

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

City Logistics Conference 2019

June 13, 2019

Lars Thoma

German Aerospace Center (DLR) – Traffic Research



Knowledge for Tomorrow



# Problem statement

## – Cargo cycles can reduce cities' traffic problems...

- Cities are burdened by heavy traffic and its externalities
- Last mile logistics thrive
- Potential analysis: Up to 50 % of trips are replaceable 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



# 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

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

# 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

# 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





# Method

## – Sample

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





# 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.	<input type="radio"/> Stimmt nicht	<input checked="" type="radio"/> Stimmt wenig	<input type="radio"/> Stimmt mittelmäßig	<input type="radio"/> Stimmt ziemlich	<input type="radio"/> Stimmt sehr
Die Einführung von Lastenrädern ist teuer.	<input type="radio"/> Stimmt nicht	<input type="radio"/> Stimmt wenig	<input type="radio"/> Stimmt mittelmäßig	<input type="radio"/> Stimmt ziemlich	<input type="radio"/> Stimmt sehr
Ich erreiche mit Lastenrädern auch für Autos gesperrte Gebiete (z. B. Fußgängerzonen).	<input type="radio"/> Stimmt nicht	<input type="radio"/> Stimmt wenig	<input type="radio"/> Stimmt mittelmäßig	<input type="radio"/> Stimmt ziemlich	<input type="radio"/> Stimmt sehr
Die Einführung von Lastenrädern ist mit organisatorischem Aufwand verbunden.	<input type="radio"/> Stimmt nicht	<input type="radio"/> Stimmt wenig	<input type="radio"/> Stimmt mittelmäßig	<input type="radio"/> Stimmt ziemlich	<input type="radio"/> Stimmt sehr
Die Kapazität der Transportkiste des Lastenrads reicht nicht aus.	<input type="radio"/> Stimmt nicht	<input type="radio"/> Stimmt wenig	<input type="radio"/> Stimmt mittelmäßig	<input type="radio"/> Stimmt ziemlich	<input type="radio"/> Stimmt sehr
Die Fahrzeit von Lastenrädern ist zuverlässig planbar (da unabhängig von der Verkehrsbelastung).	<input type="radio"/> Stimmt nicht	<input type="radio"/> Stimmt wenig	<input type="radio"/> Stimmt mittelmäßig	<input type="radio"/> Stimmt ziemlich	<input type="radio"/> 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

# 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

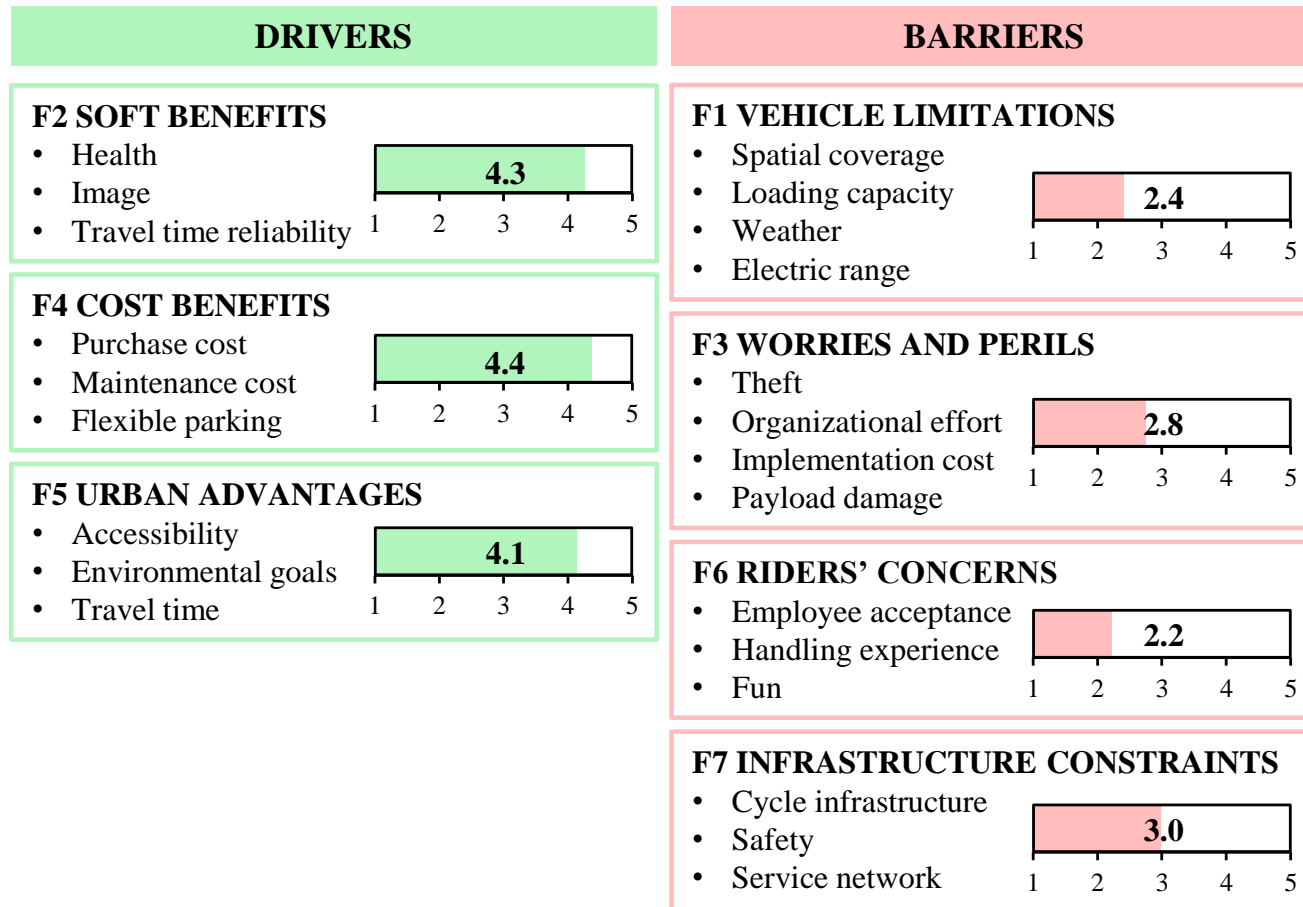
Identifying underlying drivers and barriers by means of an exploratory factor analysis

