Drivers and Barriers to the Adoption of Cargo Cycles: An Exploratory Factor Analysis

City Logistics Conference 2019

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Problem statement
– Cargo cycles can reduce cities‘ traffic problems…

- Cities are burdened by heavy traffic and its externalitites
- Last mile logistics thrive
- Potential analysis: Up to 50 % of trips are replacable by cargo cycles (BMVI 2015)

Problem statement
… but are rarely used and poorly studied

- Only very few trips are done by cargo cycles
- Very little research and theories focussing on cargo cycle usage

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What are drivers and barriers for adapting cargo cycles?

Drivers and barriers for adapting cargo cycles – Agenda

1. **Problem statement**
   Cargo cycles can be used to solve traffic problems, but are rarely used and poorly studied
2. **Method**
   Survey of real-life interested cargo cycle users
3. **Results**
   Identifying underlying drivers and barriers by means of an exploratory factor analysis
4. **Implications**
   Building a framework for describing and researching cargo cycle adoption

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Method – Introduction

Objective: collect real life data among German companies and organizations

↓

Setting up a cargo cycle testing scheme

↓

Interested companies fill out survey for quantitative primary data collection

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Method
– Sample

- 389 respondents
- 79 % male
- Mean age: 43.9 years
- Mostly fleet decision makers (92 %)

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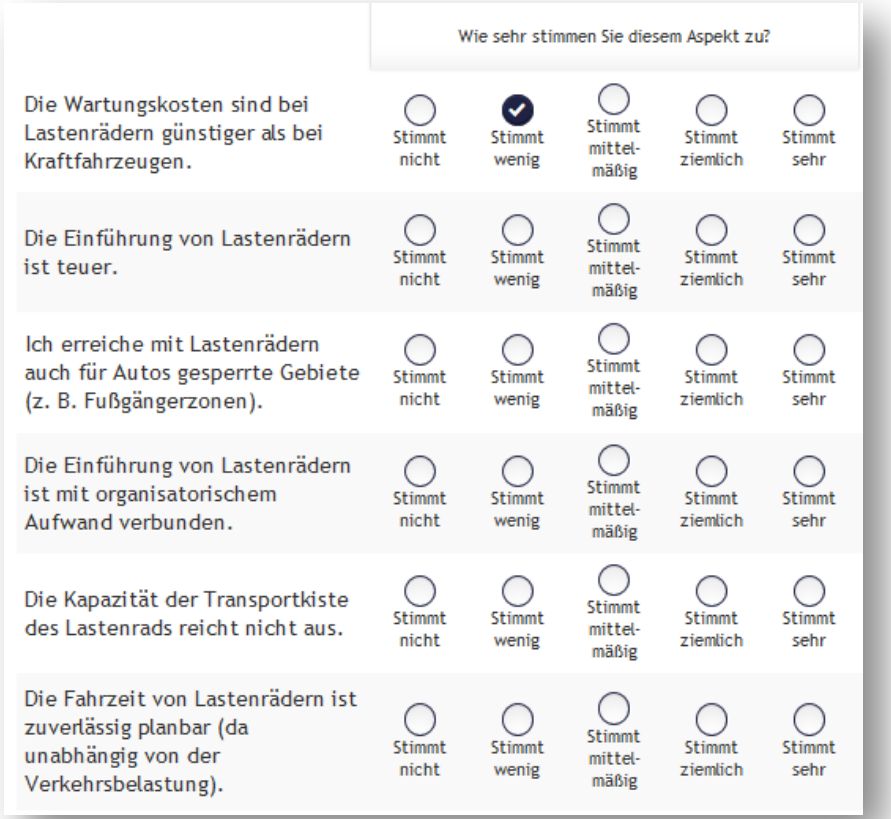
Method
– Questionnaire

- 23 items describing relevant aspects for the use of cargo cycles derived from literature research focusing on
  - Cargo cycle
  - Electric mobility
  - Diffusion of innovation
  - Case studies
- Importance rating of these 23 items on a 5-point-Likert scale
- Exemplary items
  - *Cargo cycles promote employees' health*
  - *The implementation of cargo cycles requires organizational effort*



