TECHNISCHE UNIVERSITÄT BERLIN

Cargo Bike Sharing

The Potential of a new Socially Innovative Mobility Service for Metropolitan Regions and Beyond

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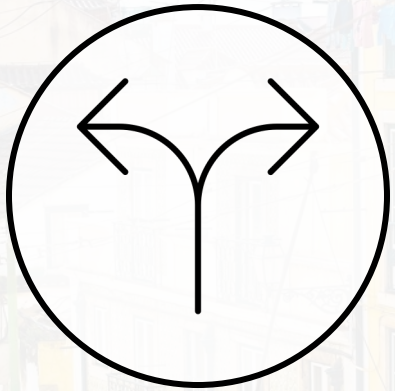
ATLANTIC OCEAN
GABON
SOUTH AFRICA

How about travelling differently?

Travel less
(Low-Mobility Societies)

Reducing overall traffic **(fewer, shorter trips)** - (e.g., through urban planning, virtual appointments, sufficiency).

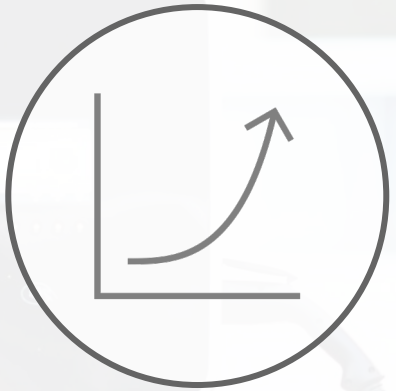
Avoid



Travel differently
(e.g. collective transport 2.0)

Change of mobility behavior through **choice of means of transport** (public transport, car sharing, (cargo) bikes, walking)

Shift



Travel more efficient
(e.g. electromobility)

Development and use of **new, more efficient technologies** (in the broadest sense)

Improve

Focus today

References: Bongardt et al. (2019); Holden et al, (2020)

Overview: Cargo bikes

- Cargo bikes (CBs) are human powered (sometimes with add. electric motor) vehicles for transporting goods and children (Riggs & Schwartz, 2018)
- Exist since late 19th century. However, currently in renaissance due to new technologies and environmental awareness (Ghebrezgiabiher & Poscher-Mika, 2018)
- (Electric) cargo bikes in between cars and bicycles with regard to cost, capacity, and range (Gruber et al., 2014)
- Considered a promising alternative to car use and car ownership (Pearce, 2016; Rivera & Henriksson, 2014)
- Numerous sustainability-related benefits: GHG-emissions, noise, pollution, space consumption (Becker & Rudolf, 2018)
- Different types exist

Source: Riggs & Schwartz (2018)

Cargo bike sharing

- Cargo bike sharing (CBS) presents opportunity to provide cargo bikes for infrequent needs (e.g., because of high purchase price) to a wider target group (Rivera & Henriksson, 2014)
- Potential for decarbonization and car-free mobility through rides on borrowed cargo bikes (instead of cars) *and* through indirect (e.g., visibility and testing) effects (Dorner & Berger, 2020)

Project partner

FORUM FREIE LASTEN RÄDER

- Commons Cargo Bikes (Freie Lastenräder)
- Founded in 2013
- Informal umbrella organization & local initiatives
- >90 cities
- Cargo bikes are borrowed free of charge
- Financed via donations, sponsoring, and public funding

References: dein-lastenrad.de; Becker & Rudolf (2018)

Previous research on CBs and CBS

User structure
- Predominantly men (Becker & Rudolf, 2018; Hess & Schubert, 2019)
- Individuals with higher education (Hess & Schubert, 2019)
- Frequent cyclists (Becker & Rudolf, 2018)

User behavior
- Used for food / bottles, purchases and children (Becker & Rudolf, 2018; Dorner & Berger, 2020)
- Often first contacts with cargo bikes (Becker & Rudolf 2018; Dorner & Berger, 2020)
- Average distance of 12,2 km (non-electric) and 15,5 km (electric) (Becker & Rudolf, 2018)

Impact on mobility behavior
- 45% of trips would have otherwise been conducted with cars (Becker & Rudolf, 2018)
- >90% intend to use cargo bikes again (Becker & Rudolf, 2018)
- 35% plan purchase of cargo bike (Becker & Rudolf, 2018)
- Approx. 70% of cargo bike owners reduce car use (Riggs, 2016)

Impact on car ownership
- Car-Sharing: substantial reduction of ownership (Firnkorn & Müller, 2012; Giesel & Nobis, 2016; Martin et al., 2010) – at the same time risk of induced car puchases (Giesel & Nobis, 2016)
- Cargo bikes: 62% of cargo bike owners thought about selling cars – however, no data on actual car ownership reduction (Riggs, 2016)

Research gaps

1. Lack of comprehensive and up-to-date assessment that also embed topic in theoretical context.

2. Lack of empirical analysis of actual car ownership impact as well as underlying motives and barriers.

3. Lack of insights on user structure and user behavior from a temporal (i.e., seasonal) perspective.

Method: Mixed methods approach

Initiative Survey

- Data collection on initiative level
- Focus on number of borrowings, registered users, financing, employees
- ➢ Responses from **78 initiatives**

User Survey

- Data collection on user level
- Focus on user structure and behavior, motives, preferences as well as impact on car use and ownership
- Responses from **2.590 users from 56 different initiatives**

Qualitative interviews

- Data collection on supra-local level
- Focus on scaling as social innovation, governance tensions as well as organizational structure
- Interviews with **3 CCB leaders** conducted as group interview

Complemented by **field observations** as well as **document and literature review** in **transdisciplinary approach.**
Additional insights from **long-term data collection in metropolitan area** (Berlin).

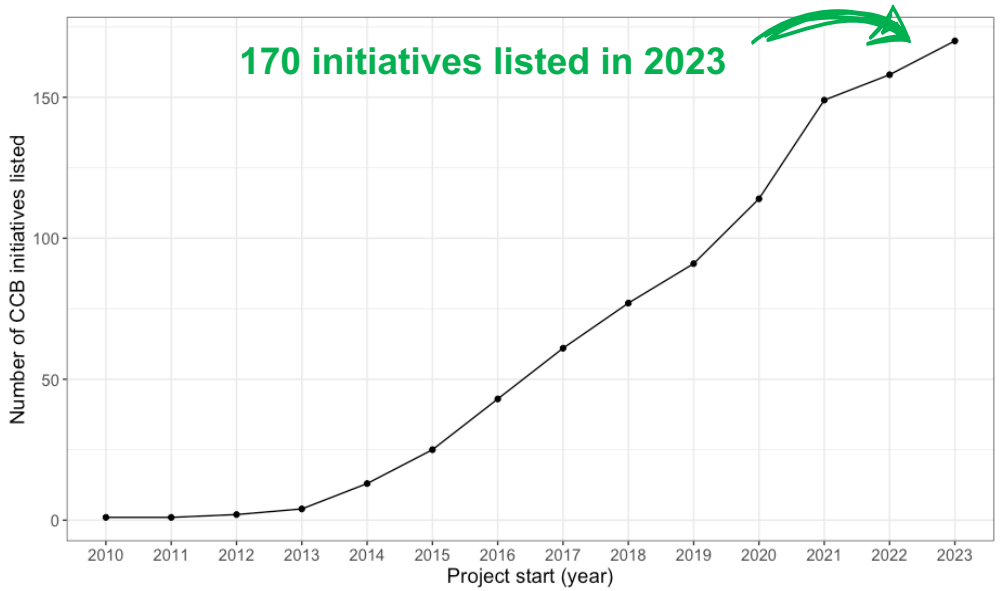
CCB can be conceptualized as social innovation

