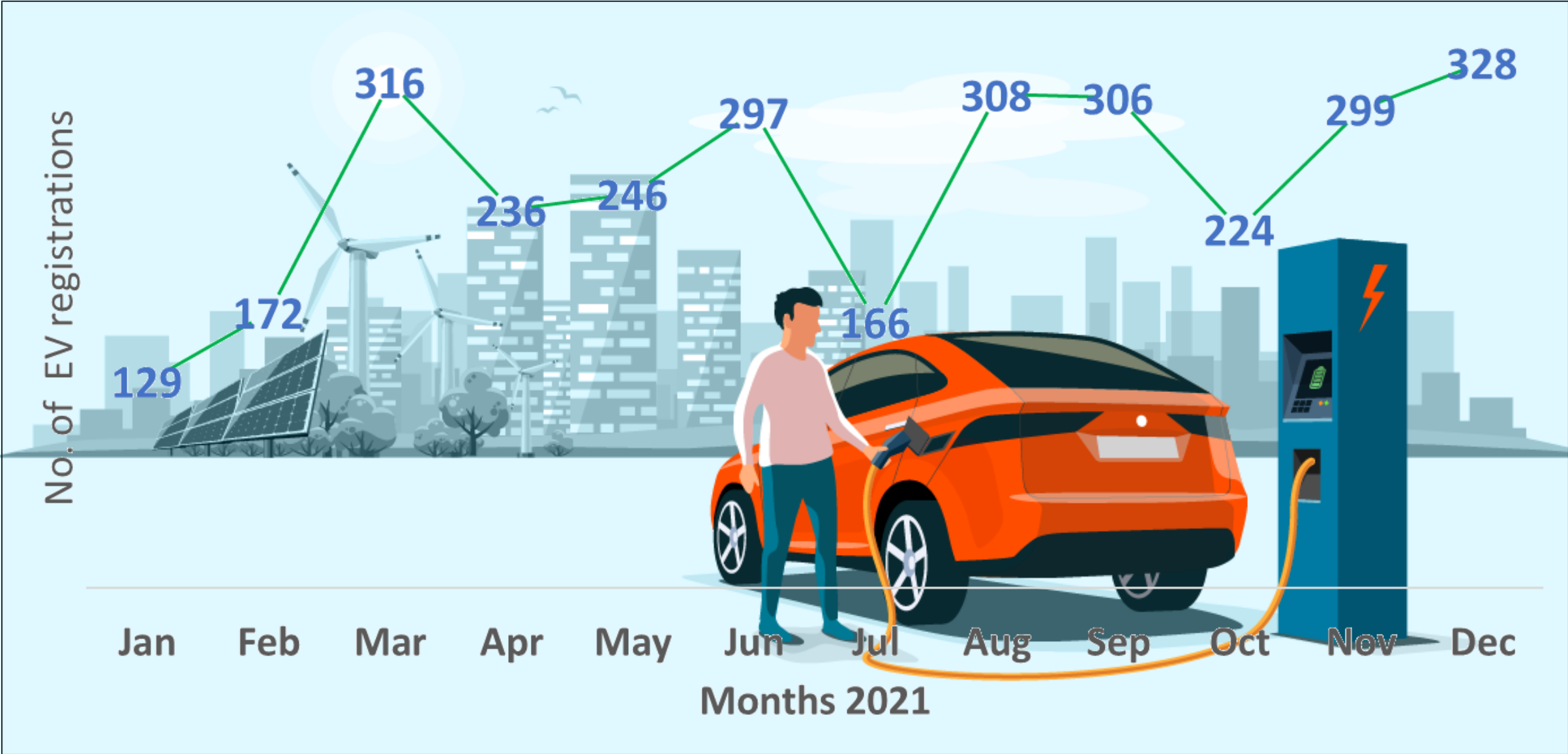**"Green is the new black: Motives and barriers of adopting electric cars among the young adults in Innsbruck, Austria"**

University of Oxford, 31.08.2022

Dr. Rumana Sarker
Senior Scientist, Unit for Intelligent Transport Systems, University of Innsbruck

Current EV ownership and charging facilities in Tyrol region

@futureenergy.com

what are the influential factors to adopt EVs?

How the users perceive the utility of the preferred charging location?

How much users are willing to pay for charging facilities?

