WP2: Transport modeling and travel behaviour analysis

Dr. ir. Gonçalo Homem de Almeida Correia

(Delft University of Technology, Department of Transport & Planning

Co-director of the hEAT Lab)

g.correia@tudelft.nl

Electric and Automated Transport Research

TU Delft: Gonçalo Correia (leader), Fanchao Liao, Jaap Vloegel, Bart van Arem

Newcastle University: Dilum Dissanayake, Margaret Bell, Neil Thorpe, Gustav Bösehans

Amsterdam University of Applied Sciences: Marije van Gent, Joyce van Brecht

Webinar 10th of September, 2020

POLIS
CITIES AND REGIONS FOR TRANSPORT INNOVATION

Interreg North-West Europe eHUBS
European Regional Development Fund

Hogeschool van Amsterdam

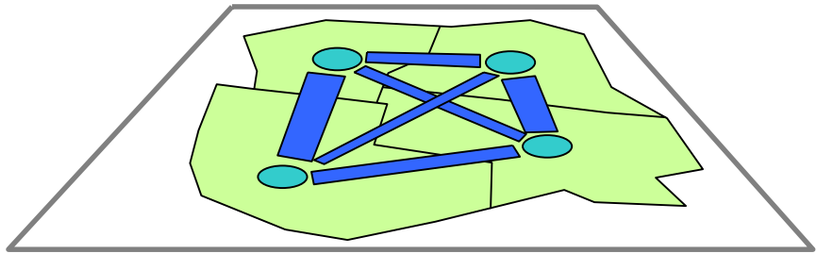
Newcastle University

TU Delft

e-Hubs
WP2

2

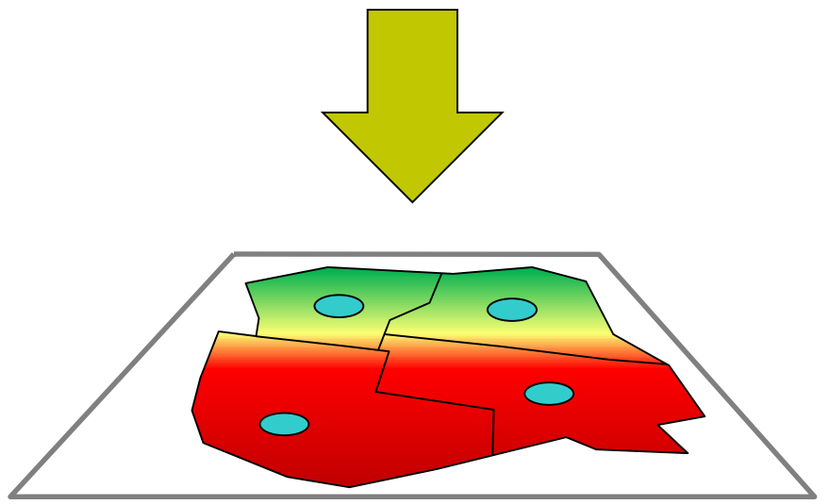
Quick scan method for computing an indicator for the potential of e-hubs location



Information layer: inputs

Spatial Multi-Criteria Evaluation (SMCE)

Avoids complicated mathematical optimization methods



Outputs: Indicator of potential for the e-hubs.

