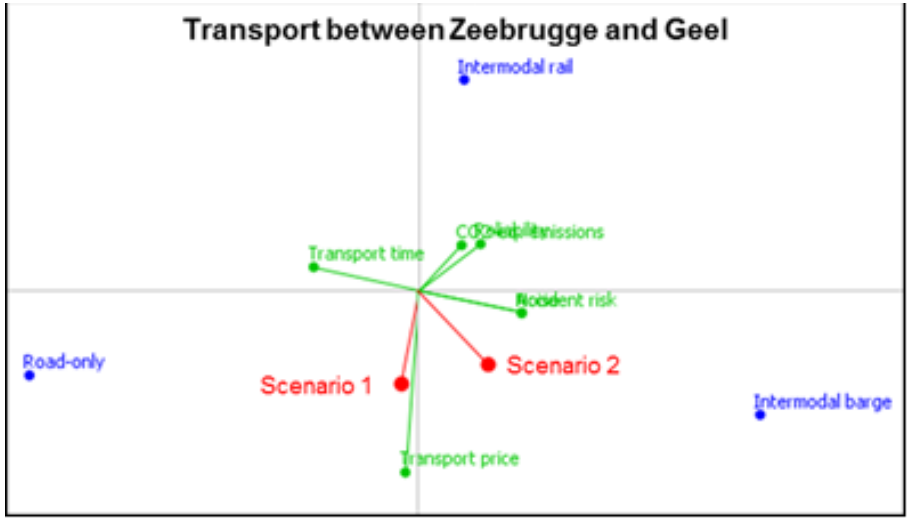


Decision matrix

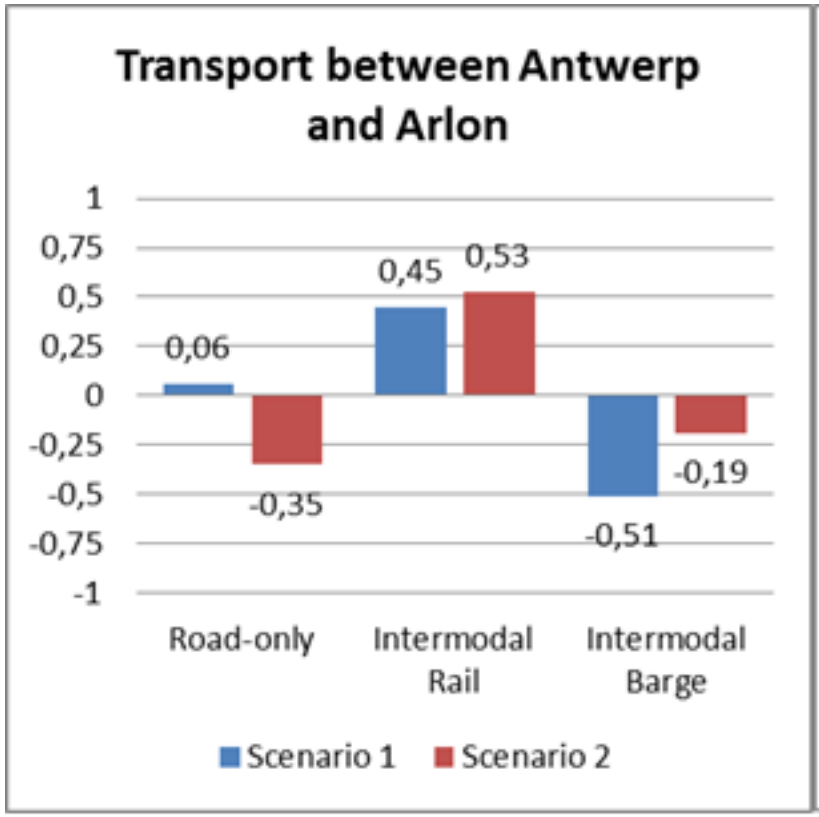
Zeebrugge-Geel	Intermodal terminal	Transport Price (€/TEU)	Transport Time (hour)	Congestion Time (min)	CO_2-eq. Emissions (kg/TEU)	Accident risk (accidents/ TEU)	Noise (dB (A)/Tonne))
Weight scenario 1(%)		40	25	30	3	1	1
Weight scenario 2(%)		23	15	17	15	15	15
Function		V-Shape	Linear	Gaussian	Gaussian	Usual	Usual
Indifference		–	0	-	-	-	-
Preference		30,0	3	15	50,0	-	-
Mode Main haul							
Road	–	434	23	2793	2766	4,2E-04	64
Rail	Athinon	439	15,7	153	861	8,5E-05	63
Barge	Meerhout	436	1893	8194	2128	4,2E-05	negligible

