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Factors Explaining the Use of Cargo Bikes and Cars in Urban Logistics: Results from a Stated Preference Experiment in Germany

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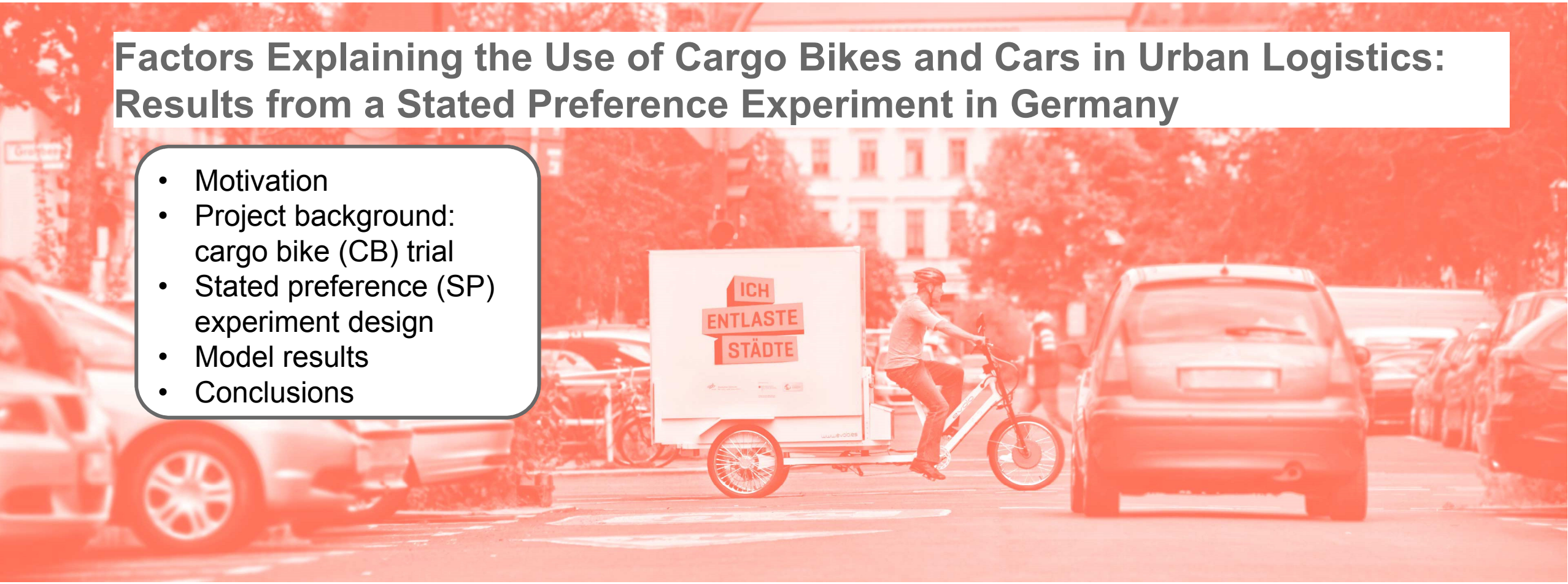
Agenda