POLIS
CITIES AND REGIONS FOR TRANSPORT INNOVATION

Interreg North-West Europe eHUBS
European Regional Development Fund

Hogeschool van Amsterdam

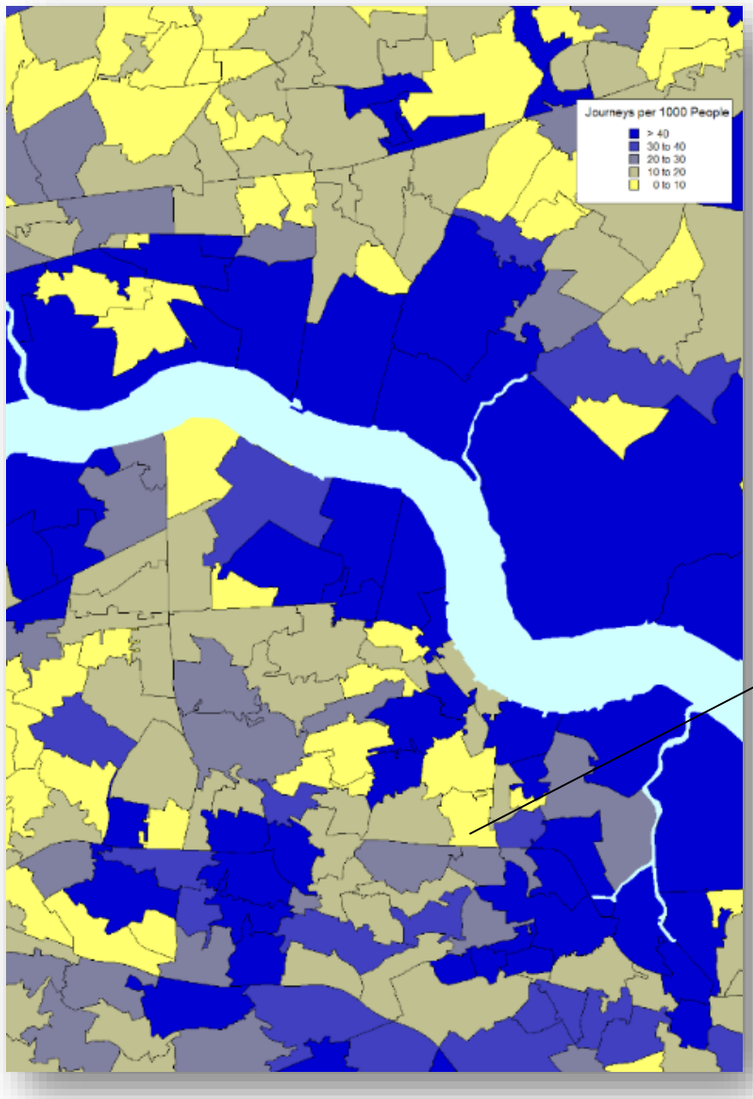
Newcastle University

TU Delft

e-Hubs
WP2

3

Information layer



- ID of each zone
- Attributes for each zone (supply and demand): Population, Jobs, Points of interest.
- Basically all the variables that we can get from the list presented above

e-Hubs
WP2

4

Two studies were found that relate attributes of the zones with the number of users

Table 4 Factor coefficients in the original papers

	EV carsharing	E-bikesharing
Reference	(Hu et al., 2018)	(Guidon et al., 2019)
Zone area	~2.6km2 (1 km hexagon)	0.09 km2 (300m*300m grid cell)
Population	0.01 (thousand per km2)	13.18 (thousand) 0.0029 (within 0.25 miles radius) (He et al., 2019)
Gender (percentage of male)	5.414	
Age (percentage of 15-65)	1.781	
Age (percentage of older than 65)	-0.476	
Income (median)		0.07 (thousand CHF)
Bus stop	0.097 (number of bus routes)	
Metro/tram stop	0.149 (number of metro lines)	0.82 (Urban rail station within 200m)
Train station		1.69 (train station within 500m)
Transit hub	0.445	1.6455 (He et al., 2019)
PT passengers		0.16
Level of accessibility		1.14 (high level accessibility 22% of zones)
Secondary road length	0.042 (km)	
Local road length	0.473 (km)	
Bike path length		0.89 (km)
Workplace		1.63 (thousands)
Restaurant POI		0.05
University	0.144	
Shopping center	0.226	
Recreational center		1.1484 (He et al., 2019)
Percentage of residential area	0.988	
Percentage of office area	1.416	
Original R2	63%	56%

Leuven

Table 6 Data source and processing for each variable: Leuven

Variable	Data source	Processing
Population density	NIS data	
Percentage of male	NIS data	
Percentage of 15-65	NIS data	
percentage of older than 65	NIS data	
Bus stop density	Bus stops	GIS calculate
Presence of train station		Mark zones next to train station
High accessibility area	Bus stops	Percentage ranking: top 20%
Secondary road density	Road network	GIS calculate
Local road density	Road network	GIS calculate
Restaurant density	Building plan	GIS calculate
University	Building plan	GIS calculate
Recreational POI Density	Building plan	GIS calculate
Percentage of residential area	Building plan	GIS calculate
Percentage of office area	Building plan	GIS calculate