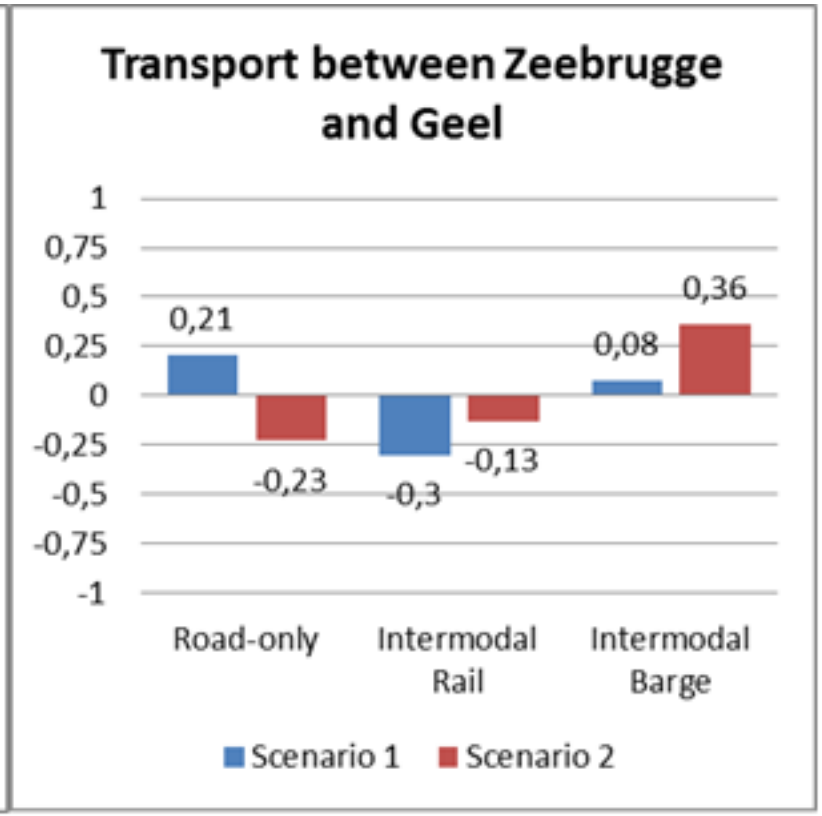
Results: GAIA Visual Stick





Results: PROMETHEE II ranking





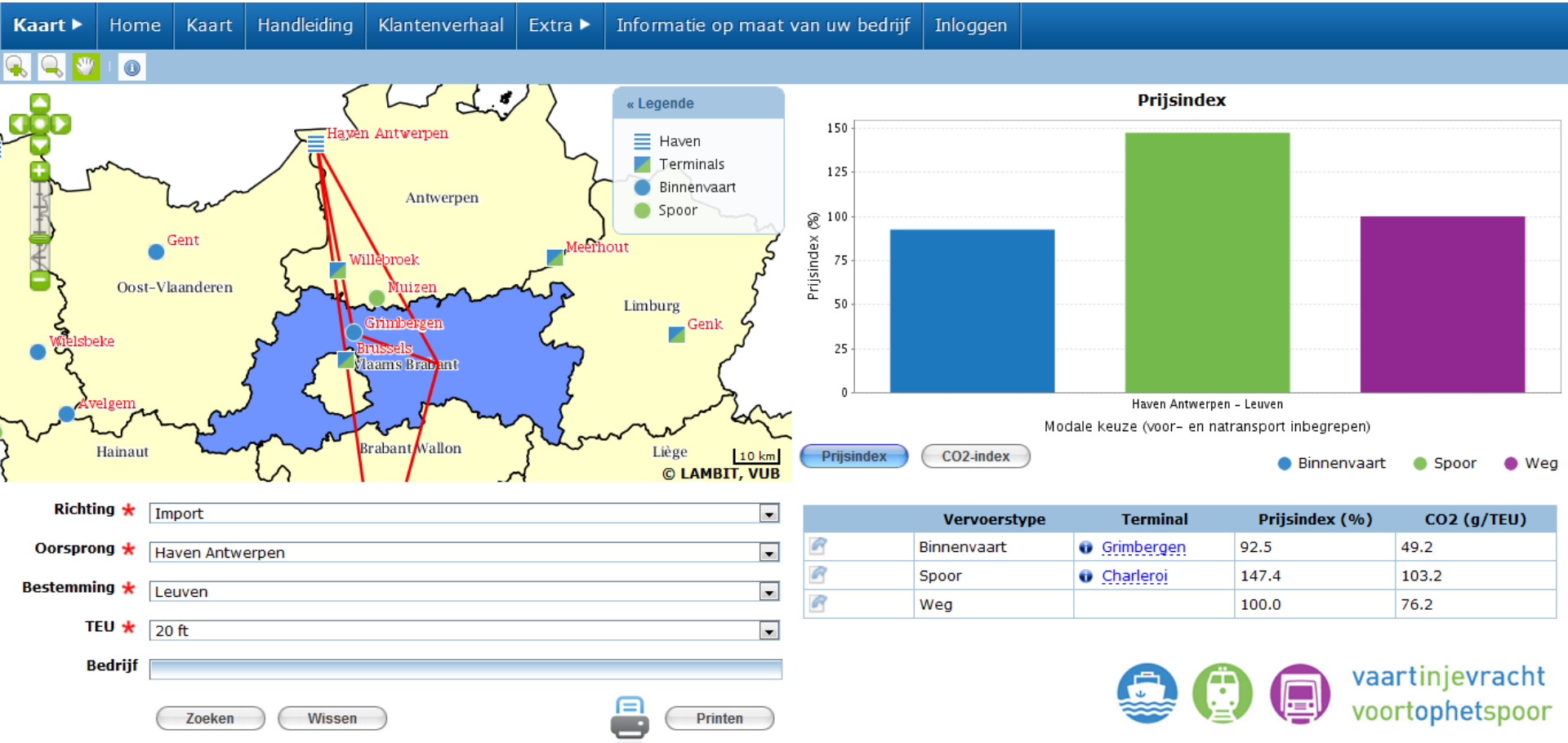
Conclusions

- Combination of MCDA & GIS for MC decisions
  - Tailor-made MC
  - Assignment model
- More sustainable MC decisions (awareness)
- Towards EC sustainability goals

The road ahead:

- Real world examples
- Selection routes based on criteria weights
- Integration in a website...

Integration in website?



	Vervoerstype	Terminal	Prijsindex (%)	CO2 (g/TEU)
	Binnenvaart	Grimbergen	92.5	49.2
	Spoor	Charleroi	147.4	103.2
	Weg		100.0	76.2

vaartinjevracht
voortophetspoor

www.multimodaalvlaamsbrabant.be

Thank you for listening!

Questions? - dries.meers@vub.ac.be

Enjoy your day(s) in Brussels!