### 4. Implications

Building a framework for describing and researching cargo cycle adoption

# Results

## – Overall factor structure



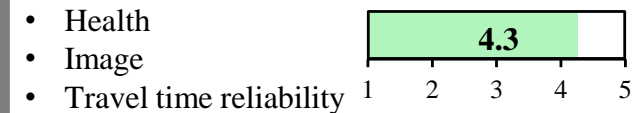
# Results

## – Drivers: Soft benefits

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

### DRIVERS

#### F2 SOFT BENEFITS



#### F4 COST BENEFITS



#### F5 URBAN ADVANTAGES



# Results

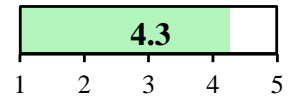
## – Drivers: Cost benefits

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

### DRIVERS

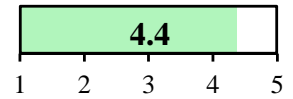
#### F2 SOFT BENEFITS

- Health
- Image
- Travel time reliability



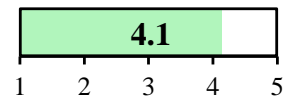
#### F4 COST BENEFITS

- Purchase cost
- Maintenance cost
- Flexible parking



#### F5 URBAN ADVANTAGES

- Accessibility
- Environmental goals
- Travel time





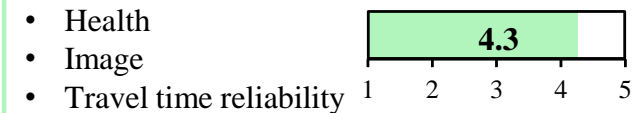
# Results

## – Drivers: Urban advantages

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

### DRIVERS

#### F2 SOFT BENEFITS



#### F4 COST BENEFITS



#### F5 URBAN ADVANTAGES



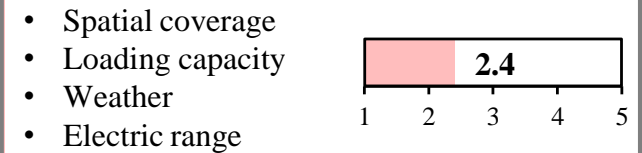
# Results

## – Barriers: Vehicle limitations

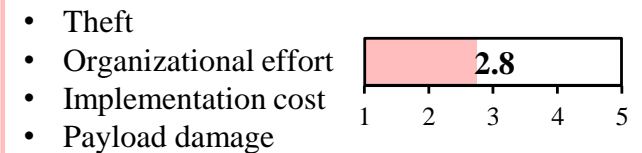
Item	Loading
Spatial coverage	.641
Loading capacity	.593
Weather	.524
Electric range	-.497