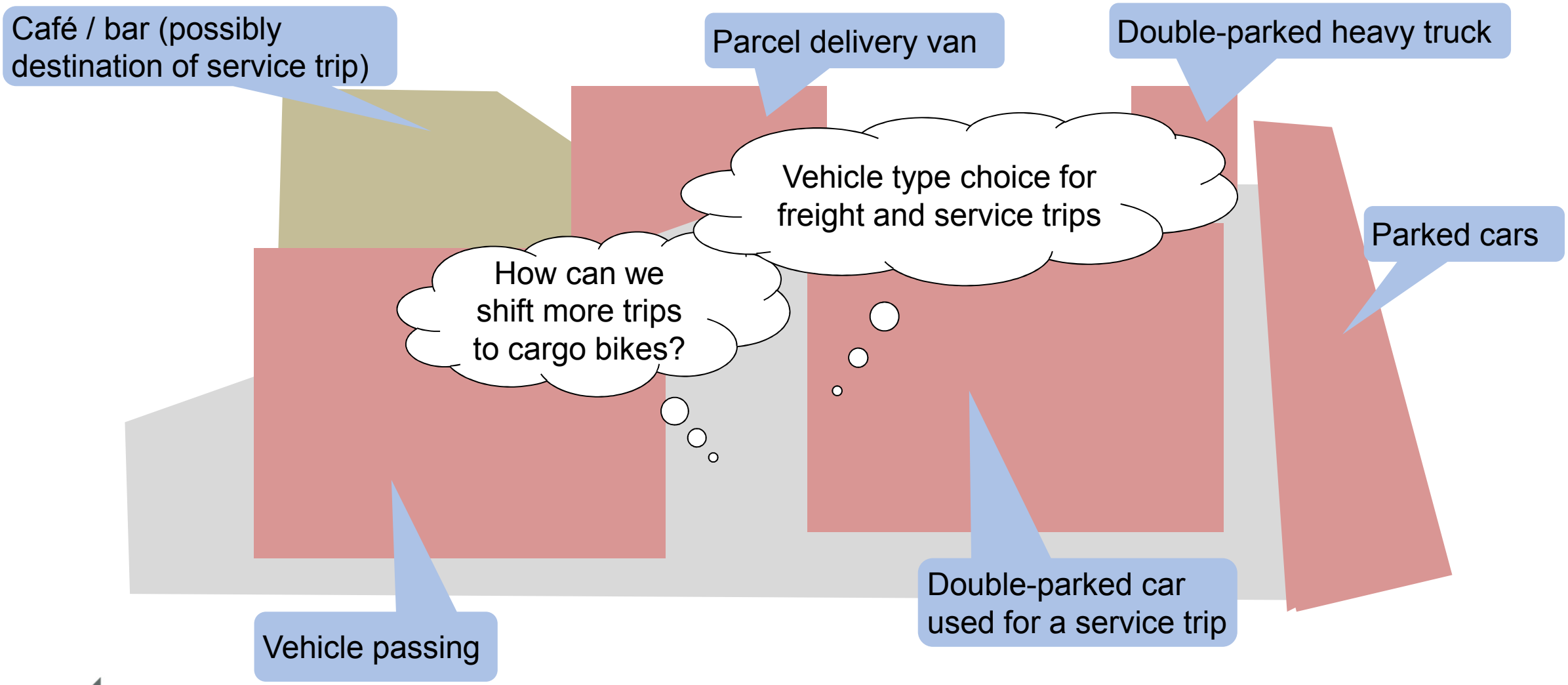
Factors Explaining the Use of Cargo Bikes and Cars in Urban Logistics: Results from a Stated Preference Experiment in Germany



- Motivation
- Project background: cargo bike (CB) trial
- Stated preference (SP) experiment design
- Model results
- Conclusions

Note: Background picture removed due to copyright

Just a “boring“ German street scene…?



Research question and context

Research question:

Which factors explain the use of cargo bikes (CB) and cars in urban logistics?

CARGO BIKE (CB) **CAR**

Research context and method:

- Organizations willing to change from car (or van) use to CB
- SP choice experiment at the end of a CB trial phase
- Additional RP data
- Mixed logit to model vehicle type choice

Project background: Germany-wide CB trial *"Taking the load off cities"* (German title "Ich entlaste Städte")

Large-scale CB trial…
- 152 vehicles
- 2 years of testing in total
- 3 months for each participant

…for a diverse target group…
- Companies of all industries
- Public institutions
- NGOs, initiatives
- Freelancers, self-employed

… with similarities
- All are willing to downshift
- All gained operational CB experience

Supported by:

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

NATIONAL CLIMATE INITIATIVE

based on a decision of the German Bundestag

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Some examples of the CB trial participants

Brewery
Beer deliveries to local supermarkets

Toy repair service
Transport of toys

Beekeepers
Transport of beehives

Movie production
Transport of equipment to film location

Church community
Helping priests for on-site visits

Real estate firm
Trips to viewing appointments

Electrical engineering
Customer support trips

Caramel factory
Delivery of sweets

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CB trial fleet: 5 main types of construction, 23 different models, 152 vehicles