	Wie sehr stimmen Sie diesem Aspekt zu?				
Die Wartungskosten sind bei Lastenrädern günstiger als bei Kraftfahrzeugen.	Stimmt nicht	Stimmt wenig ✓	Stimmt mittel-mäßig	Stimmt ziemlich	Stimmt sehr
Die Einführung von Lastenrädern ist teuer.	Stimmt nicht	Stimmt wenig	Stimmt mittel-mäßig	Stimmt ziemlich	Stimmt sehr
Ich erreiche mit Lastenrädern auch für Autos gesperrte Gebiete (z. B. Fußgängerzonen).	Stimmt nicht	Stimmt wenig	Stimmt mittel-mäßig	Stimmt ziemlich	Stimmt sehr
Die Einführung von Lastenrädern ist mit organisatorischem Aufwand verbunden.	Stimmt nicht	Stimmt wenig	Stimmt mittel-mäßig	Stimmt ziemlich	Stimmt sehr
Die Kapazität der Transportkiste des Lastenrads reicht nicht aus.	Stimmt nicht	Stimmt wenig	Stimmt mittel-mäßig	Stimmt ziemlich	Stimmt sehr
Die Fahrzeit von Lastenrädern ist zuverlässig planbar (da unabhängig von der Verkehrsbelastung).	Stimmt nicht	Stimmt wenig	Stimmt mittel-mäßig	Stimmt ziemlich	Stimmt sehr

Method
– Statistical analysis

- Exploratory factor analysis for data reduction
- Identifying an underlying factor structure
- Principal component factor extraction with varimax rotation allows most sensible interpretation of factors
- Number of extracted factors determined by Kaiser criterion (Eigenvalue > 1)
- KMO criterion in our sample = .71
  (above recommended cut-offs between .5 and .6)
- Significant Bartlett's test indicate the appropriateness of the data set for exploratory factor analysis
- Calculating unweighted factor scores by averaging the scores of items that load highest on that specific factor

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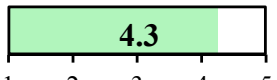
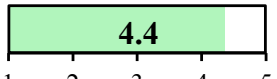
Results
– Overall factor structure

DRIVERS

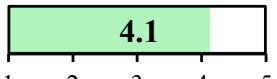
F2 SOFT BENEFITS
- Health
- Image
- Travel time reliability



F4 COST BENEFITS
- Purchase cost
- Maintenance cost
- Flexible parking

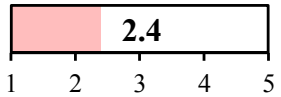


F5 URBAN ADVANTAGES
- Accessibility
- Environmental goals
- Travel time

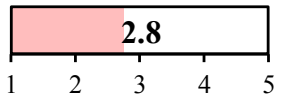


BARRIERS

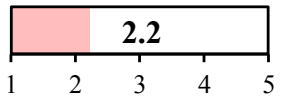
F1 VEHICLE LIMITATIONS
- Spatial coverage
- Loading capacity
- Weather
- Electric range



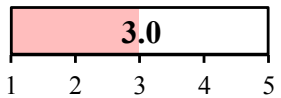
F3 WORRIES AND PERILS
- Theft
- Organizational effort
- Implementation cost
- Payload damage



F6 RIDERS' CONCERNS
- Employee acceptance
- Handling experience
- Fun



F7 INFRASTRUCTURE CONSTRAINTS
- Cycle infrastructure
- Safety
- Service network



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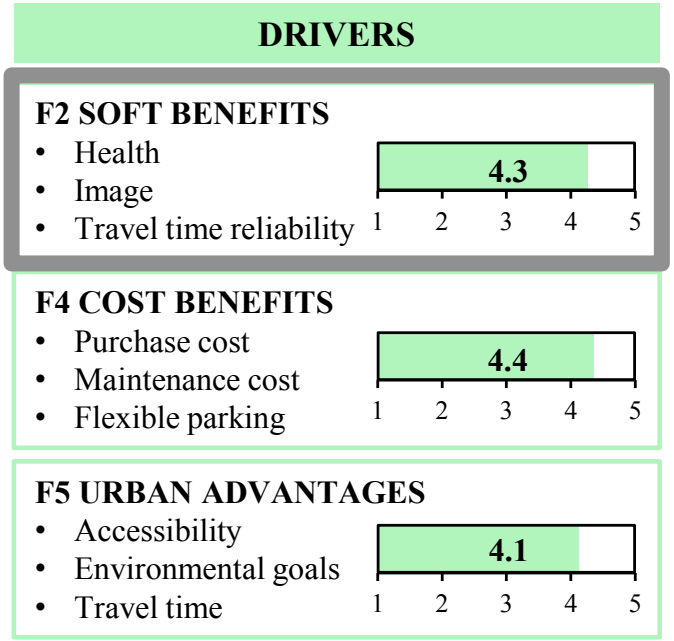
Results
– Drivers: Soft benefits