Table 7 Models used for calculating shared mobility potential score: Leuven

Variable	Operationalization	Unit	EV sharing	E-bike sharing
Population	Population density	Number per 0.01 km2	0.01	0.12
Gender	Percentage of male		5.414	
Age	Percentage of 15-65		1.781	
Age	percentage of older than 65		-0.476	
Bus stop	Bus stop density	Number per km2	0.252	
Train station	Presence of train station	Dummy variable (1 or 0)	0.445	1.69
Level of accessibility	High accessibility area	Dummy variable (1 or 0)		1.14
Secondary road length	Secondary road density	Km per km2	0.109	
Local road length	Local road density	Km per km2	1.23	
Restaurant POI	Restaurant density	Number per km2		0.0045
University	Presence of university	Dummy variable (1 or 0)	0.144	
Recreational	Recreational POI Density	Number per km2		0.013
Residential area	Percentage of residential area		0.988	
Office area	Percentage of office area		1.416	

e-Hubs
WP2

6

POLIS
CITIES AND REGIONS FOR TRANSPORT INNOVATION

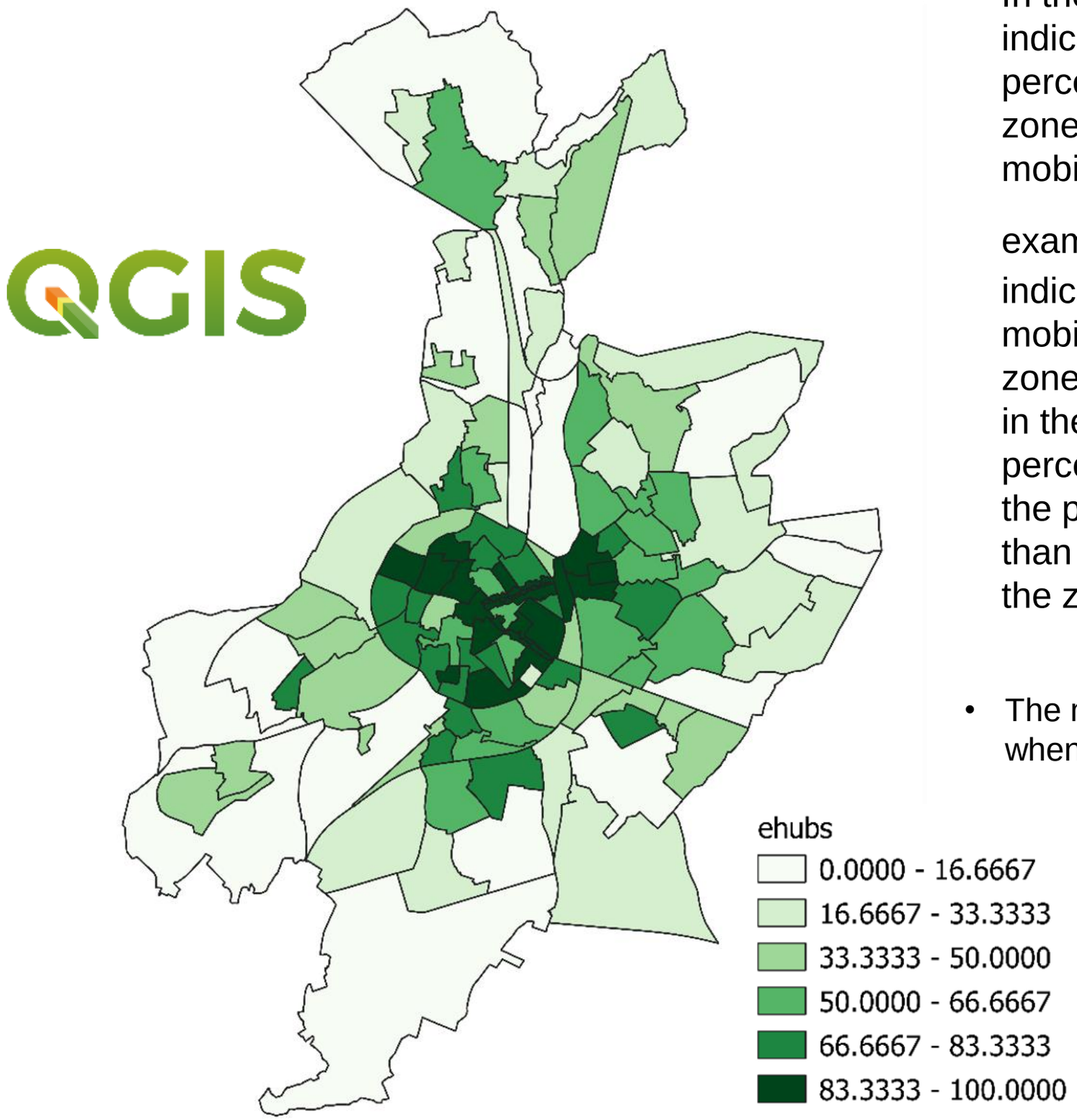
Interreg North-West Europe eHUBS

Hogeschool van Amsterdam

Newcastle University

TU Delft

Leuven quick scan map for e-hubs potential



- In the heat map, the indicator denotes the percentage rank of a zone in terms of shared mobility potential. For example, 83.33 – 100.0 indicates that shared mobility potential of the zones with this color are in the 83.33-100 percentile (in other words, the potential is higher than 83.33-100 percent of the zones).

- The method can be adapted for when better data is available

e-Hubs
WP2

7

POLIS
CITIES AND REGIONS FOR TRANSPORT INNOVATION

Interreg
North-West Europe
eHUBS
European Regional Development Fund

Hogeschool van Amsterdam

Newcastle University

TU Delft

Survey to the general population