Heatmap Visualization of EV Charging Station in Innsbruck
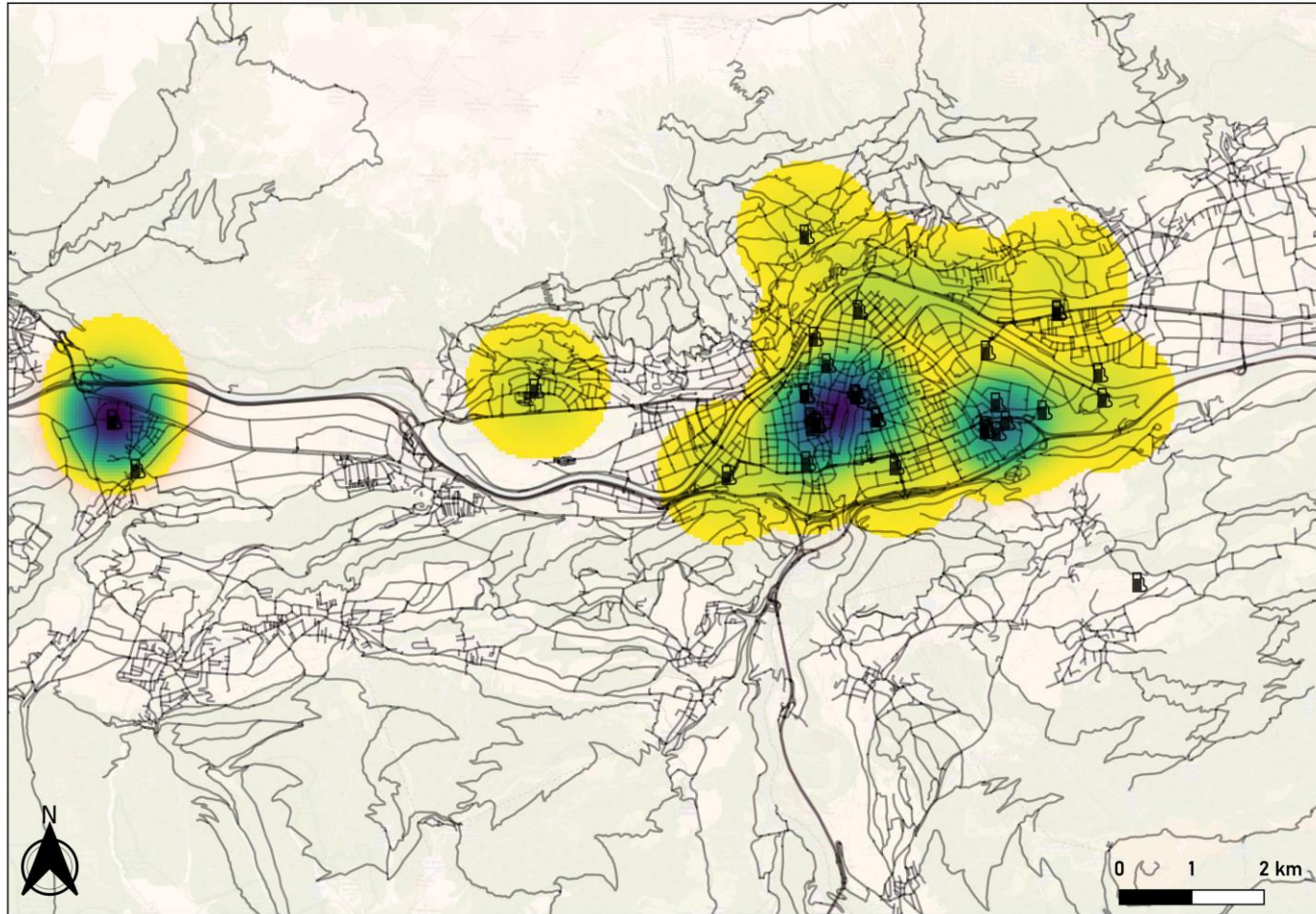
Location Index Map
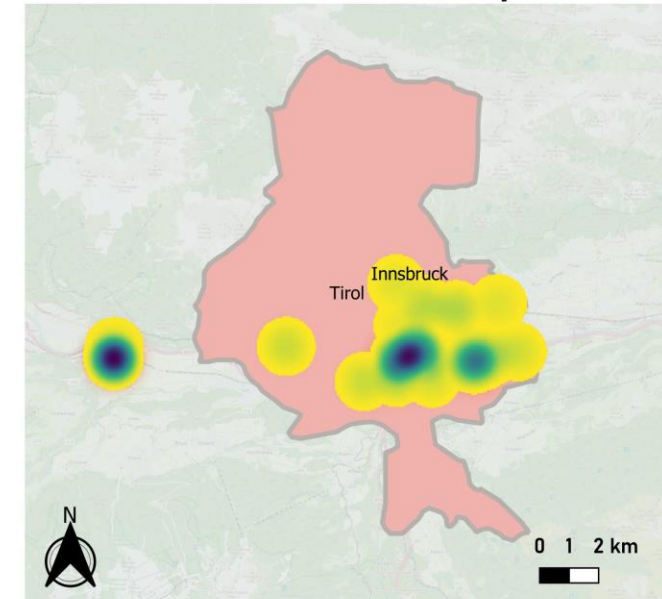
Legend

Heatmap Series
- Low Concentration EV CS
- Medium to Low Concentration EV CS
- High to Medium Concentration EV CS
- Very High Concentration EV CS
- Charging stations
- Road Network Innsbruck

EVCS = Electric vehicle Charging Station

18 participants

Motives and barriers to adopt EV
+ Willingness to pay for charging infrastructure

606 samples (82% response rate)