	Definition	Commons Cargo Bikes (CCB)
Social Innovation	Success is not solely measured by traditional metrics such as profit or growth	Alternative metrics include, for instance, replaced car trips
	Organizational forms are open and social welcoming input from anyone	Collaboration with hosts and open forum to provide input and start discussions
	Coalitions are important and organizations are embedded in wider networks	Network within CCB movement, with local actors and beyond (e.g., cycling association)
Social Economy	Distributed networks and communication technology for relationship building	Distributed system connected with online forum and wiki
	No distinct boundaries between production and consumption	Users are invited to engage in CCB initiatives
	Emphasis on collaboration, care, and maintenance instead of one-time use	Concept of sharing focuses on collaboration and resource efficiency
	High importance of values and missions	CCB movement is guided by strong values and strong mission

References: Becker & Rudolf, 2018; Murray et al., 2010; Rublack, 2020

CCB looks back on a decade of rapid scaling

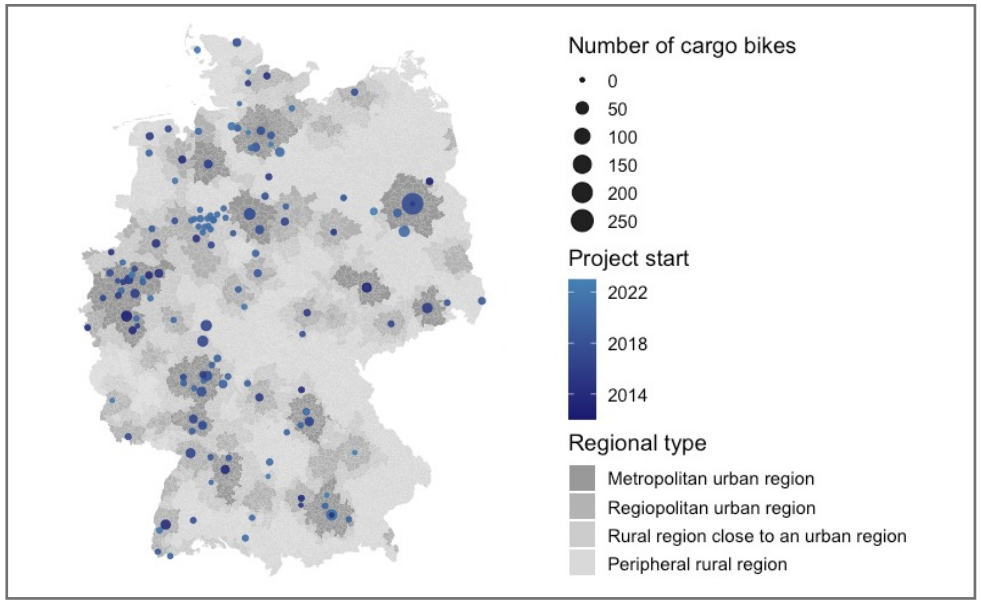
Numerical scaling



Note: 2023 includes 10 initiatives 'in preparation' as well as 1 initiative without specified start year

- 1,109 cargo bikes provided (n = 150)
- 91,111 registered users (n = 75)
- 53,693 annual borrowings (n = 67)

Geographical scaling



Note: 11 initiatives from Austria, UK, Hungary, Sweden and Italy were excluded to improve readability

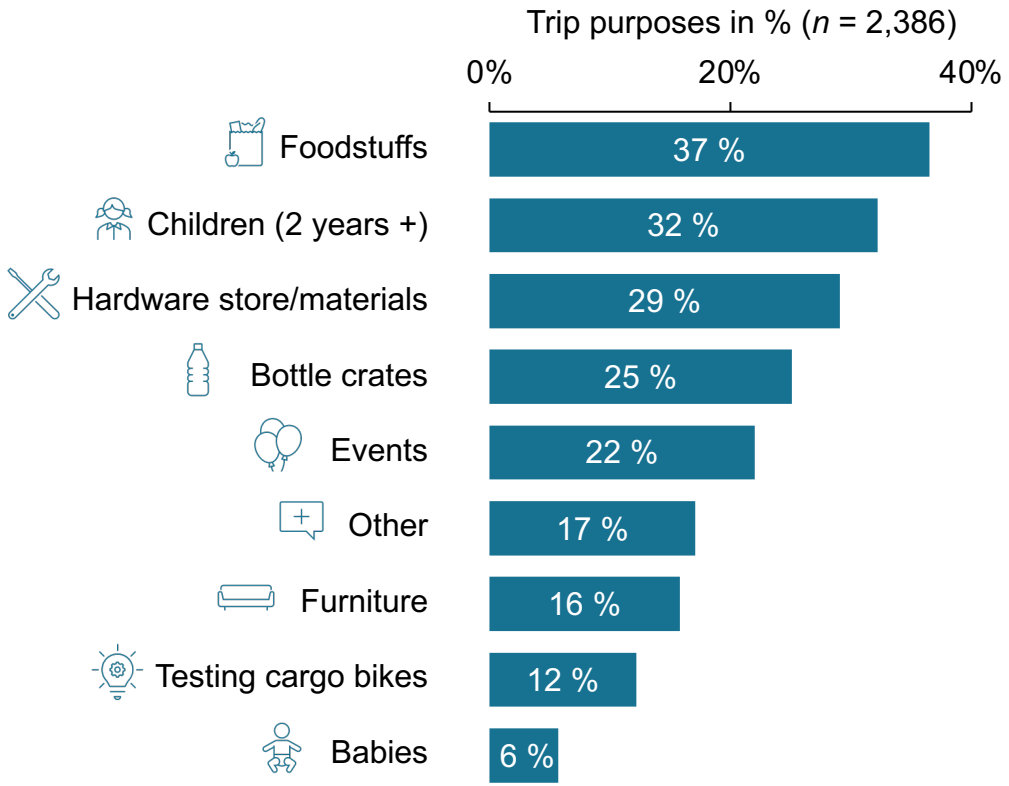
- 67 % in urban regions and 33 % in rural regions
- More CBs, users and borrowings in urban regions
- Similar relative demand per CB between regions