Newcastle University

- Goal → Identify potential user groups based on **attitudes** towards shared mobility, car use and the environment based on 20 pre-tested items

Three steps:

- Factor analysis
- Cluster analysis
- Comparison

e-Hubs
WP2

8

Attitudes examples

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I'd be interested in using eHUBS for non-work trips when they've become available in my city.	○	○	○	○	○	○	○
I prefer travelling the way I'm used to rather than using eHUBS.	○	○	○	○	○	○	○
Shared mobility solutions like eHUBS are too complicated for me to use.	○	○	○	○	○	○	○
Shared mobility options can't fulfil my mobility needs.	○	○	○	○	○	○	○

POLIS
CITIES AND REGIONS FOR TRANSPORT INNOVATION

Interreg North-West Europe eHUBS
European Regional Development Fund

Hogeschool van Amsterdam

Newcastle University

TU Delft

e-Hubs
WP2

9

Data collected

City	Sample
Arnhem (NL)	2% 25
Amsterdam (NL)	36% 505
Nijmegen (NL)	15% 208
Leuven (BEL)	21% 294
Dreux (FRA)	1% 10
Kempten (GER)	11% 155
Manchester (UK)	0.1% 2
Other (please specify)	15% 219
TOTAL	1418

Some cities are just starting to collect the data

e-Hubs
WP2

10

Sample from Amsterdam

- Representative Amsterdam sample

Age group	Population	%	Targeted sample	Achieved sample
18 – 24 age	87,168	12.52	63 (13%)	71 (14%)
25 – 34 age	174,953	25.13	126 (25%)	134 (27%)
35 – 44 age	124,051	17.82	89 (18%)	94 (19%)
45 – 54 age	114,812	16.49	82 (16%)	81 (16%)
55 – 64 age	92,579	13.30	66 (13%)	67 (13%)
65 – 74 age	62,216	8.93	45 (9%)	44 (9%)
75 or older	40,319	5.79	29 (6%)	12 (2%)
Total	696,098	100	500	503

e-Hubs
WP2

11

Factor analysis

@ Gus factor analysis to what? The questions right? Is it possible to show them all? You produced these three factors?