Qualitative Interview

Policy Implications

01 **02** **03** **04** **05**

SP Survey March - April 2022

SEM Analysis+ DCM Analysis
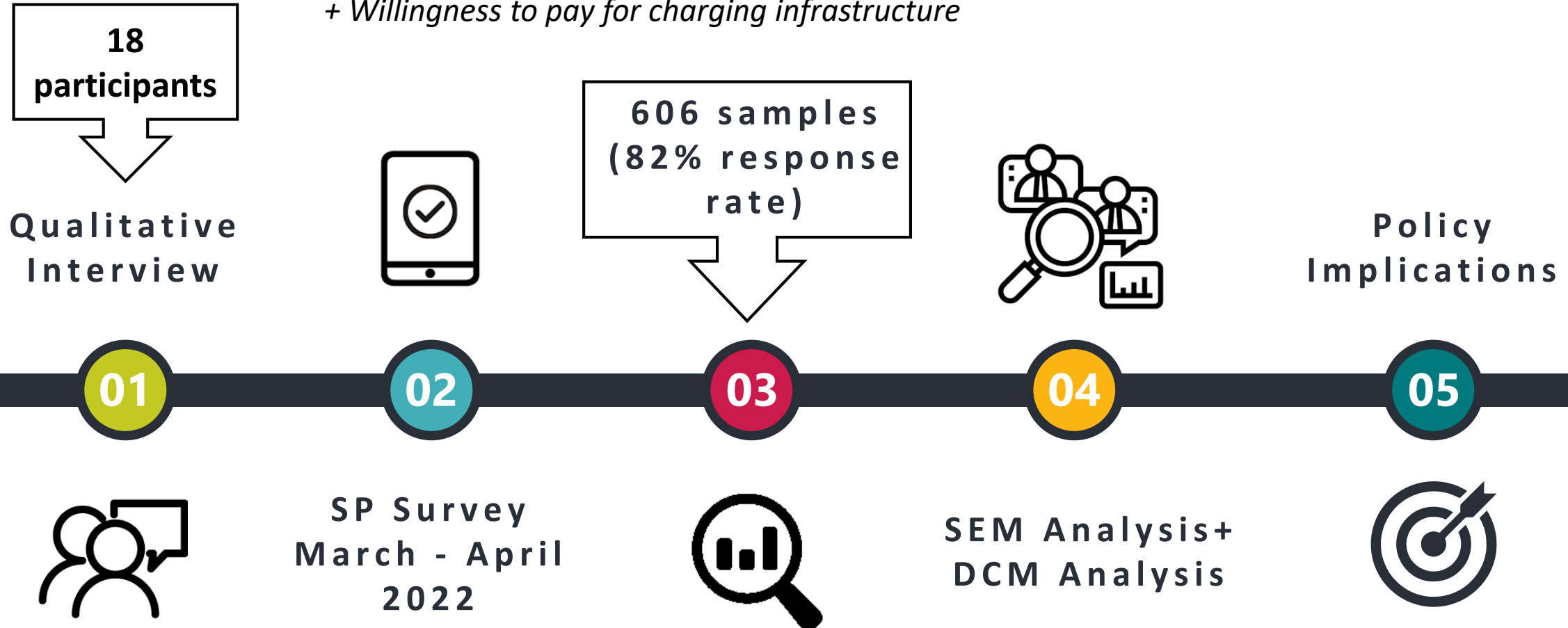
What are the most important factors to adopt EV?

