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A Reference Model for Allocating Road Toll Charges to Transport Products

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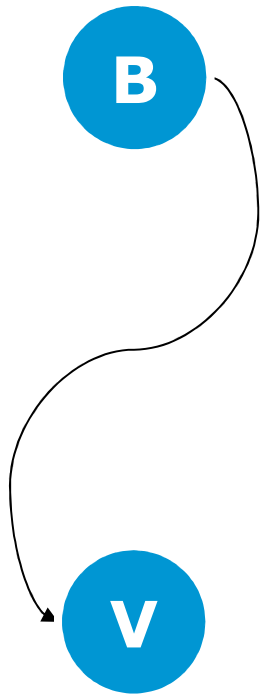
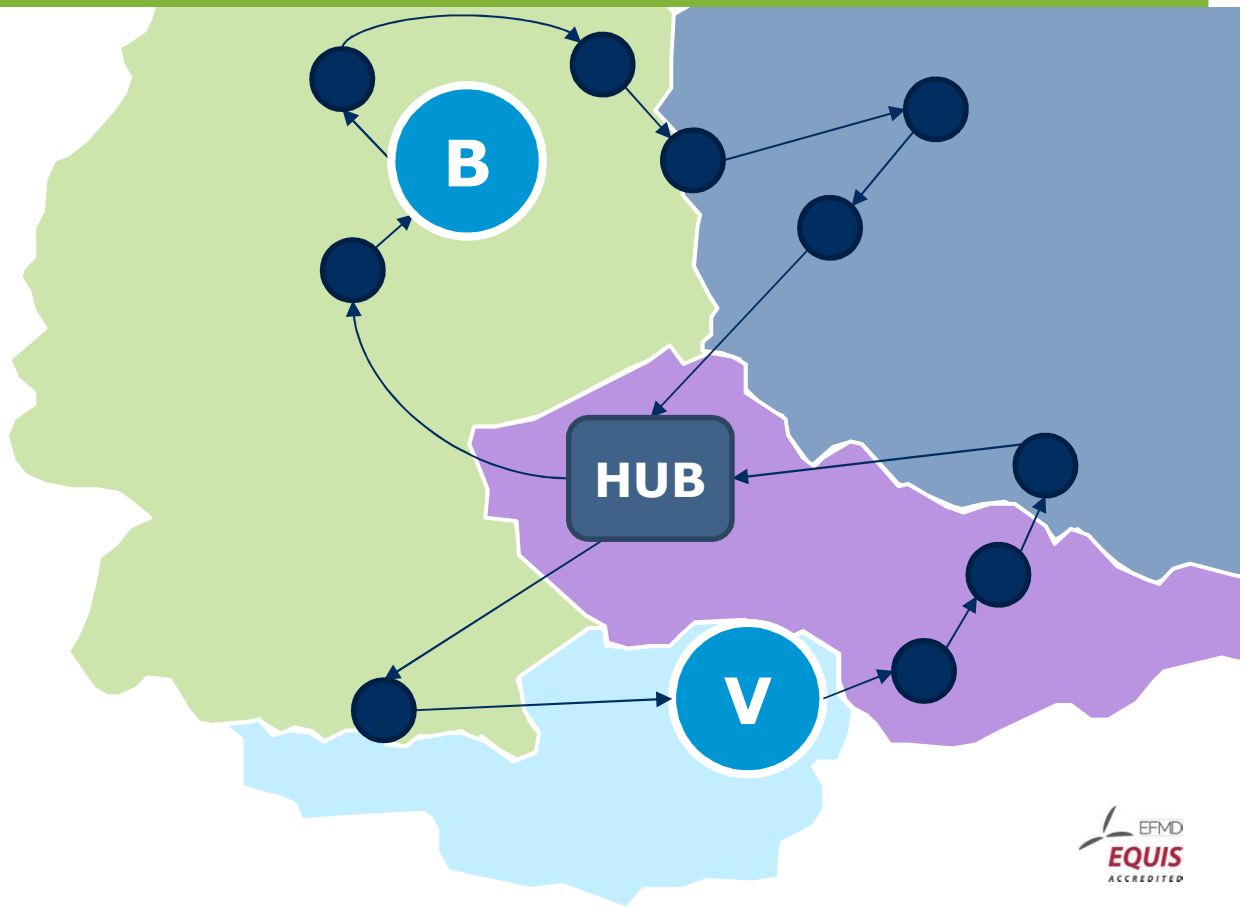
Motivation
Toll cost allocation as a challenge





Research gap and question

Toll cost allocation as a blind spot in academia?

