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

City Logistics Conference 2019
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German Aerospace Center (DLR) – Traffic Research
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 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
Problem statement

... but are rarely used and poorly studied

- Only very few trips are done by cargo cycles
- Very little research and theories focusing 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

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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*
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
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4. **Implications**
   Building a framework for describing and researching cargo cycle adoption
Results
– Overall factor structure

<table>
<thead>
<tr>
<th>DRIVERS</th>
<th>BARRIERS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F2 SOFT BENEFITS</strong></td>
<td><strong>F1 VEHICLE LIMITATIONS</strong></td>
</tr>
<tr>
<td>Health</td>
<td>Spatial coverage</td>
</tr>
<tr>
<td>Image</td>
<td>Loading capacity</td>
</tr>
<tr>
<td>Travel time reliability</td>
<td>Weather</td>
</tr>
<tr>
<td></td>
<td>Electric range</td>
</tr>
<tr>
<td><strong>F4 COST BENEFITS</strong></td>
<td><strong>F3 WORRIES AND PERILS</strong></td>
</tr>
<tr>
<td>Purchase cost</td>
<td>Theft</td>
</tr>
<tr>
<td>Maintenance cost</td>
<td>Organizational effort</td>
</tr>
<tr>
<td>Flexible parking</td>
<td>Implementation cost</td>
</tr>
<tr>
<td></td>
<td>Payload damage</td>
</tr>
<tr>
<td><strong>F5 URBAN ADVANTAGES</strong></td>
<td><strong>F6 RIDERS’ CONCERNS</strong></td>
</tr>
<tr>
<td>Accessibility</td>
<td>Employee acceptance</td>
</tr>
<tr>
<td>Environmental goals</td>
<td>Handling experience</td>
</tr>
<tr>
<td>Travel time</td>
<td>Fun</td>
</tr>
<tr>
<td></td>
<td><strong>F7 INFRASTRUCTURE CONSTRAINTS</strong></td>
</tr>
<tr>
<td></td>
<td>Cycle infrastructure</td>
</tr>
<tr>
<td></td>
<td>Safety</td>
</tr>
<tr>
<td></td>
<td>Service network</td>
</tr>
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</table>
## Results

### – Drivers: Soft benefits

<table>
<thead>
<tr>
<th>Item</th>
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<tbody>
<tr>
<td>Health</td>
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<tr>
<td>Image</td>
<td>.615</td>
</tr>
<tr>
<td>Travel time reliability</td>
<td>.547</td>
</tr>
</tbody>
</table>

### 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

---

**Drivers**

1. **F2 SOFT BENEFITS**
   - Health
   - Image
   - Travel time reliability

2. **F4 COST BENEFITS**
   - Purchase cost
   - Maintenance cost
   - Flexible parking

3. **F5 URBAN ADVANTAGES**
   - Accessibility
   - Environmental goals
   - Travel time
## Results

### – Drivers: Cost benefits

<table>
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<tr>
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<td>Flexible parking</td>
<td>.486</td>
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</tbody>
</table>

### 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

<table>
<thead>
<tr>
<th>Item</th>
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<tbody>
<tr>
<td>Accessibility</td>
<td>0.697</td>
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<tr>
<td>Environmental goals</td>
<td>0.524</td>
</tr>
<tr>
<td>Travel time</td>
<td>0.463</td>
</tr>
</tbody>
</table>

**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
– Barriers: Vehicle limitations

<table>
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<tr>
<th>Item</th>
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<tr>
<td>Spatial coverage</td>
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<tr>
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<td>.593</td>
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<tr>
<td>Weather</td>
<td>.524</td>
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<tr>
<td>Electric range</td>
<td>-.497</td>
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</table>
# Results

## – Barriers: Worries and perils

<table>
<thead>
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<tr>
<td>Theft</td>
<td>.646</td>
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<tr>
<td>Organizational effort</td>
<td>.590</td>
</tr>
<tr>
<td>Implementation cost</td>
<td>.583</td>
</tr>
<tr>
<td>Payload damage</td>
<td>.466</td>
</tr>
</tbody>
</table>

### 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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![Chart](chart.png)
# Results

## – Barriers: Riders’ concerns

<table>
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<tr>
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<tbody>
<tr>
<td>Employee acceptance</td>
<td>.653</td>
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<tr>
<td>Handling experience</td>
<td>.607</td>
</tr>
<tr>
<td>Fun</td>
<td>-.462</td>
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### BARRIERS

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# Results

## – Barriers: Infrastructure constraints

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Cycle infrastructure</td>
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<tr>
<td>Safety</td>
<td>.527</td>
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<tr>
<td>Service network</td>
<td>.484</td>
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</tbody>
</table>

## BARRIERS

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

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

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- Employee acceptance
- Handling experience
- Fun

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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**

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  - Loading capacity
  - Weather
  - Electric range

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  - Implementation cost
  - Payload damage

- **F6 RIDERS’ CONCERNS**
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  - Handling experience
  - Fun

- **F7 INFRASTRUCTURE CONSTRAINTS**
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  - Safety
  - Service network
Drivers and barriers for adapting cargo cycles

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   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!

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Rutherfordstraße 2
12489 Berlin
## Item loadings on the seven factors

<table>
<thead>
<tr>
<th>Item</th>
<th>F1 Vehicle limitations</th>
<th>F2 Soft benefits</th>
<th>F3 Worries &amp; perils</th>
<th>F4 Cost benefits</th>
<th>F5 Urban advantages</th>
<th>F6 Riders’ concerns</th>
<th>F7 Infrastructure constraints</th>
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<td>0.653</td>
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<td>-0.245</td>
<td>-0.032</td>
<td>0.261</td>
<td>-0.072</td>
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<td>0.607</td>
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