Research project: PeCASO

	Group 1	Group 2	Total
	Non-EV Drivers	**EV Drivers**	
< 25 years old	1	2	3
25 – 50 years old	3	3	6
> 50 years old	7	2	9
Total	7	11	18
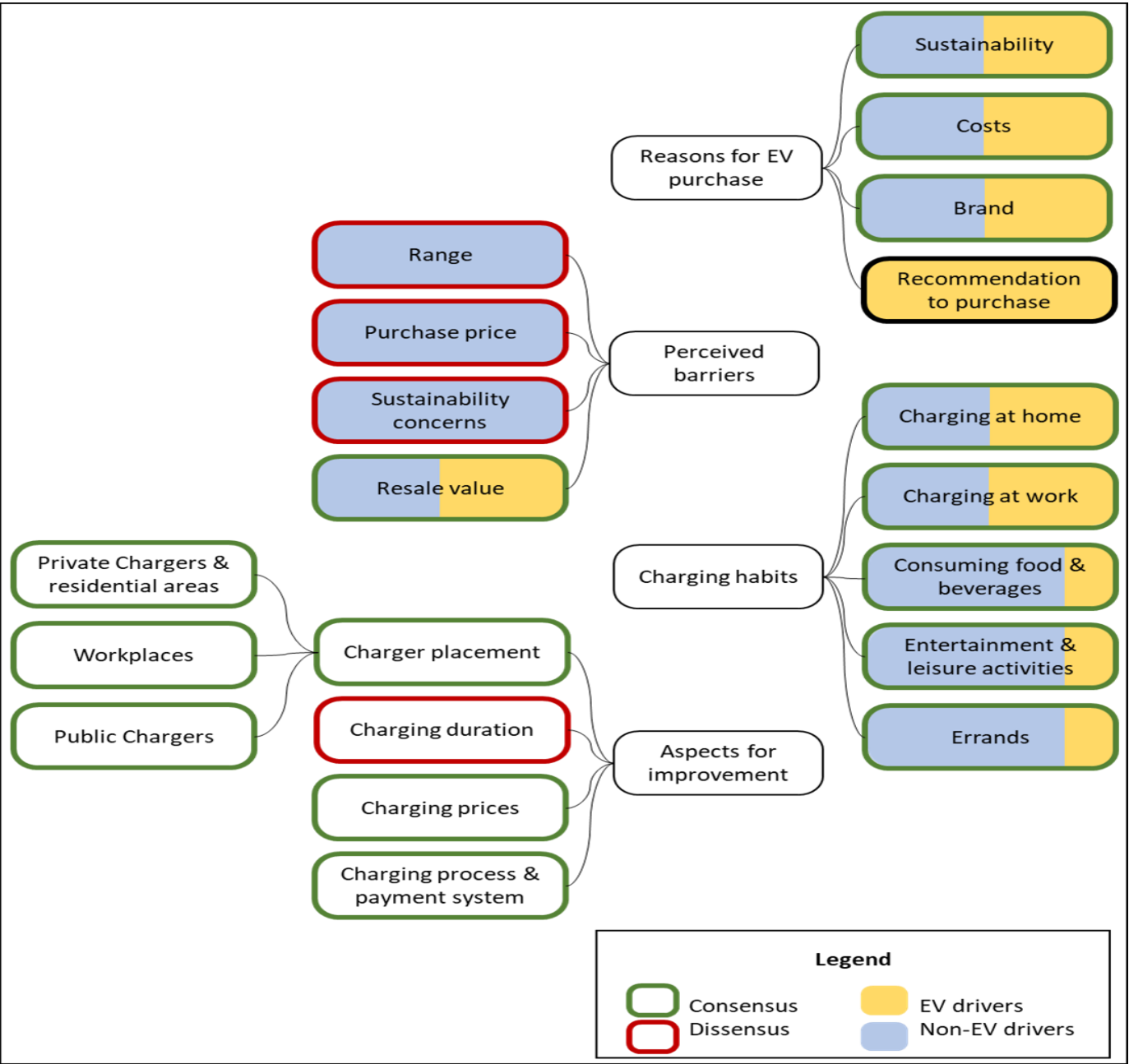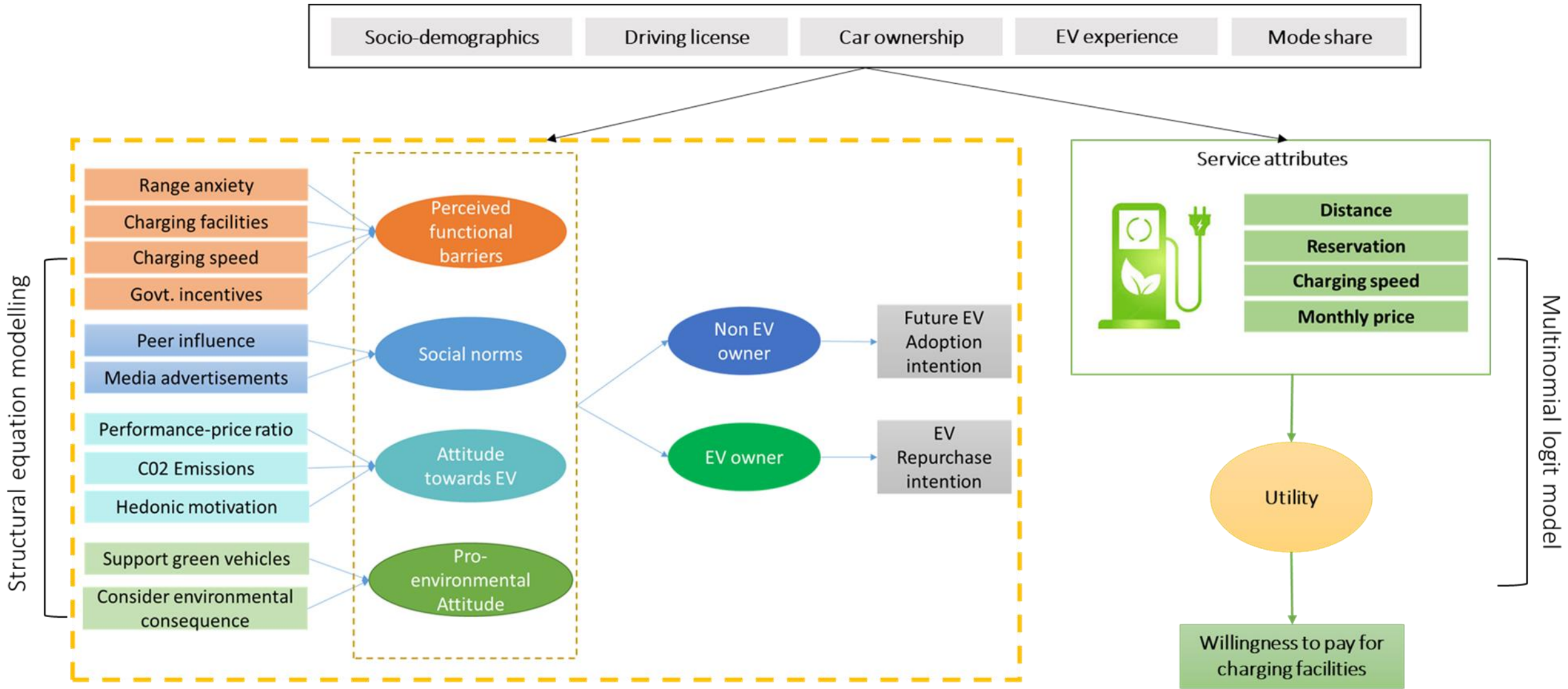
Sample characteristics