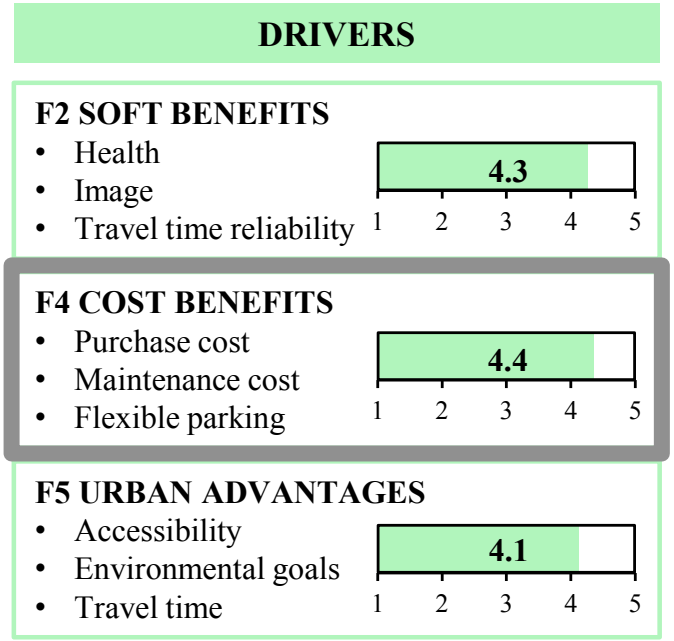
Item	Loading
Health	.673
Image	.615
Travel time reliability	.547