Pizza delivery bike

Tricycle, front load

Heavy load tricycle

Long John bike

“Specialist” CB

Longtail bike

Sample descriptive statistics: Vehicle use

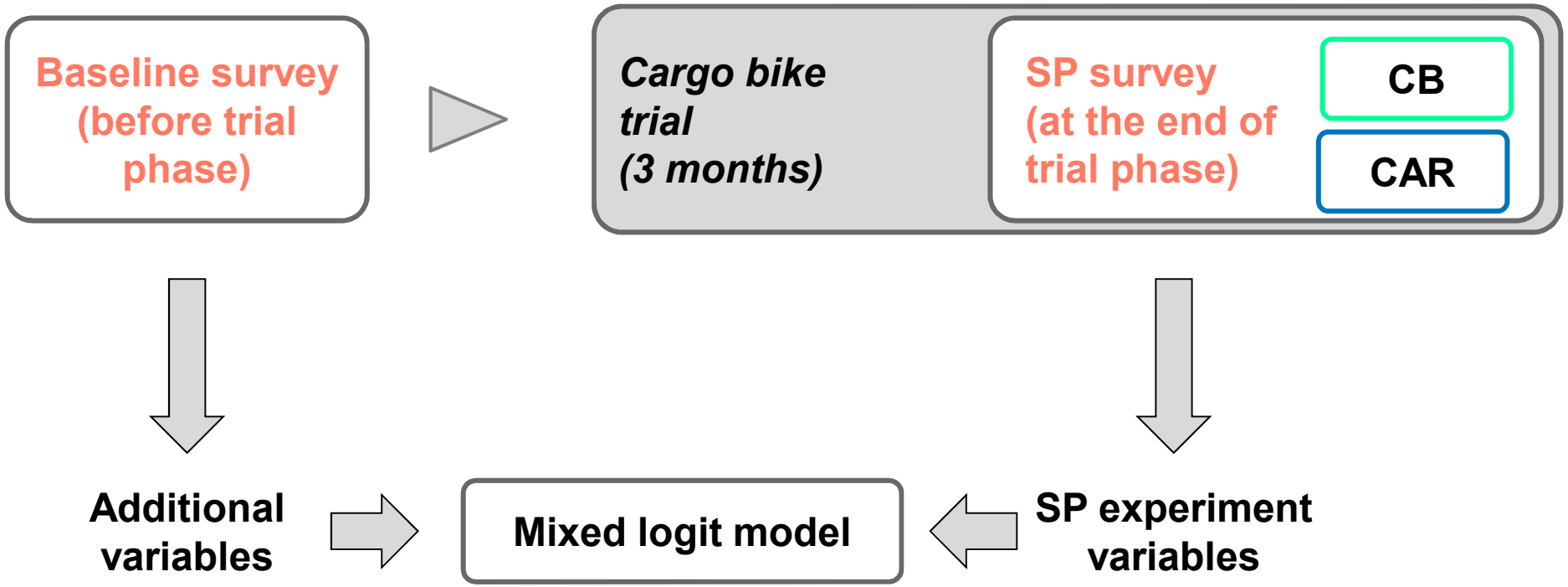
No. of wheels	Construction type	Typical model	No. of models	No. of participants in sample
2	Pizza delivery bike		1	**26**
	Long John bike		10	**206**
	Longtail bike		2	**9**
3	Tricycle, front load		6	**84**
	Heavy-load tricycle		4	**14**

Sum=339
(sample size)

Distance parameter	Value	Data basis
Mean daily mileage	12.1 km 7.5 mi	5,002 GPS-tracked days
Mean single trip distance	5.1 km 3.2 mi	11,736 GPS-tracked trips

Main operational purpose	Share of CB trial participants
Delivery of goods	21%
Pick-up / procurement of goods	13%
Provision of services	38%
Other business-related errands	25%
Private errands	3%

Study design: Overview



Study design: Example of a SP choice experiment

SP survey question: ***Which vehicle would you choose for a trip under the following conditions?***

INDEPENDENT ATTRIBUTES

TRIP DISTANCE (ROUNDTRIP)
5 km (3.1 mi)

TEMPERATURE **18 °C (64 °F)**

PRECIPITATION **YES**

ALTERNATIVE-SPECIFIC ATTRIBUTES

	CARGO BIKE	CAR
PARKING	At point of destination	Parking available
INFRASTRUCTURE	Safe bike path	Street
TRAVEL TIME	13 min	18 min
TOTAL COST OF TRIP	€ 5	€ 6
RISK OF DAMAGING GOODS	15 %	0 %
RISK OF DELAY	15 %	0 %

☐ **TRIP WOULD NOT BE CARRIED OUT UNDER THESE CIRCUMSTANCES**

Study design: Attributes of SP experiments

2 SETS OF CARDS FOR TRIP DISTANCE (ROUNDTRIP)
5 km (3.1 mi) || 12 km (7.5 mi)

INDEPENDENT ATTRIBUTES

TEMPERATURE	-3 °C (27 °F) | 5 °C (41 °F) | 18 °C (64 °F)
PRECIPITATION	Yes  No 

ALTERNATIVE-SPECIFIC ATTRIBUTES

	☐ CARGO BIKE	☐ CAR
PARKING	At point of destination	No stopping zone | Parking available
INFRASTRUCTURE	Safe bike path | Mixed use street	Street
TRAVEL TIME	13 | 21 | 30 min || 32 | 51 | 72 min	10 | 12 | 18 min || 25 | 30 | 45 min
TOTAL COST OF TRIP	€ 3.5 | € 5 | € 7.5 || € 8.4 | € 12 | € 18	€ 6 | € 8.5 | € 12.5 || € 14.4 | € 20.4 | € 30
RISK OF DAMAGING GOODS	0 % | 5 % | 15 %	0 % | 5 % | 15 %
RISK OF DELAY	0 % | 5 % | 15 %	0 % | 5 % | 15 %