Sample = 496 responses (68% from Innsbruck)
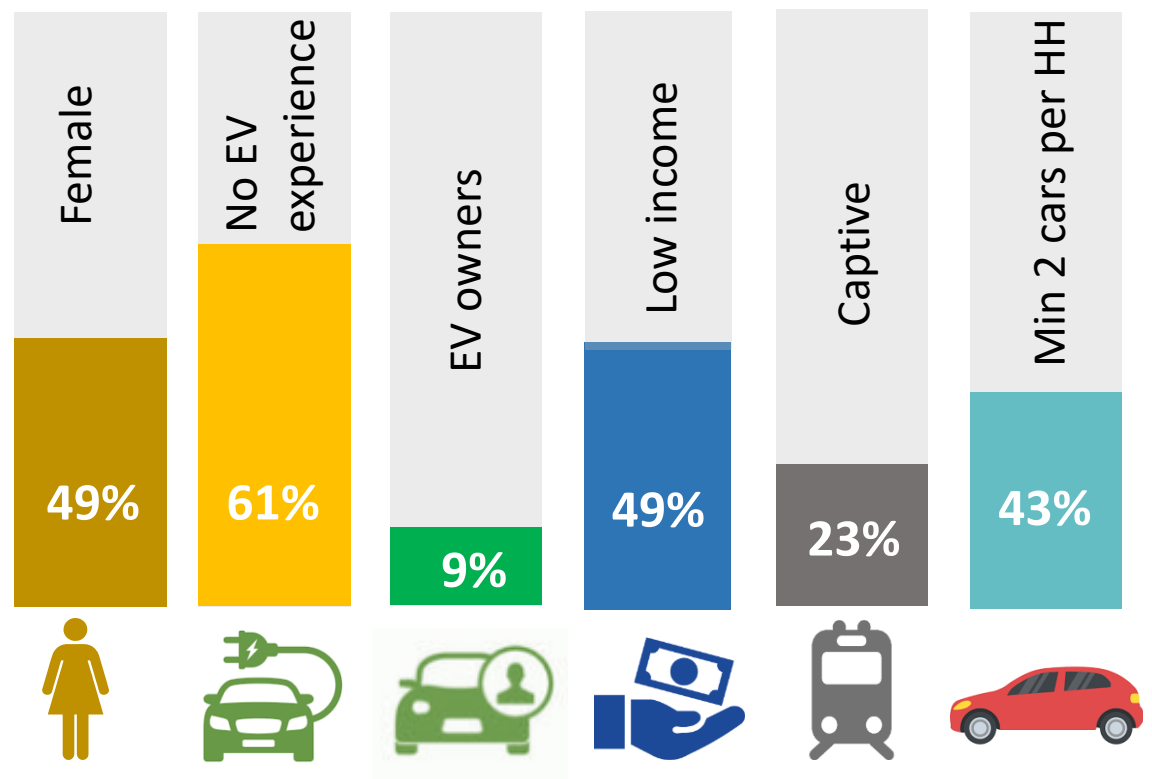
universität innsbruck · iKB

Legend: Mid-20s · Mid-30s · >40 · Full-time · Part-time · Student · Others

Category	Value
Female	49%
No EV experience	61%
EV owners	9%
Low income	49%
Captive	23%
Min 2 cars per HH	43%

Age
- Mid-20s: 41%
- Mid-30s: 28%
- >40: 31%

On the younger side

Employment
- Full-time: 37%
- Part-time: 5%
- Student: 43%
- Others: 15%
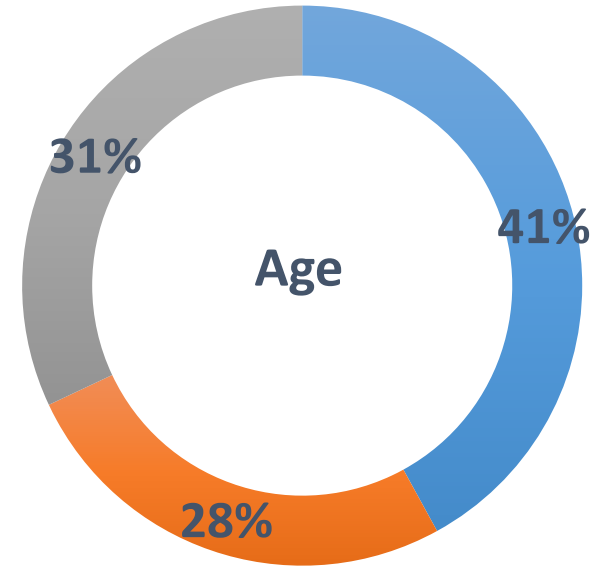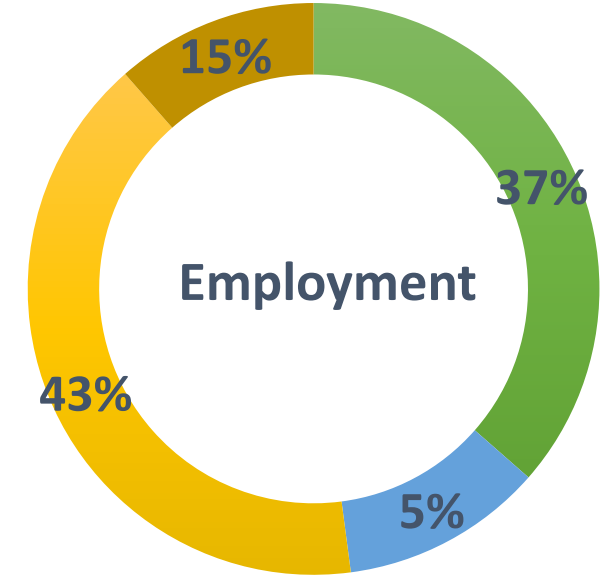
Mostly students