DLR

Results
– Drivers: Cost benefits

Item	Loading
Purchase cost	.752
Maintenance cost	.604
Flexible parking	.486



DLR

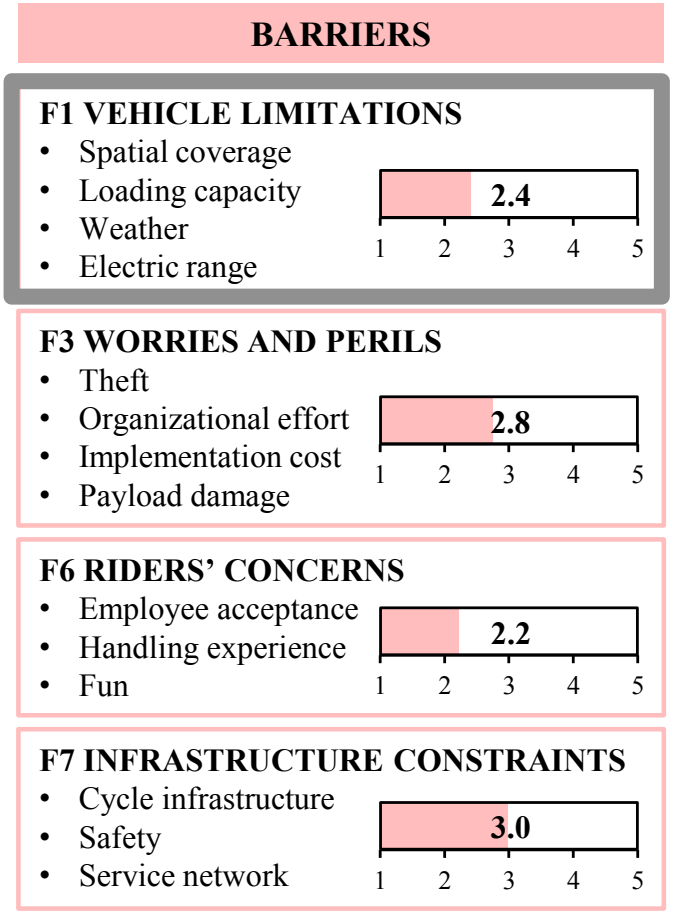
Results
– Drivers: Urban advantages

Item	Loading
Accessibility	.697
Environmental goals	.524
Travel time	.463

DLR

Results
– Barriers: Vehicle limitations

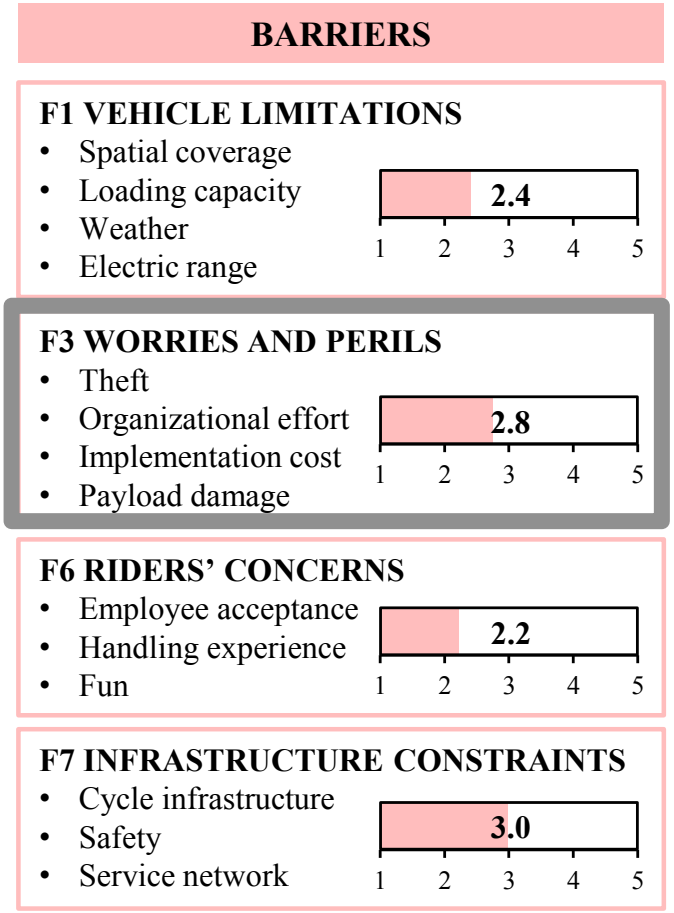
Item	Loading
Spatial coverage	.641
Loading capacity	.593
Weather	.524
Electric range	-.497



DLR

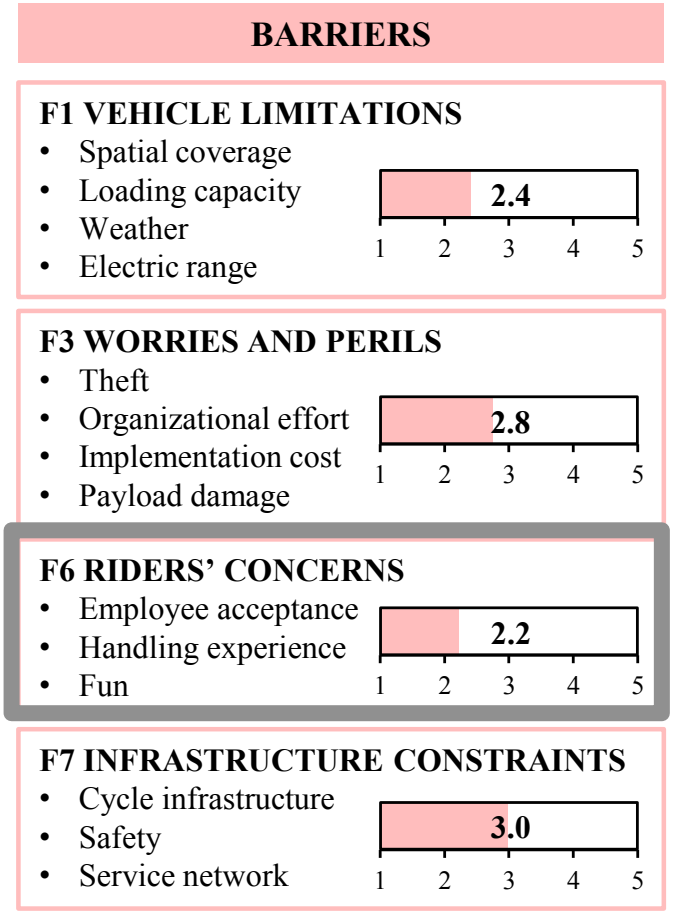
Results
– Barriers: Worries and perils

Item	Loading
Theft	.646
Organizational effort	.590
Implementation cost	.583
Payload damage	.466