Positive attitude towards shared mobility

Pro-environmental attitude

Barriers towards shared mobility use

POLIS
CITIES AND REGIONS FOR TRANSPORT INNOVATION

Interreg North-West Europe eHUBS
European Regional Development Fund

Hogeschool van Amsterdam

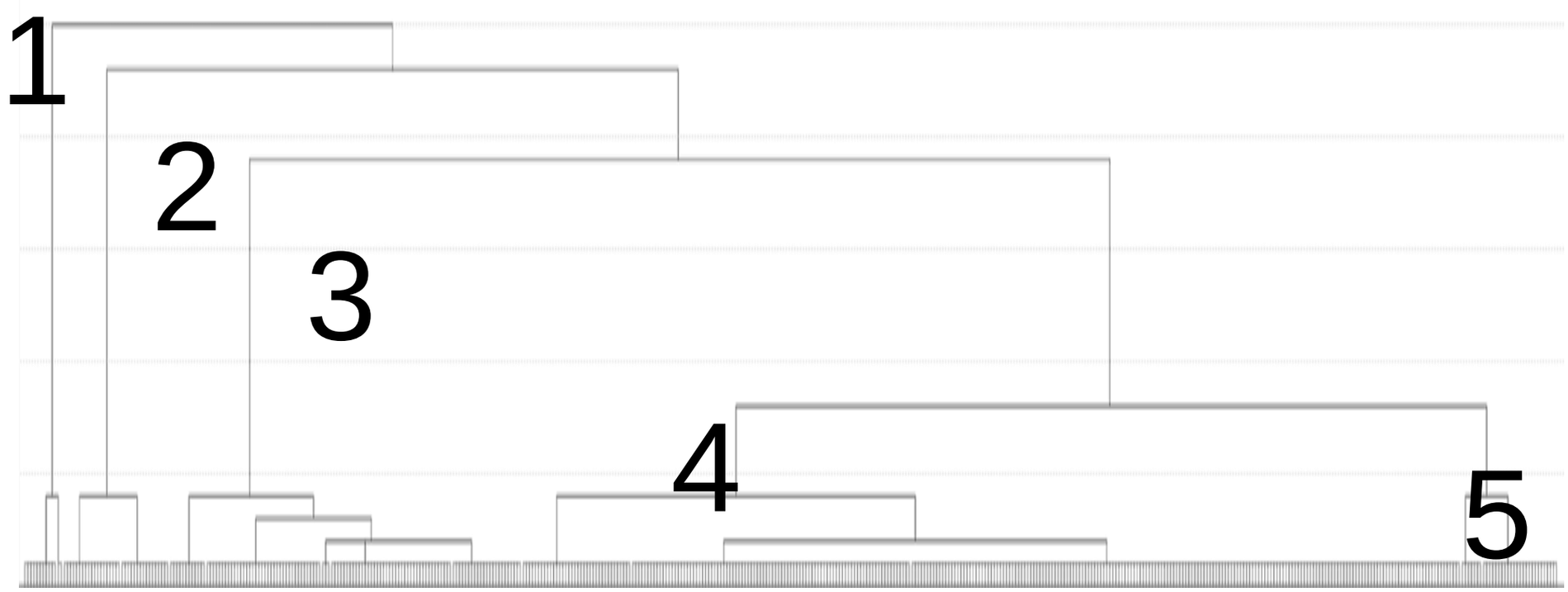
Newcastle University

TU Delft

e-Hubs
WP2

12

Clustering of the respondents according to those three variables



Number of clusters (k)	N cases in Cluster 1	N cases in Cluster 2	N cases in Cluster 3	N cases in Cluster 4	N cases in Cluster 5	N cases in Cluster 6
2	483	22				
3	439	48	18			
4	346	97	44	18		
5	44	2	16	346	97	
6	39	338	96	18	12	2

e-Hubs
WP2

13

Comparing clusters

Clusters were compared based on:

- Scores on attitudinal factors
- Demographic variables
- Traveller identity (e.g., cyclist)
- Current SM use and intentions
- Perceived barriers to SM use

e-Hubs
WP2

14

How do clusters differ regarding attitudes

Components	1	2	3	4
Positive attitude towards shared mobility	+	+	- -	-
Pro-environmental attitude	0	+	+	- -
Barriers towards shared mobility use	+	-	0	-
Number of respondents (*N*)	346	97	44	18
% of sample	69%	19%	9%	3%