More than 5 years of driving license **72%**

<20 km of daily travel **73%**

Additional facilities in charging stations

Dr. Rumana Sarker, UDESMO Workshop, University of Oxford
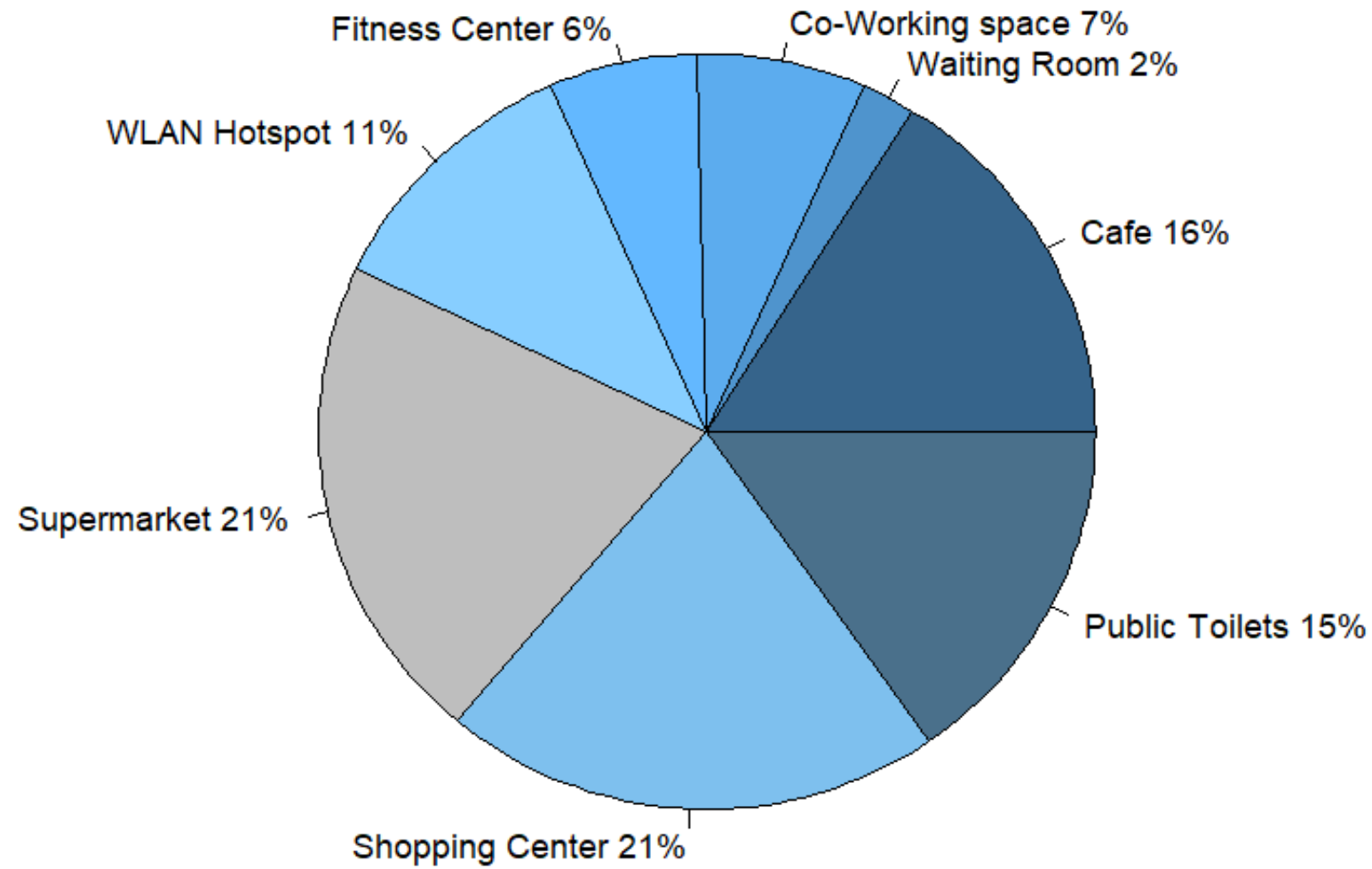
Attitude towards EV

■ **Non EV owners** ■ **EV owners**

Responses (%)

86%

81%

69%

67% 67%

38%

I believe that buying an EV has a positive effect on the environment than buying a conventional car (i.e., low noise, low emission).

I think buying an EV is better (good performance-price ratio) than a conventional car in the long run