Diverse user structure and user behavior

User structure and behavior

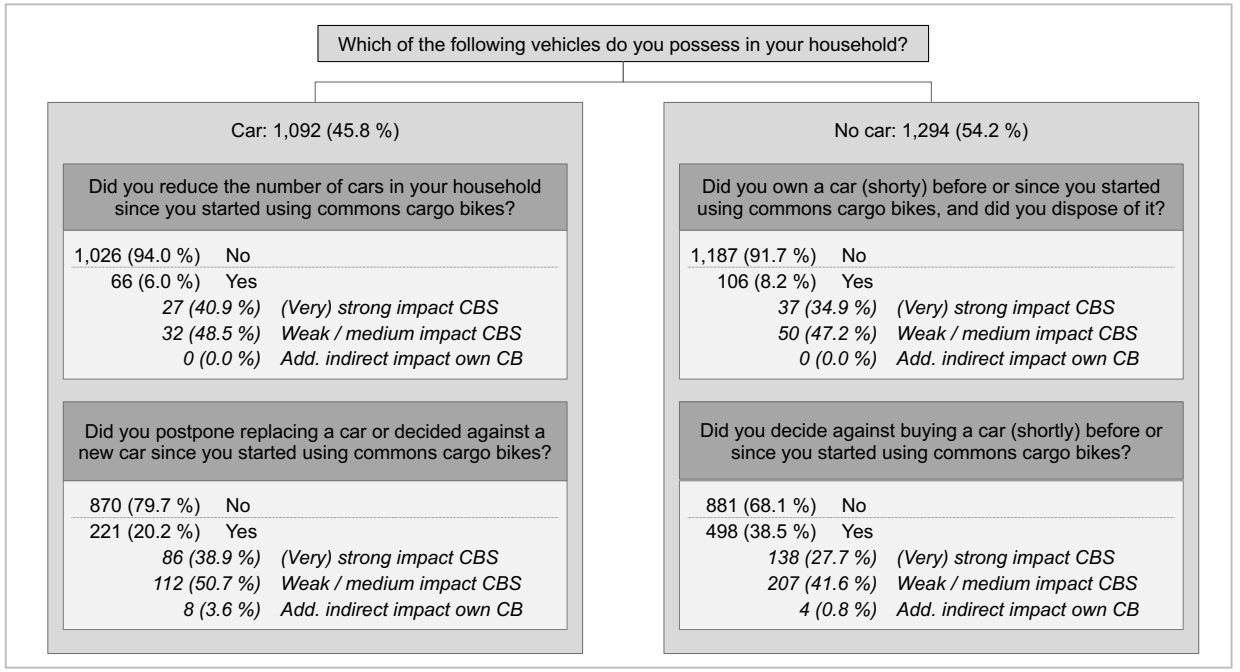
- **43% female** and **53 % male** users
- **42 years** average age
- **59 % cyclists** (main transport mode)
- **15.4 km** average trip length
- **31 % first time users;** 19 % > 8 usages
- Informal **communication** channels dominate

Trip purposes



Car ownership reduction I

- Depending on car ownership status, users were asked different questions regarding car ownership reduction decisions
- These questions relate to different paths towards car ownership reduction (Firnkorn & Müller, 2012)
- If respondents chose “Yes” for one of the questions, they were asked about the impact of CBS and (if available) their own CB on their decision



Car ownership reduction II

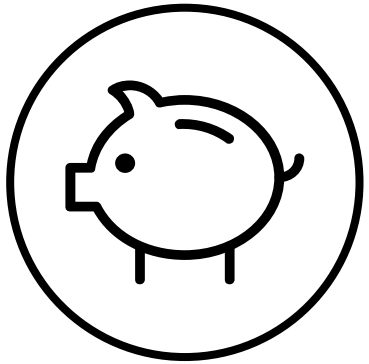
- Compared with the total number of active users, car ownership is reduced substantially
- Magnitude of car ownership reduction depends on causality definition (narrow vs. broad causality)
- Largest share of reduction can be attributed to decisions against purchasing a car (status quo)

Table 1 Commons cargo bikes impact on car ownership in the active sample

	Broad causality	Narrow causality
Current number of cars (with commons cargo bikes)	1,341	1,341
Car - Reduction	+ 59	+ 27
No car - Reduction	+ 87	+ 37
No car - Not purchased	+ 349	+ 138
Correction for double counts	- 64	- 26
Current possession of private cars if commons cargo bikes were not offered	1,772	1,517
Car net reduction (incl. not purchased)	**- 431**	**- 176**
Percentage of active sample reducing car ownership (incl. not purchased)	**18.1%**	**7.4%**

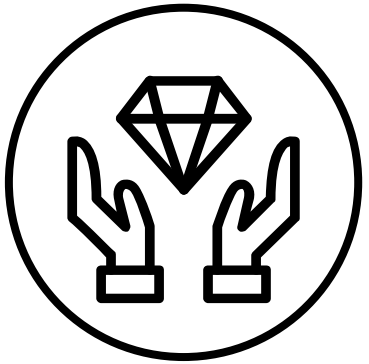
Note: Reduction potential of postponed replacements not included