- undisputed **importance of road freight transport** for economic prosperity
- significant **expansion** of **road infrastructure** (esp. in CEE)
- increasing **introduction of toll systems**
- **heterogeneous** and country-specific toll **solutions**

Demand for transparent, effective and simple **calculation schemes** for determining and allocating transport costs

Research gap and question

Toll cost allocation as a blind spot in academia?

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- hardly / not addressed in scientific literature
- insufficient consideration in traditional GIS
- often inefficient and inexplicable ‚practitioner models'

RQ1 What are the **requirements** for a cost allocation scheme for distance-based road toll charges in freight transport?

RQ2 How can a **reference model** for road toll cost calculation and allocation be formulated?

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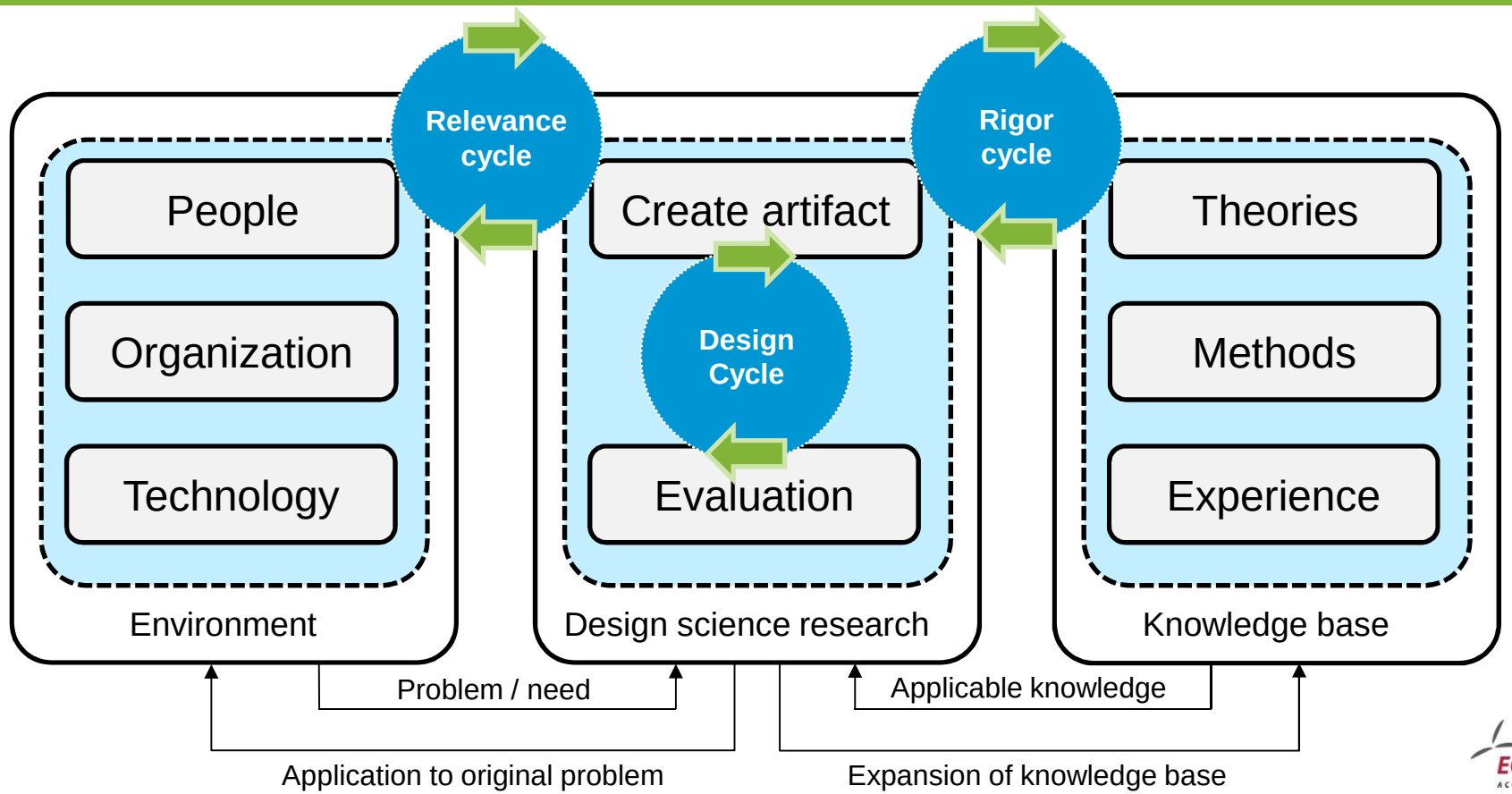
Research design



Requirements analysis

Various stakeholders have to be considered

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Shipper

- transparent and consistent
  - relation-specific
  - inter-relational consistency
- fair (reflection of true costs)
- cost attribution based on causation principle