I think it is cool to drive an EV than a conventional car

agree + strongly agree
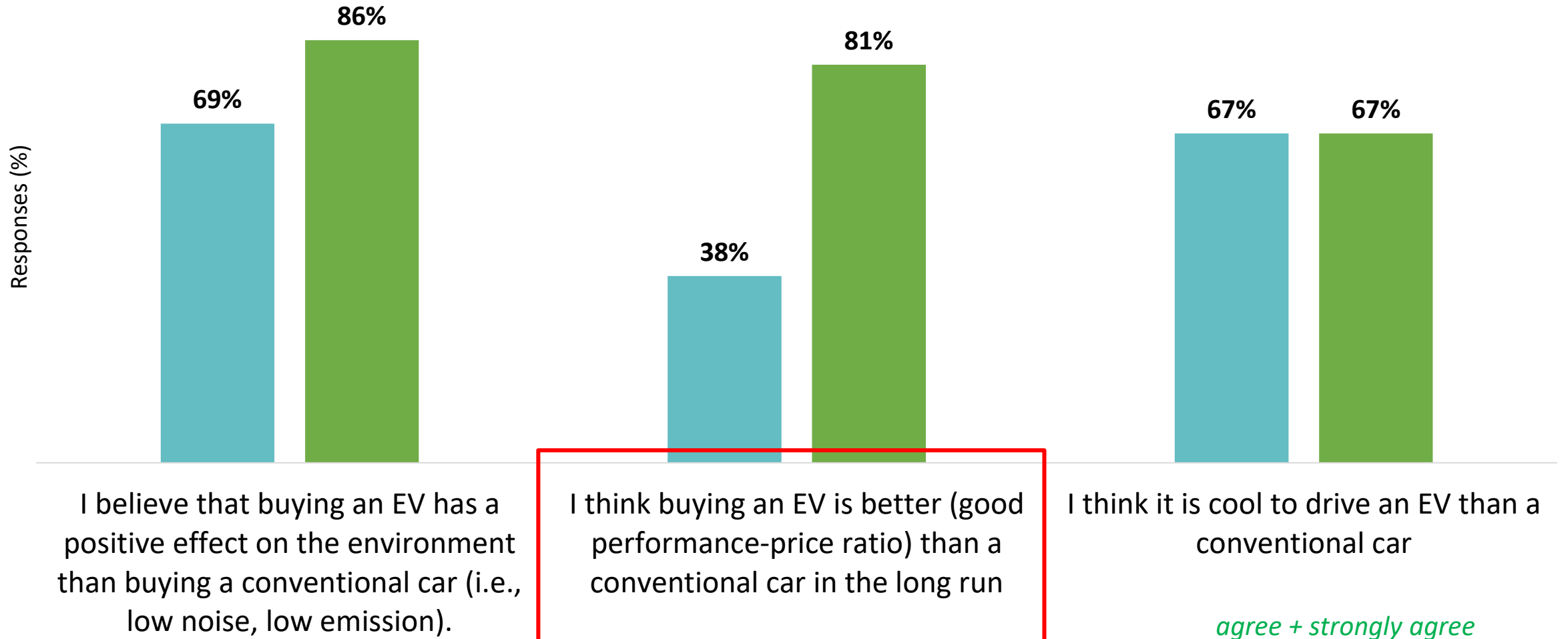
Perceived functional barrier

Non EV owners ■   **EV owners** ■

- I am not able to afford an EV even with the purchase subsidies and tax exemption by the Government — Non EV owners: 51%, EV owners: 26%
- I am concerned about EV range when thinking of buying an EV — Non EV owners: 54%, EV owners: 31%
- Insufficient charging infrastructure makes it difficult to buy an EV — Non EV owners: 70%, EV owners: 46%
- Longer charging time at the charging station discourages me to buy an EV — Non EV owners: 34%, EV owners: 10%
- I will worry about battery life and battery disposal if I buy an EV — Non EV owners: 71%, EV owners: 25%
- Concerns with residual/resale value discourage me to buy an EV — Non EV owners: 20%, EV owners: 16%

agree + strongly agree

Subjective Norms

■ Non EV owners   ■ EV owners

Responses (%)

People in my life, whose opinion I value, would support my decision of purchasing EV
- Non EV owners: 57%
- EV owners: 74%

People who are important to me already own an EV
- Non EV owners: 20%
- EV owners: 50%

People who are important to me are considering buying EV
- Non EV owners: 38%
- EV owners: 64%

The excellent advertising by media gave me a positive feeling about buying an EV
- Non EV owners: 14%
- EV owners: 19%

The promotion of EV in social media has influenced me positively about buying an EV
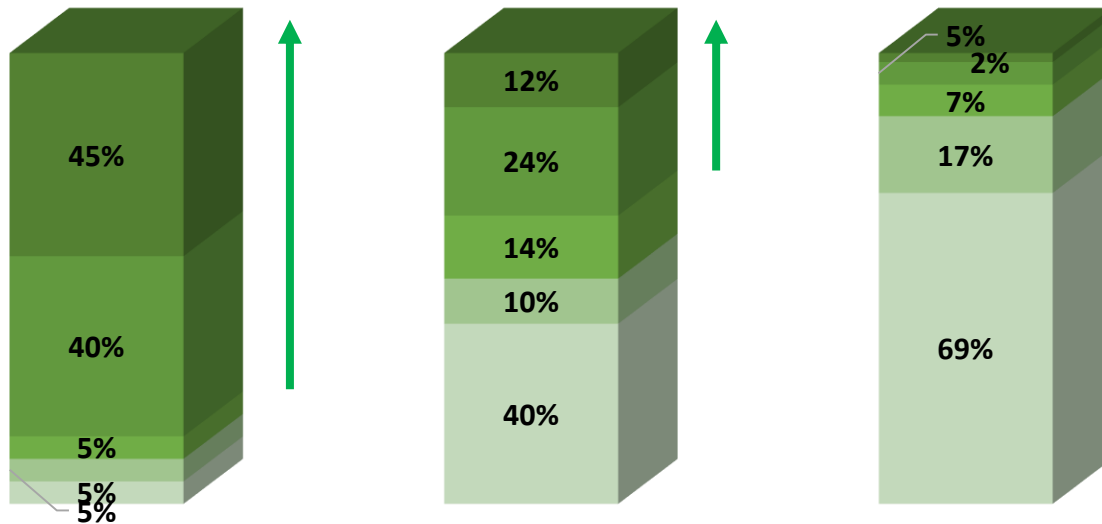- Non EV owners: 13%
- EV owners: 21%

agree + strongly agree

REPURCHASE INTENTION- EV owners

Legend: Strongly disagree, Disagree, Neutral, Agree, Strongly agree

I am satisfied with my current EV, and will purchase EV again if necessary
- 45%
- 40%
- 5%
- 5%
- 5%