Background: Motives for transport mode choice



Instrumental Motives

Affective Motives



Symbolic Motives

Environmental Motive

Examples

- Flexibility
- Price
- Safety

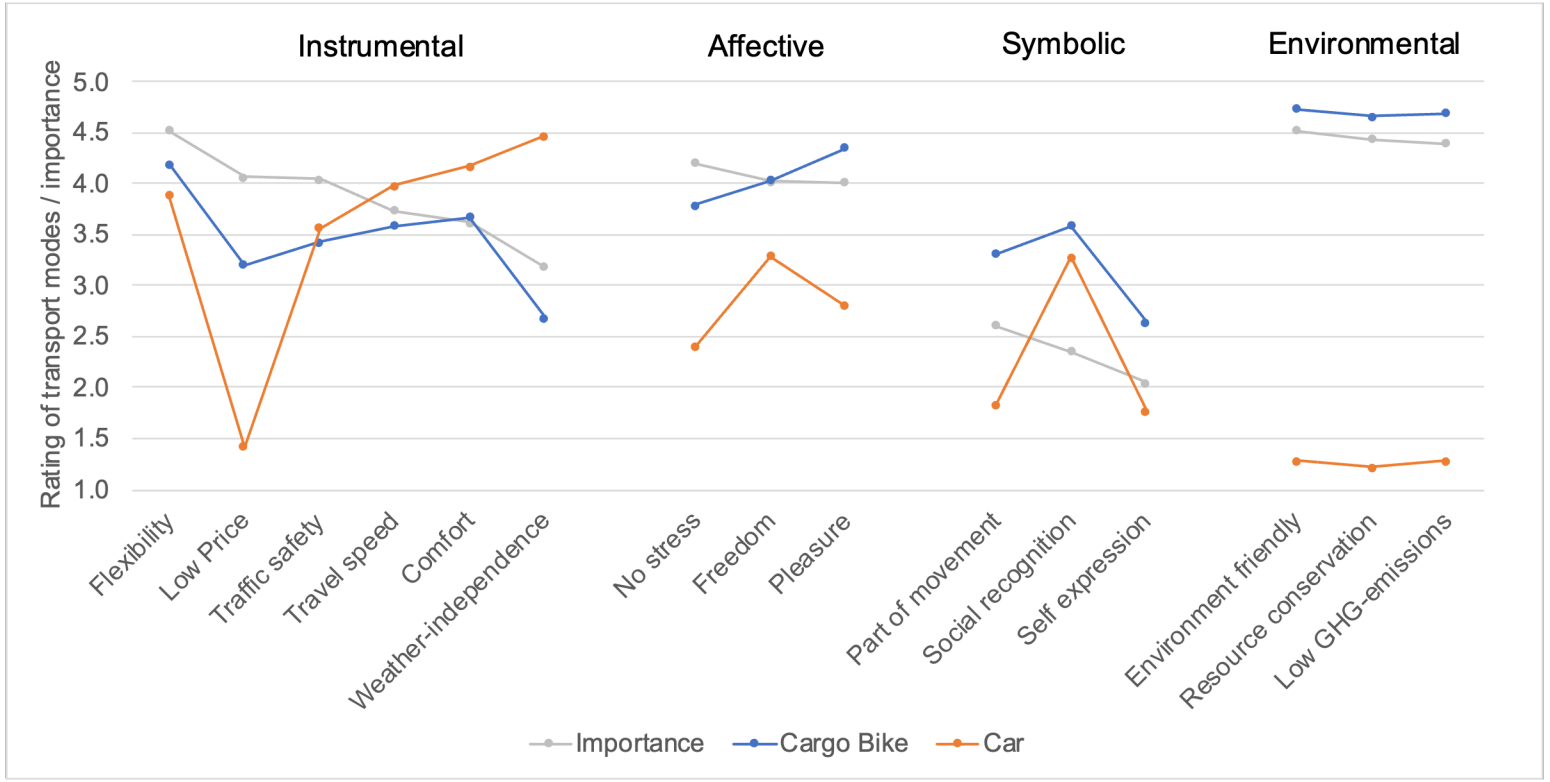
- No stress
- Freedom
- Pleasure

- Part of a movement
- Social recognition
- Self expression

- Environment friendly
- Resource conservation
- Low GHG-emissions

References: Steg (2005); Noppers et al. (2014)

Overall motive gaps between CBs and cars



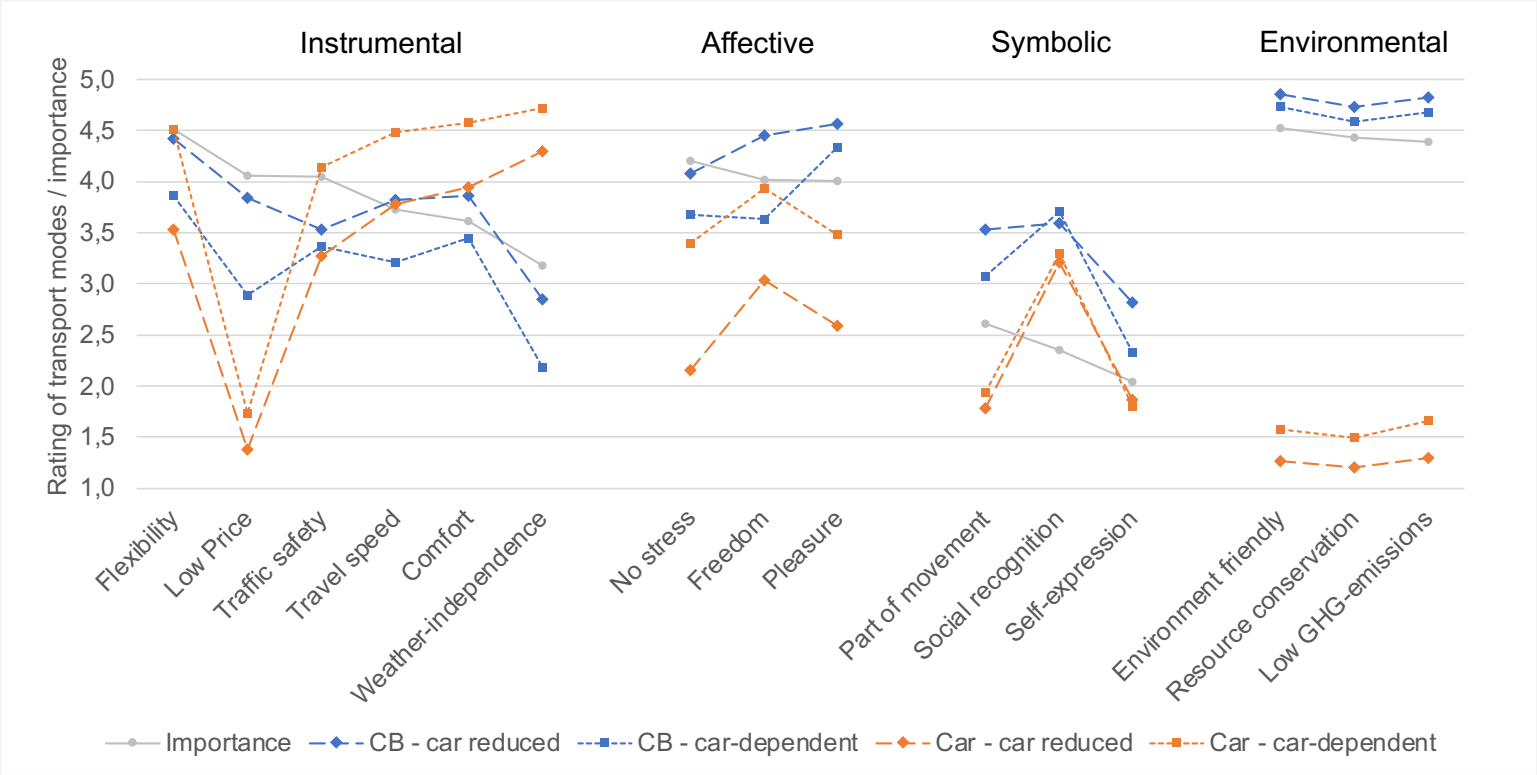
Note: All mode differences are highly significant ($p < .001$) based on Wilcoxon signed-rank tests

Cargo bikes are rated superior with regard to flexibility and price (instrumental aspects).