POLIS
CITIES AND REGIONS FOR TRANSPORT INNOVATION

Interreg North-West Europe eHUBS
European Regional Development Fund

Hogeschool van Amsterdam

Newcastle University

TU Delft

e-Hubs
WP2

15

Cluster 1 (*n* = 346)

- Young to middle aged adults (65% are 18 to 44)
- Lowest share of households with no children (43%)
- Highest share of households with at least one car available (73%)
- Greatest proportion of respondents who identify as a **car driver** (43%)
- Show some interest in the use of either e-bikes (58/100) or e-cars (59/100) from an eHUB

e-Hubs
WP2

16

Cluster 2 (*n* = 97)

- Similar to Cluster 1 in terms of age, gender, income
- Highest proportion of respondents with a university degree (69%)
- Highest share of households with at least one bicycle available (92%)
- Highest proportion of respondents identifying either as **multi-modal users** (33%) or **cyclists** (27%)
- Show interest in using e-bikes (59/100), but an even stronger interest to use e-cars (69/100)

e-Hubs
WP2

17

Cluster 3 (*n* = 44)

- Older adults (only 27% are 18 to 44)
- More likely to be female (57%) and less likely to have a university degree (41%)
- Tend to live in a single person household (48%) with no children (68%)
- Least likely to have a bicycle available (only 66%)
- **Most satisfied** with their current regular trip or commute (88/100)
- Express the **least interest** in using either e-bikes (18/100) or e-cars (20/100) from an eHUB

e-Hubs
WP2

18

Cluster 4 (*n* = 18)

- Similar to Cluster 3 in terms of age and education
- Majority is male (61%) and tends to live in a single person household (56%) with no children (83%)
- Least likely to hold a driver's license (56%).
- Highest proportion of members identifying themselves as either **Walkers** (22%) or **PT users** (17%)
- Little interest in using either e-bikes (38/100) or e-cars (34/100) from an eHUB in the future

POLIS
CITIES AND REGIONS FOR TRANSPORT INNOVATION

Interreg North-West Europe eHUBS
European Regional Development Fund

Hogeschool van Amsterdam

Newcastle University

TU Delft

General recommendations

Barriers (Cluster 1)	Solution
Fear of no shared vehicle being available when needed (15%)	have a sufficiently large number of vehicles available at all times
Cannot leave vehicles where desired (11%)	have a large number of locations where vehicles can be accessed / left behind
I prefer to use existing public transport (17%)	provide clear and easy to understand information on how to operate vehicles

General recommendations

Barriers (Cluster 1)	Solution
Too expensive (16%), badly maintained/dirty (5%), unsafe (6%)	be affordable, well maintained/clean, and safe
Travel data/privacy concerns (6%)	guarantee and stress the confidentiality of users' travel data
Hard to reserve and pick up vehicles (8%) / hard to register and pay (5%)	have an easy rental, registration and payment process

POLIS
CITIES AND REGIONS FOR TRANSPORT INNOVATION

Interreg North-West Europe eHUBS
European Regional Development Fund

Hogeschool van Amsterdam

Newcastle University

TU Delft

WP2: Transport modeling and travel behaviour analysis

Dr. ir. Gonçalo Homem de Almeida Correia

(Delft University of Technology, Department of Transport & Planning

Co-director of the hEAT Lab)

g.correia@tudelft.nl

Electric and Automated Transport Research

TU Delft: Gonçalo Correia (leader), Fanchao Liao, Jaap Vloegel, Bart van Arem

Newcastle University: Dilum Dissanayake, Margaret Bell, Neil Thorpe, Gustav Bösehans

Amsterdam University of Applied Sciences: Marije van Gent, Joyce van Brecht

Webinar 10th of September, 2020

POLIS
CITIES AND REGIONS FOR TRANSPORT INNOVATION

Interreg North-West Europe eHUBS
European Regional Development Fund

Hogeschool van Amsterdam

Newcastle University

TU Delft

References

Hu, S., Chen, P., Lin, H., Xie, C., Chen, X., 2018. Promoting carsharing attractiveness and efficiency: An exploratory analysis. Transp. Res. Part D Transp. Environ. 65, 229–243. https://doi.org/10.1016/j.trd.2018.08.015