### BARRIERS

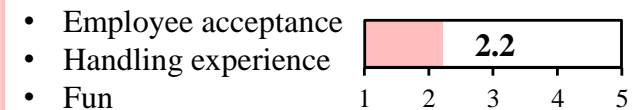
#### F1 VEHICLE LIMITATIONS



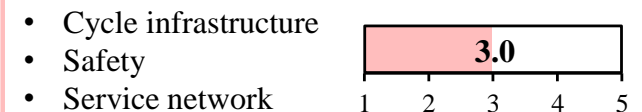
#### F3 WORRIES AND PERILS



#### F6 RIDERS' CONCERNS



#### F7 INFRASTRUCTURE CONSTRAINTS



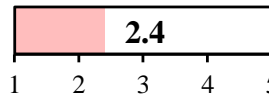
# Results

## – Barriers: Worries and perils

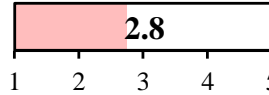
Item	Loading
Theft	.646
Organizational effort	.590
Implementation cost	.583
Payload damage	.466

### BARRIERS

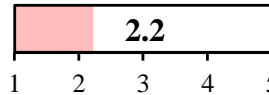
#### F1 VEHICLE LIMITATIONS

- Spatial coverage
  - Loading capacity
  - Weather
  - Electric range
- 

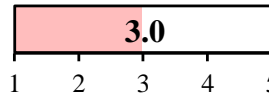
#### F3 WORRIES AND PERILS

- Theft
  - Organizational effort
  - Implementation cost
  - Payload damage
- 

#### F6 RIDERS' CONCERNS

- Employee acceptance
  - Handling experience
  - Fun
- 

#### F7 INFRASTRUCTURE CONSTRAINTS

- Cycle infrastructure
  - Safety
  - Service network
- 

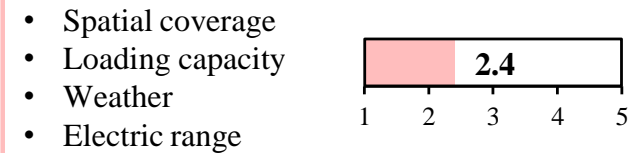
# Results

## – Barriers: Riders' concerns

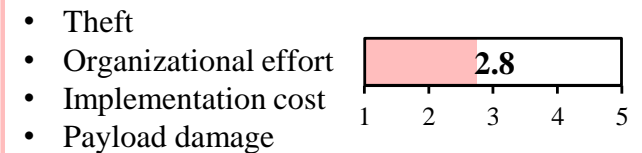
Item	Loading
Employee acceptance	.653
Handling experience	.607
Fun	-.462

### BARRIERS

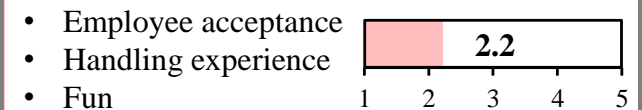
#### F1 VEHICLE LIMITATIONS



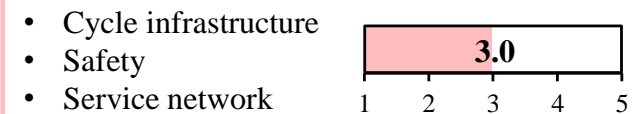
#### F3 WORRIES AND PERILS



#### F6 RIDERS' CONCERNS



#### F7 INFRASTRUCTURE CONSTRAINTS



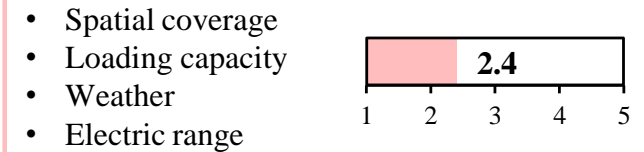
# Results

## – Barriers: Infrastructure constraints

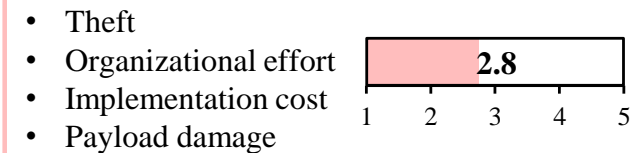
Item	Loading
Cycle infrastructure	.719
Safety	.527
Service network	.484