Cargo bikes are rated superior on affective, symbolic and environmental attributes.
Car still rather strongly associated with freedom and social recognition.

In contrast, cargo bikes are perceived inferior regarding traffic safety, travel speed, comfort, and weather-independence.

Motive differences – group comparison

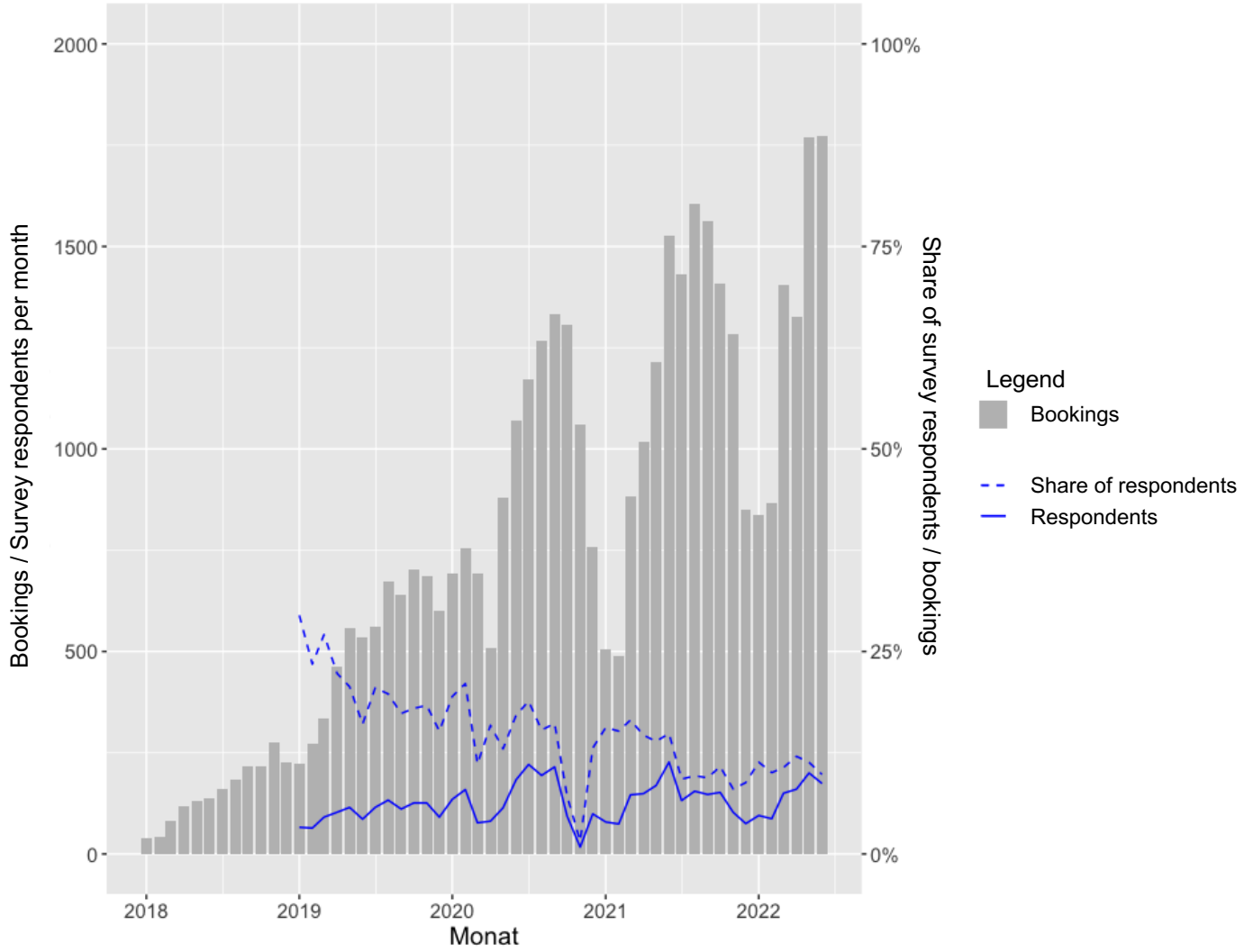


Additional analyses compare participants that reduced car ownership (narrow causality) with participants that use cars as main mode (car-dependent).

‘Car reduced’ without or with smaller gaps on essential instrumental aspects (dashed lines).

Even car-dependent respondents rate cargo bikes superior on symbolic, environmental, and some affective attributes. Discrepancy regarding freedom.

Excursus: Time Series Analysis



Summary

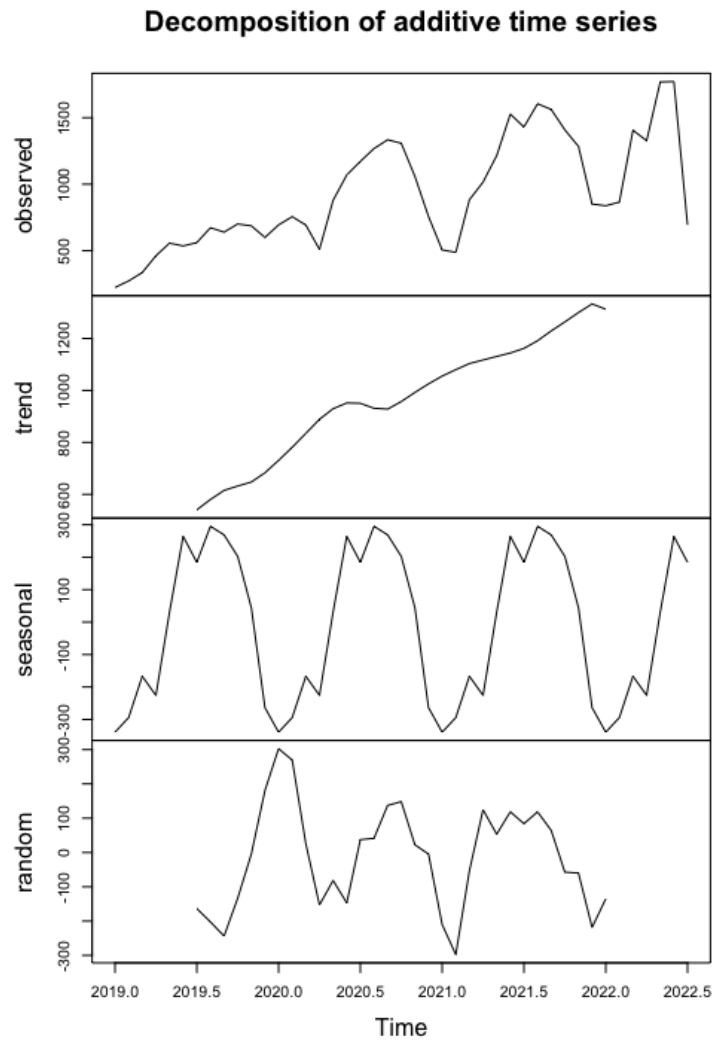
42,029 booking data
(January 2018 - June 2022)