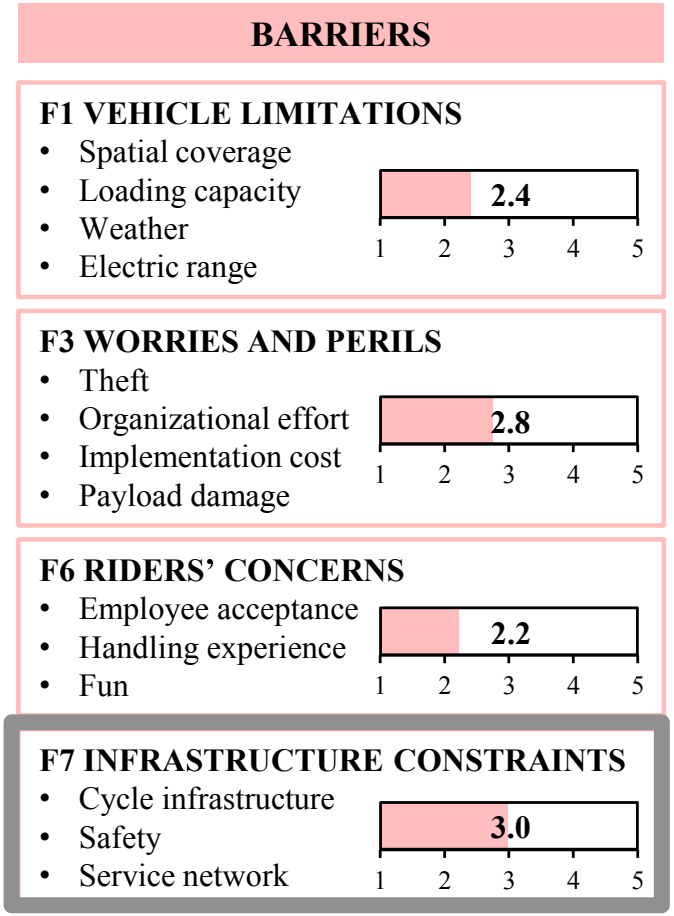
Results
– Barriers: Riders' concerns

Item	Loading
Employee acceptance	.653
Handling experience	.607
Fun	-.462



Results
– Barriers: Infrastructure constraints

Item	Loading
Cycle infrastructure	.719
Safety	.527
Service network	.484



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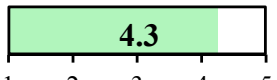

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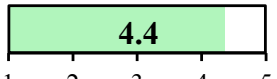

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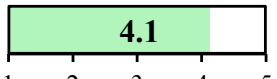

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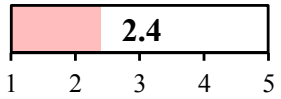

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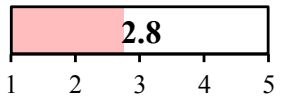

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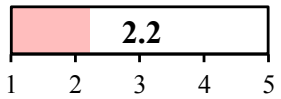

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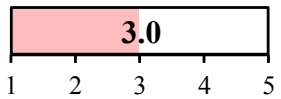

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Implications

- Based on the results of the factor analysis, we propose a framework for describing and researching the adoption of cargo cycles in last mile logistics
- Our results indicate that among barriers, infrastructure constraints are considered as most important
- Among drivers, importance rating are closely together, with cost benefits scoring slightly highest

Thank you very much for your attention!

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Item loadings on the seven factors

Item	F1 Vehicle limitations	F2 Soft benefits	F3 Worries & perils	F4 Cost benefits	F5 Urban advantages	F6 Riders' concerns	F7 Infrastructure constraints	h2
Spatial coverage	.641	-.108	.033	-.084	.057	.078	-.063	.44
Loading capacity	.593	-.267	.122	.025	.014	-.215	.218	.53
Weather	.524	-.084	.229	.165	-.210	.241	.042	.47
Electric range	-.497	-.213	.180	.378	.106	-.041	-.125	.50
Health	-.041	.673	.088	.127	.024	-.119	-.051	.50
Image	.004	.615	-.133	-.028	.324	.189	.060	.54
Travel time reliability	-.238	.547	.121	.225	.135	-.089	.024	.45
Theft	-.141	.057	.646	-.044	-.067	.172	.144	.50
Organizational effort	.228	.016	.590	-.067	.148	.297	-.234	.57
Implementation cost	.153	.071	.583	-.112	.129	-.329	.105	.52
Payload damage	.085	-.062	.466	.163	-.378	.116	.289	.49
Purchase cost	-.257	.017	-.074	.752	.045	.065	.089	.65
Maintenance cost	.130	.220	-.103	.604	.091	-.032	-.215	.50
Flexible parking	.028	.174	.013	.486	.263	-.058	-.010	.34
Accessibility	.033	.060	-.002	.156	.697	.028	-.020	.52
Environmental goals	-.065	.218	.011	.149	.524	.030	.244	.41
Travel time	-.405	.075	.208	.218	.463	-.168	.004	.50
Employee acceptance	.321	-.023	.026	.068	-.044	.653	.084	.54
Handling experience	-.245	-.032	.261	-.072	.050	.607	.028	.51
Fun	-.270	.443	.077	.117	-.010	-.462	-.065	.51
Cycle infrastructure	.020	.030	-.042	-.076	.083	-.025	.719	.53
Safety	.159	.183	.246	-.042	-.276	.292	.527	.56
Service network	.050	-.297	.210	-.020	.195	.049	.484	.41
Explained Variance (%)	13.9	9.1	6.2	5.8	5.3	5.0	4.6	

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