### BARRIERS

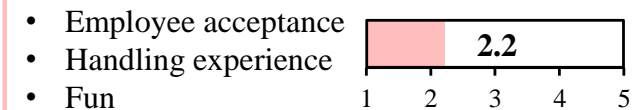
#### F1 VEHICLE LIMITATIONS



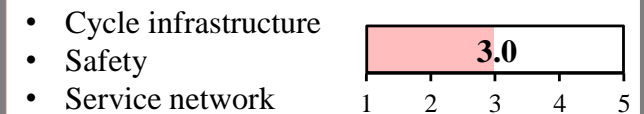
#### F3 WORRIES AND PERILS



#### F6 RIDERS' CONCERNS

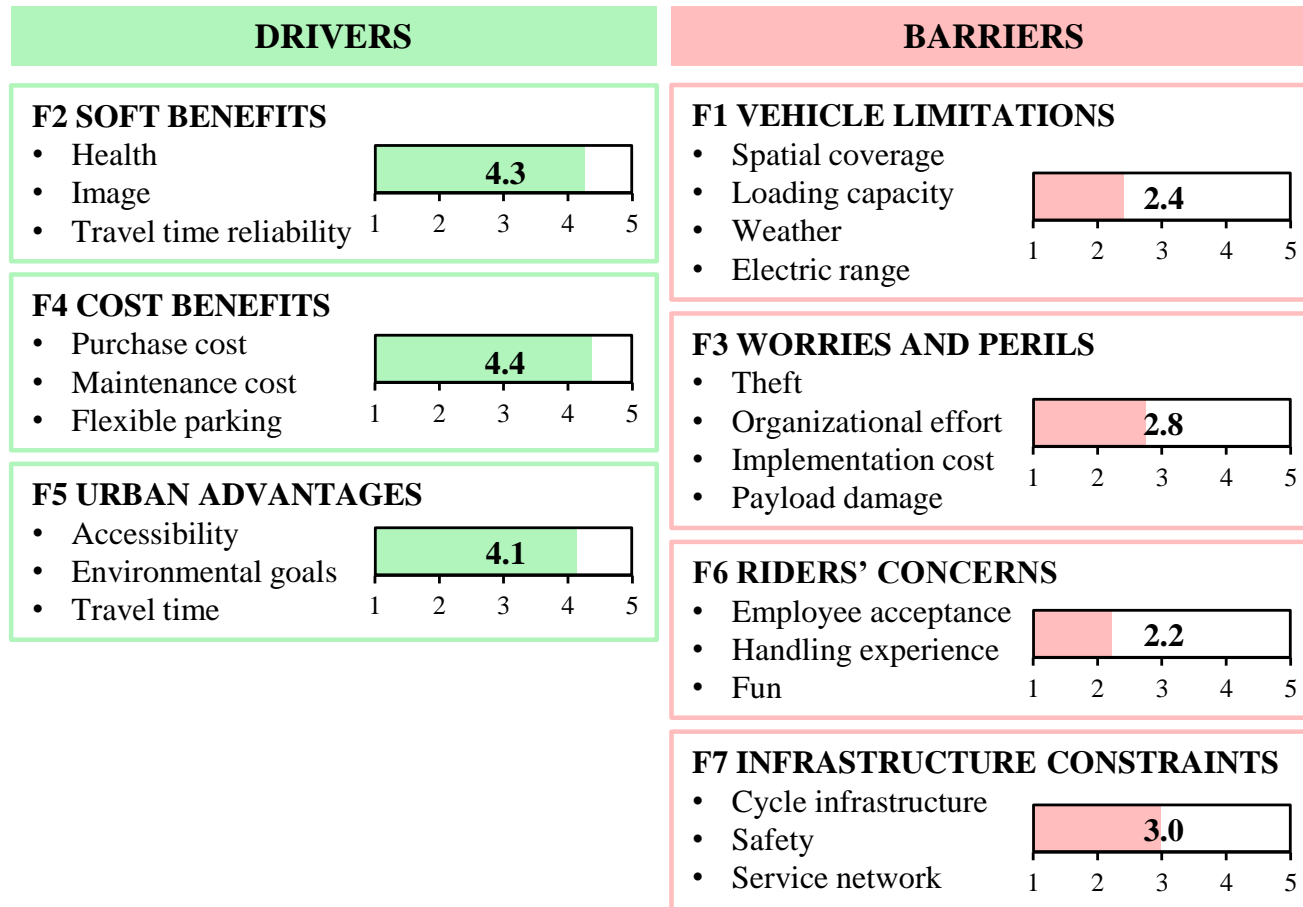


#### F7 INFRASTRUCTURE CONSTRAINTS



# Results

## – Overall factor structure





# 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

# 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!

Lars Thoma

[lars.thoma@dlr.de](mailto:lars.thoma@dlr.de)

German Aerospace Center (DLR) | Traffic Research | Commercial Transport

Rutherfordstraße 2

12489 Berlin



Knowledge for Tomorrow





# 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 Infrastructur e 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	