5,336 total survey data
(December 2018 - July 2022)

Average **share of survey participation:** 15.2%
(automated post use survey)

Survey participation decreases over time: e.g., because multiple users do not complete the survey every time
(R^2 = .35, p < .001)

Number of bookings



Note: Based on 42 data points (01/2019 – 06/2022)

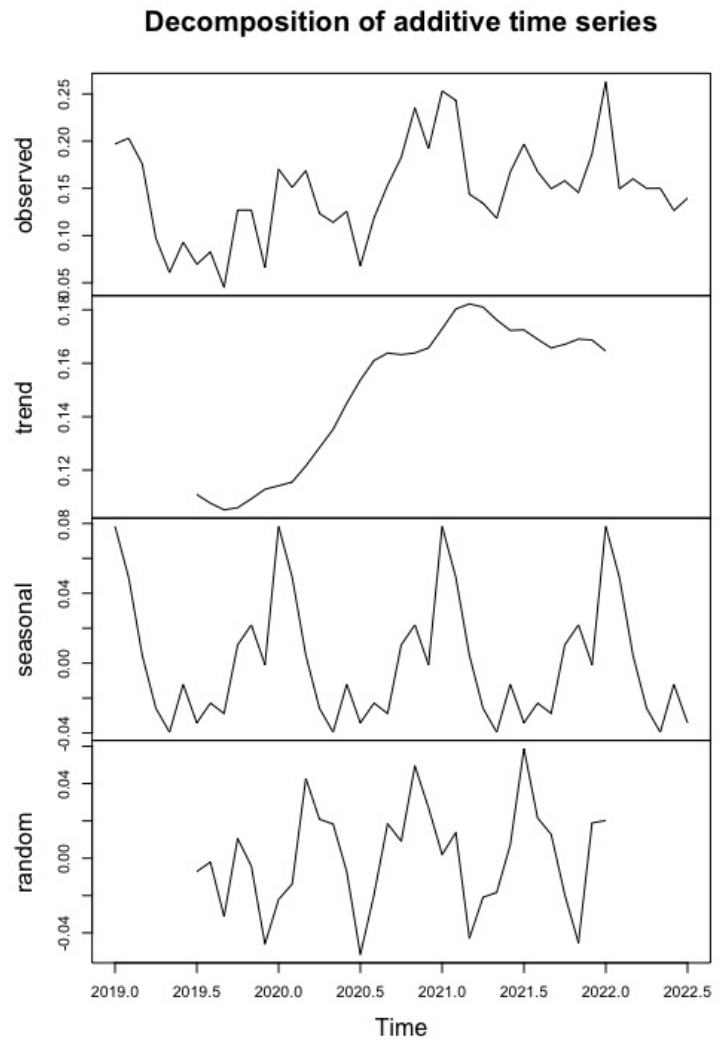
Summary

Overall:
Time significant predictor for number of bookings (R^2 = .52, p < .001)

Trend:
Bookings increasing over time

Seasonal effects:
More bookings in summer compared to winter months

Share of heavy users



Note: Based on 42 data points (01/2019 – 06/2022)

Summary

Overall:
Time significant predictor for heavy users with more than eight bookings
(R^2 = .11, p = .026)

Trend:
Share of heavy users increases

Seasonal effects:
Share of heavy users particularly high in winter months

Five take aways

1. CBS is promising alternative mobility solution – for **different regional contexts!**
2. **Use cases** and **users** are diverse – CBS also allows for **first contacts with CBs.**
3. High intention to re-use CBs. Considerable impact on car use **and car ownership.**
4. **Structural barriers (e.g., infrastructure)** need to be addressed to use potential.
5. Research is needed to **understand how weather-related issues can be overcome.**

Thanks for your attention!

Do you have any comments or questions?

Have a look at the corresponding publication in Transportation Research Part F (Open Access):

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Appendix A: Descriptive statistics - Motives

Table 3
Descriptive statistics of importance ratings.

Dimension	Attribute	*M*	*SD*	Cronbach's α
Instrumental		3.86	0.49	.56
	Flexibility	4.52	0.64	
	Low price	4.06	0.88	
	Traffic safety	4.05	0.87	
	Travel speed	3.73	0.94	
	Comfort	3.62	0.87	
	Weather-independence	3.18	0.98	
Affective		4.08	0.63	.55
	No stress	4.20	0.75	
	Freedom	4.02	1.00	
	Pleasure	4.01	0.86	
Symbolic		2.34	0.90	.69
	Part of movement	2.61	1.19	
	Social recognition	2.35	1.14	
	Self-expression	2.04	1.11	
Environmental		4.45	0.71	.89
	Environment friendly	4.53	0.72	
	Resource conservation	4.44	0.79	
	Low GHG-emissions	4.39	0.83	

Note: Based on the question "How important are the following attributes to you in a transport mode?". Scale ranging from 1 (very unimportant) to 5 (very important).

Appendix B: Group differences

Table 4
Overview of group differences between "car reduced" and "car-dependent" participants.

Sample characteristic	Car reduced ($n = 174$)	Car-dependent ($n = 186$)	Significance
Age (Mean)	41.5	43.8	$t(358) = -2.06, p = .040$
Gender (%)[1]			$X^2\ (1, N = 350) = 1.21, p = .272$
Female	38.5 %	45.7 %	
Male	56.9 %	53.2 %	
Diverse	1.7 %	0.0 %	
CB ownership (%)	28.2 %	10.8 %	$X^2\ (1, N = 360) = 17.59, p < .001$
Car ownership (%)[2]	14.4 %	100.0 %	$X^2\ (1, N = 360) = 271.75, p < .001$
Regional type (%) [3]			$X^2\ (3, N = 332) = 6.37, p = .100$
Metropolitan urban region	69.1 %	64.7 %	
Regiopolitan urban region	12.1 %	8.4 %	
Rural region close to an urban region	7.3 %	15.6 %	
Peripheral rural region	11.5 %	11.4 %	

Note: 1. Chi-Square test based on female and male participants only, due to low frequencies in other cells; N/A not listed in table. 2. Households with at least one car. 3. Participants without specified location excluded (9 for "car reduced", 19 for "car-dependent").