Guidon, S., Becker, H., Dediu, H., Axhausen, K.W., 2019. Electric Bicycle-Sharing: A New Competitor in the Urban Transportation Market? An Empirical Analysis of Transaction Data. Transp. Res. Rec. 2673, 15–26. https://doi.org/10.1177/0361198119836762

Appendix

TU Delft

Positive attitude (α = .88, R^2 = .23)

1. I'd be interested in using eHUBS for non-work trips when they've become available in my city.	Adoption intention for leisure	.85
2. I'd be interested in using eHUBS for commuting trips when they've become available in my city.	Adoption intention for commute	.83
3. I would enjoy trying out and using different electric vehicles from an eHUB.	Trialability	.82
4. Shared mobility options provide me with more flexibility in the way I travel.	Relative advantage	.78
5. I am confident that, if I wanted to, I could use eHUBS without problems.	Complexity	.67
6. I'm often among the first people to experiment with new technologies.	Affinity for technology	.60
7. I feel confident to ride an electric bicycle.	PBC e-bike	.58

e-Hubs
WP2

25

Pro-env attitude (α = .88, R^2 = .20)

8. For the sake of the environment, everyone should reduce how much they use cars.	Pro car use reduction	.79
9. I feel a moral obligation to reduce my emissions of greenhouse gases.	Personal norm	.77
10. People who drive cars that are better for the environment should pay less to use the roads.	Green incentive	.77
11. Congestion, air pollution and noise from road traffic is a real problem in my city.	Perceived severity of environmental issues	.76
12. People around me find it important to reduce emissions of greenhouse gases.	Perceived subjective norm	.70
13. Almost everyone around me owns a private car.	Perceived social norm	.52

Perceived barriers (α = .83, R^2 = .16)

14. Shared mobility solutions like eHUBS are too complicated for me to use.	Complexity	.74
15. I do not feel confident to use an electric car.	PBC e-car	.69
16. People should be allowed to use their cars as much as they like, even if it causes damage to the environment.	Contra car use reduction	.68
17. Shared mobility options can't fulfil my mobility needs.	Perceived compatibility	.62
18. There is no point in using shared mobility options if you already own a car.	Added value	.60
19. I prefer travelling the way I'm used to rather than using eHUBS.	Habit	.59
20. I'd rather wait for other people to try eHUBS before I use them.	Delayed adoption intention	.46

e-Hubs
WP2

27

Shared mobility usage and perceived barriers relation with the clusters

Shared mobility use and perceived barriers	Cluster 1 (*n* = 346)	Cluster 2 (*n* = 97)	Cluster 3 (*n* = 44)	Cluster 4 (*n* = 18)
I don't use any shared vehicles	63%	53%	96%	89%
Use shared bikes on a regular basis	19%	16%	2%	6%
Use shared cars on a regular basis	20%	30%	5%	11%
Use e-scooters on a regular basis	7%	11%	2%	-
I am satisfied with my own car/bike	34%	26%	68%	28%
I prefer to use existing public transport	17%	10%	34%	6%
I do not see the added value of shared mobility	8%	4%	23%	17%
I'm afraid that there is no shared vehicle available when I need it	15%	14%	23%	6%
It is too expensive to rent vehicles	16%	19%	16%	11%
The shared vehicle location is too far from me	10%	11%	11%	17%
I don't feel safe to use shared vehicles	6%	3%	11%	11%
It is hard to reserve and pick up vehicles	8%	7%	11%	6%
I cannot leave the vehicles where I want	11%	7%	9%	-
I'm concerned with my travel data/privacy	6%	8%	11%	-
I haven't heard of it/I'm not aware of its existence	6%	1%	2%	6%
Shared vehicles are badly maintained/dirty	5%	2%	5%	6%
It is hard to register and pay for vehicles	5%	3%	2%	-
Other barriers	3%	2%	9%	11%