☐ TRIP WOULD NOT BE CARRIED OUT UNDER THESE CIRCUMSTANCES

Results overview: Actual choice of alternatives

Sample size: 3,051 choices by 339 respondents

CARGO BIKE

n=1,815 (59%)

CAR

n=1,088 (36%)

NON-CHOICE

n=148 (5%)

Results overview: Factors explaining the use of cargo bikes and cars

SP EXPERIMENT VARIABLES

- TEMPERATURE ✓
- PRECIPITATION ✓
- PARKING ✓
- ROAD INFRASTRUCTURE ✓
- TRAVEL TIME ✓
- TOTAL COST OF TRIP ✓
- RISK OF DAMAGING GOODS ✓
- RISK OF DELAY ✗

ADDITIONAL VARIABLES

ORGANIZATIONAL FACTORS

- Main operational purpose ✓
- Change in fleet management during CB trial ✓
- Suitability of CB for transport tasks ✓
- Type of organization ✗
- Number of employees ✗
- Fleet configuration prior to CB trial ✗
- Time-critical transports ✗

INDIVIDUAL FACTORS

- Operative use of CB by respondent during trial ✓
- Age ✗
- Sex ✗

CONTEXTUAL FACTORS

- Population density at trial site ✗
- CB trial was conducted in winter ✗

✓ ***significant*** ✗ ***non-significant***

Results of a Mixed Logit Model: SP experiment variables

Car | Cargo Bike | Non-Choice | Generic

Moderate temperatures increase the intention to use CB…

… but rain is among the strongest factors to avoid cycling.

Lack of parking prevents car use.

Good bike infrastructure has a noticeable effect.

Longer travel times reduce willingness to use CB to a greater extent than for cars.

Variable	Value	Base	Choice Ref.	Est. value	t-value
TEMPERATURE	5 °C (41 °F)	-3 °C (27 °F)	CAR	-0.39	-2.76
			NC	-1.14	-3.84
	18 °C (64 °F)	-3 °C (27 °F)	CAR	-0.97	-7.52
			NC	-1.78	-5.91
PRECIPITATION	Yes	No	CAR	2.58	20.31
			NC	3.06	11.64
PARKING	No stopping zone	Parking available	CAR	-0.52	-4.69
ROAD INFRASTRUCTURE	Safe bike path	Road with mixed traffic	CB	0.34	3.39
TRAVEL TIME			CAR	-0.01	-2.15
			CB	-0.06	-16.53
TOTAL COST OF TRIP			GEN	-0.04	-5.83
RISK OF DAMAGING GOODS			GEN	-0.02	-4.24

Total cost of trip and risk of damaging goods show expected sign

n=3,051 SP experiments
Log-Likelihood: -1838.1

Model results: Additional variables

Car | Cargo Bike | Non-Choice | Generic

CB were rather chosen for the provision of services or other business-related errands than for goods delivery.

Positive effects during trial phase push decisions towards CB.

Individual experience of vehicle use increases CB choice.

Sigmas (normally distributed) take account for the panel effect.

Variable	Value	Base	Choice Ref.	Est. value	t-value
MAIN OPERATIONAL PURPOSE	Delivery of goods	All other purposes	CAR	0.47	2.53
CHANGE IN FLEET MGMT DURING CB TRIAL	Positive change	No or negative change	CAR	-0.48	-2.88
SUITABILITY OF CB FOR TRANSPORT TASKS	High suitability	Low suitabilty	CAR	-0.93	-5.80
OPERATIVE USE OF CB BY RESPONDENT DURING TRIAL	Respondent is only CB user	Respondents and others, only others are users	CAR	-0.50	-3.29
ALTERNATIVE-SPECIFIC CONSTANTS			CAR	-1.92	-8.49
			NC	-7.99	-16.45
SIGMA			CAR	1.00	12.11
			CB	-0.04	-0.15
			NC	-2.30	-8.42

n=3,051 SP experiments
Log-Likelihood: -1838.1

Conclusions and outlook

- Contribution reveals factors leading to vehicle type choice in an unusual segment of urban logistics with…
  - smaller vehicles involved,
  - short trip distances,
  - service trips and freight trips of non-logisticians.
- Findings are (rather) valid for organizations that are already willing to downshift.
- Service providers might be a better target group for CB deployment than delivery companies.
- Good bicycle infrastructure and reduction of car parking show substantial effects.
- Trial programs can remove reservations and obstacles.
- Rain is much more deterrent than cold temperatures.

One out of the 23 tested CB models was equipped with rain protection.

Thank you! Questions?

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