Appendix C: Factor structure

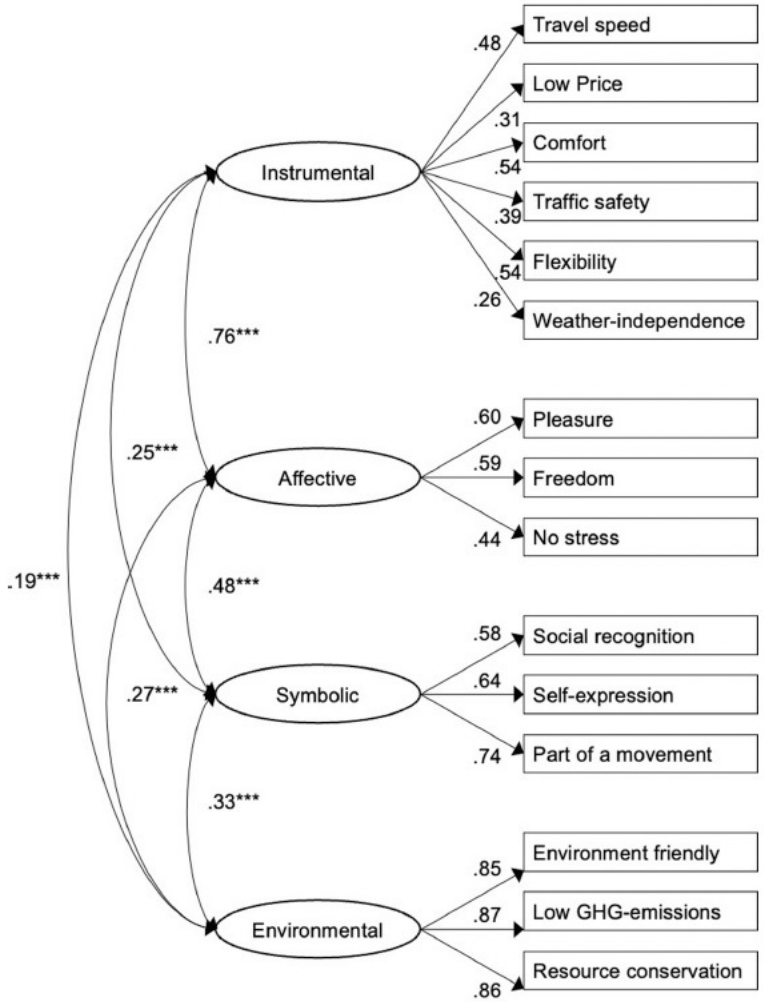


Fig. A1. Results of the Confirmatory Factor Analysis (CFA) regarding the importance of motives.

Appendix C: Factor structure

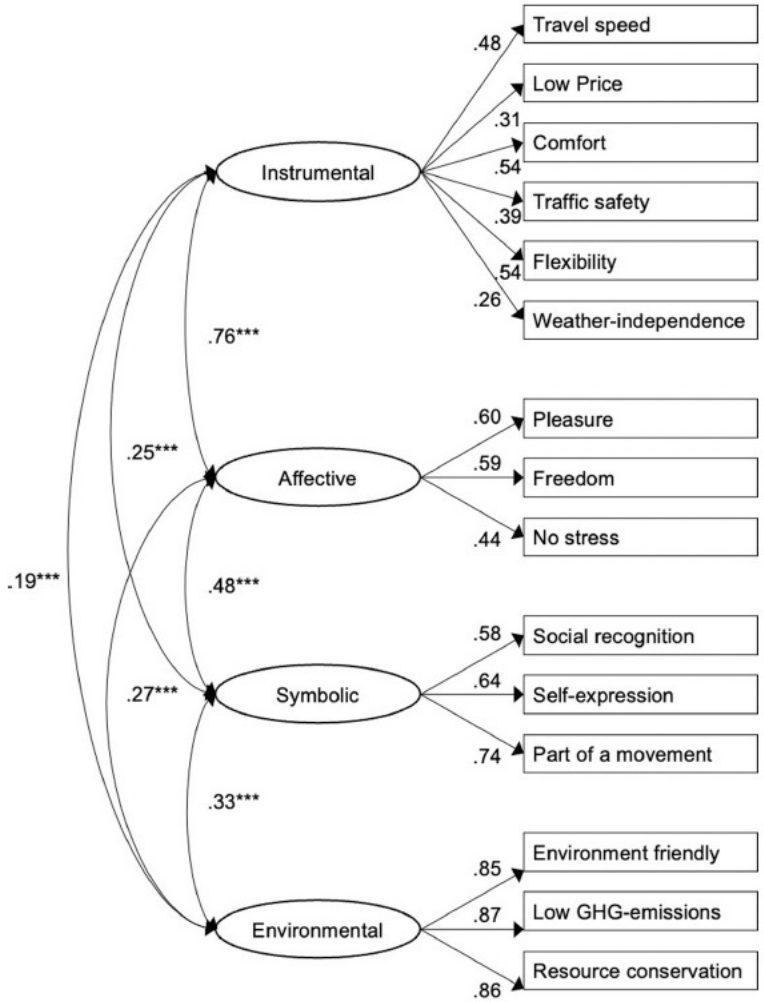


Fig. A1. Results of the Confirmatory Factor Analysis (CFA) regarding the importance of motives.

Appendix D: Correlation and regression analysis

Table A1
Pearson correlations of factor means.

	Instrumental	Affective	Symbolic	Environmental
Instrumental	1.00			
Affective	.40***	1.00		
Symbolic	.17***	.29***	1.00	
Environmental	.13***	.19***	.25***	1.00