Transport company

- communicable
- transparent
- cost-effective
- affordable
- automated or manual processing
- approximation of enterprise-specific production system (e.g. hub structure)

Modeler

- reasonably precise
- expandable
  - countries / regions
  - road classes, …
- adaptable
- low maintenance effort

Stakeholder requirements as a critical success factor

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Proposed reference model

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Distance matrix

PLZ	1	2	3	4	...	n
1						
2						
3						
4						
...						
n						

- Calculation of **toll-specific distance** for O/D pairs

Zone matrix

PLZ	1	2	3	4	...	n
1	1	2	3	4	...	3
2	2	0	2	1	...	8
3	3	2	0	7	...	1
4	4	1	7	1	...	2
...	...	...	...	...	...	5
n	3	8	1	2	5	0

- Weighted toll-distance-based zoning

Cost rate approximation

G. \ Zone	1	2	3	...	m
< 1k	EUR	EUR	EUR	...	EUR
< 2k	EUR	EUR	EUR	...	EUR
< 3k	EUR	EUR	EUR	...	EUR
< 4k	EUR	EUR	EUR	...	EUR
...	...	...	...	...	EUR
< Xk	EUR	EUR	EUR	EUR	EUR

- Cost calculation for combination of
  - distance zone
  - *weight of shipment**

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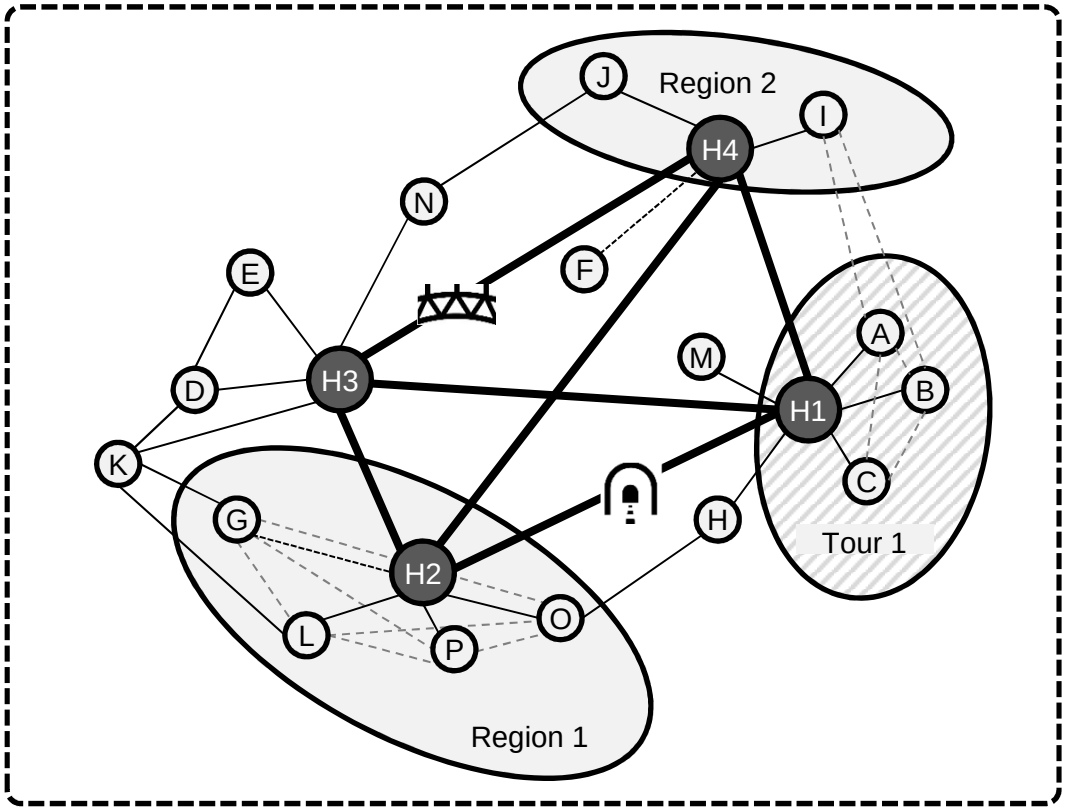
Proposed reference model



Step 1: Define set of nodes

Step 2: Model network and production logic

Step 3: Define routes for all pairs of (O/D) nodes

Step 4: Calculate effective toll distances

Conclusion

- Road transport is an integral element of economic systems
- Toll systems are increasingly heterogeneous
- Requirement for standardized cost allocation procedures
- Topic underrepresented in academic literature

- Addressed by proposing a reference model for cost allocation
- First case studies demonstrate applicability and acceptability
- Future research
  - Extensions
  - Application to different domains (ABC)