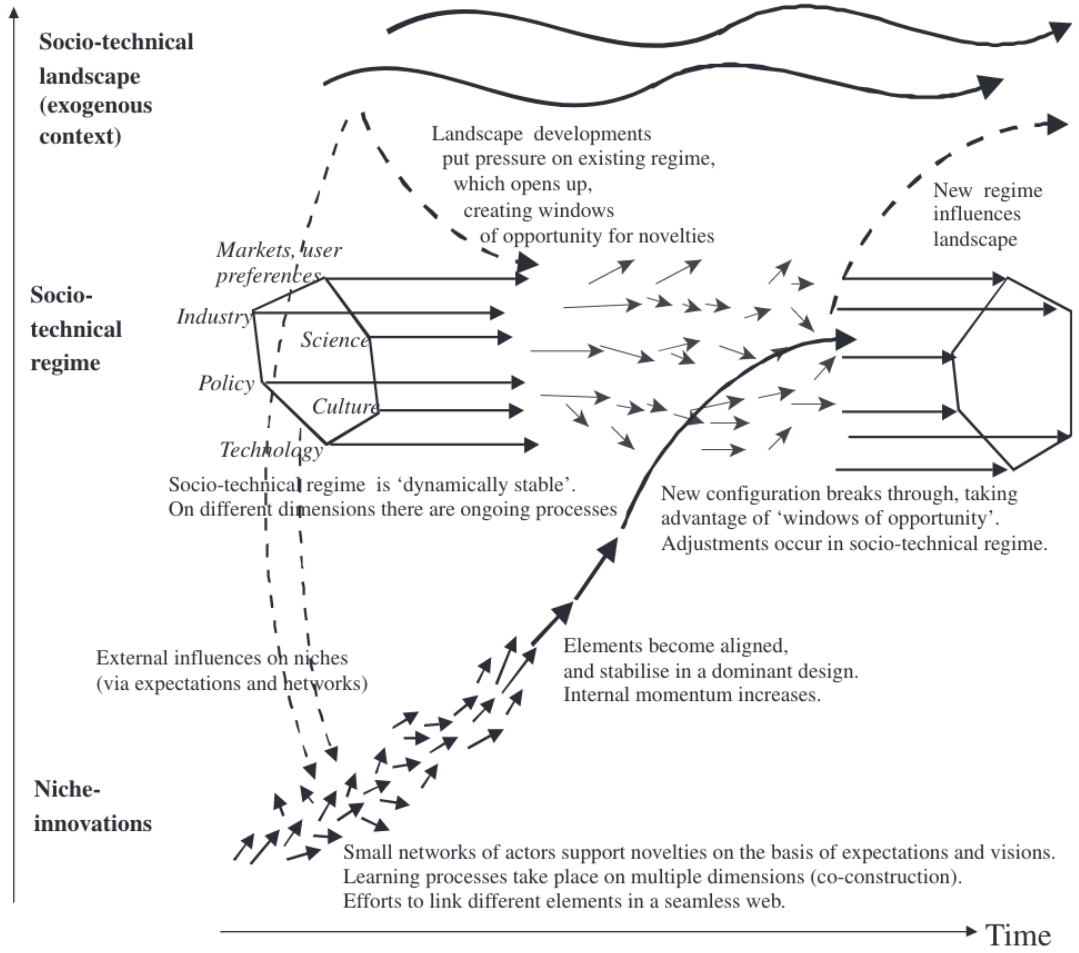
Note: *** $p < .001$ (two-tailed test).

Table A2
Regression of relevant dependent variables on ratings of CBs and cars.

	R 2	*F*	*df*	*β*	*t*	*p*
DV: Intention to use CBs	0.09	61.18	2,379			< .001
Instrumental				0.03	0.86	.389
Affective				0.28	10.88	< .001
Symbolic				0.02	1.38	.169
Environmental				−0.00	−0.10	.917
DV: Intention to sell car	0.07	22.91	1,084			< .001
Instrumental				−0.45	−5.22	< .001
Affective				−0.15	−3.17	.002
Symbolic				0.09	1.92	.055
Environmental				−0.08	−1.39	.165

Note: Ratings of CBs were used to predict intention to use CBs while ratings of cars were used to predict intention to sell cars. Regression for intention to sell car is based on car owners only.

Appendix E: Multi-Level-Perspective (MLP)



Reference: Geels (2012)

Literature (1/2)

Becker, S., & Rudolf, C. (2018). Exploring the Potential of Free Cargo-Bikesharing for Sustainable Mobility. GAIA - Ecological Perspectives for Science and Society, 27(1), 156–164. https://doi.org/10.14512/gaia.27.1.11

Bongardt, D., Stiller, L., Swart, A., & Wagner, A. (2019). Sustainable Urban Transport: Avoid-Shift-Improve (A-S-I). Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). https://www.transformative-mobility.org/wp-content/uploads/2023/03/ASI_TUMI_SUTP_iNUA_No-9_April-2019-Mykme0.pdf

Dorner, F., & Berger, M. (2020). Peer-to-peer Cargo Bike Sharing: Findings from LARA Share project. Proceedings of 8th Transport Research Arena TRA 2020, 1–11. https://doi.org/10.26226/morressier.5e4fe9c16bc493207536f8ed

Firnkorn, J., & Müller, M. (2012). Selling Mobility instead of Cars: New Business Strategies of Automakers and the Impact on Private Vehicle Holding. Business Strategy and the Environment, 21(4), 264–280. https://doi.org/10.1002/bse.738

Geels, F. W. (2012). A socio-technical analysis of low-carbon transitions: Introducing the multi-level perspective into transport studies. Journal of Transport Geography, 24, 471–482. https://doi.org/10.1016/j.jtrangeo.2012.01.021

Giesel, F., & Nobis, C. (2016). The Impact of Carsharing on Car Ownership in German Cities. Transportation Research Procedia, 19, 215–224. https://doi.org/10.1016/j.trpro.2016.12.082

Hess, A.-K., & Schubert, I. (2019). Functional perceptions, barriers, and demographics concerning e-cargo bike sharing in Switzerland. Transportation Research Part D: Transport and Environment, 71, 153–168. https://doi.org/10.1016/j.trd.2018.12.013

Holden, E., Banister, D., Gössling, S., Gilpin, G., & Linnerud, K. (2020). Grand Narratives for sustainable mobility: A conceptual review. Energy Research & Social Science, 65, 101454. https://doi.org/10.1016/j.erss.2020.101454

Martin, A., Suhrcke, M., & Ogilvie, D. (2012). Financial Incentives to Promote Active Travel. American Journal of Preventive Medicine, 43(6), e45–e57. https://doi.org/10.1016/j.amepre.2012.09.001

Literature (2/2)

Murray, R., Caulier-Grice, J., & Mulgan, G. (2010). The Open Book of Social Innovation. NESTA.

Noppers, E. H., Keizer, K., Bolderdijk, J. W., & Steg, L. (2014). The adoption of sustainable innovations: Driven by symbolic and environmental motives. Global Environmental Change, 25, 52–62. https://doi.org/10.1016/j.gloenvcha.2014.01.012

Riggs, W. (2016). Cargo bikes as a growth area for bicycle vs. auto trips: Exploring the potential for mode substitution behavior. Transportation Research Part F: Traffic Psychology and Behaviour, 43, 48–55. https://doi.org/10.1016/j.trf.2016.09.017

Riggs, W., & Schwartz, J. (2018). The impact of cargo bikes on the travel patterns of women. Urban, Planning and Transport Research, 6(1), 95–110. https://doi.org/10.1080/21650020.2018.1553628

Rublack, E. (2020). Strategic Design for Social Innovation. Mapping a road for Commons Cargobike [Unpublished Manuscript]. https://dein-lastenrad.de/images/9/95/Esther_Rublack_Mapping_a_road_for_Commons_Cargobike.pdf

Steg, L. (2005). Car use: Lust and must. Instrumental, symbolic and affective motives for car use. Transportation Research Part A: Policy and Practice, 39(2–3), 147–162. https://doi.org/10.1016/j.tra.2004.07.001