I am currently using EV as my second car and will completely shift to EV in future
- 12%
- 24%
- 14%
- 10%
- 40%

I am not happy with my current EV and will return to my conventional car
- 5%
- 2%
- 7%
- 17%
- 69%

ADOPTION INTENTION - Non EV Owners

Legend: Strongly disagree, Disagree, Neutral, Agree, Strongly agree
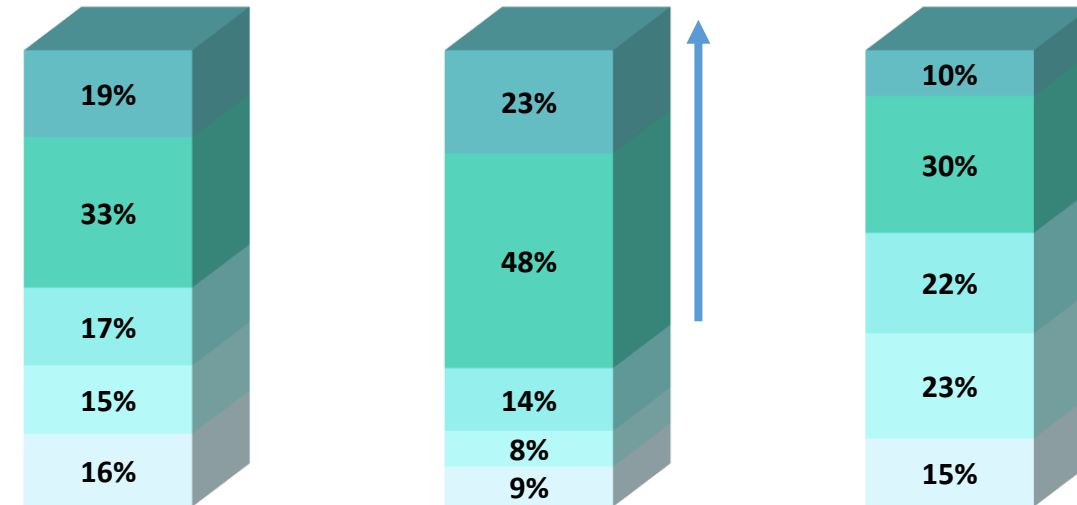
I am willing to buy an electric car in near future
- 19%
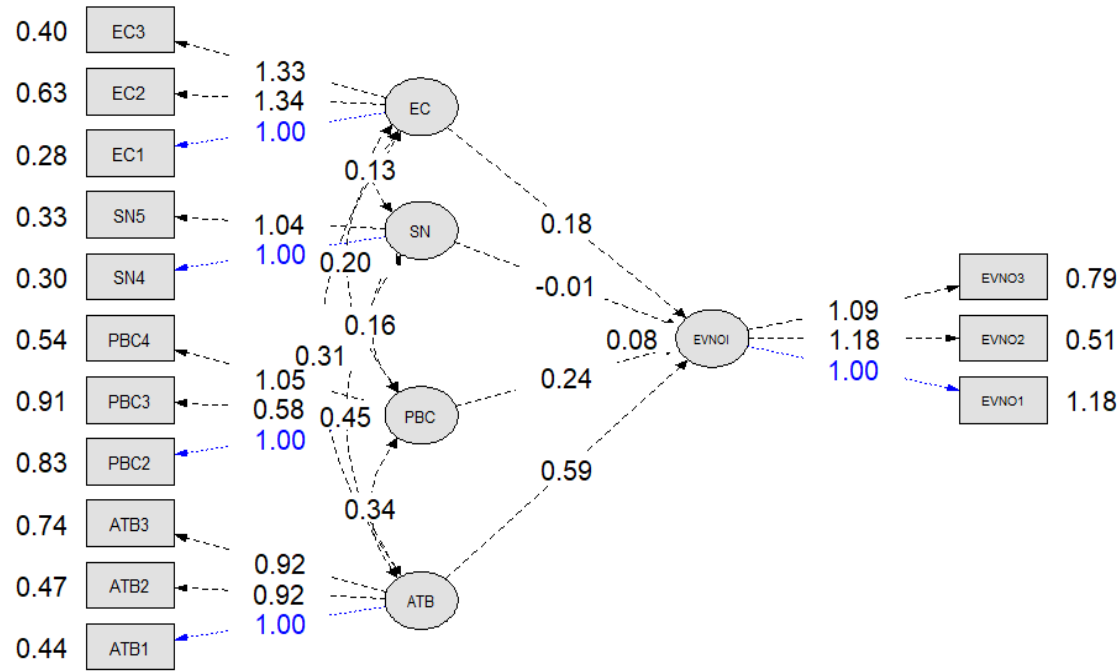- 33%
- 17%
- 15%
- 16%

I am willing to forgo some advantages with conventional car (e.g., less concern with fueling) to buy an EV
- 23%
- 48%
- 14%
- 8%
- 9%

I am willing to spend more money to buy an EV
- 10%
- 30%
- 22%
- 23%
- 15%

Path model for Non-EV owners

*CFI= 0.93, *TLI = 0.90

SEM estimates for focused group – Non EV owner.

Model Estimates Perceived barriers (PBC)	Estimates	Z- value	P-value	Cronbach's Alpha (α)	KMO (overall Sampling adequacy)
Measurement Model					
PBC->PBC2R	fixed	-	0.00		
PBC->PBC3R	0.581***	8.63	0.00		
PBC->PBC4R	1.046***	10.621	0.00		
Subjective Norms (SN)					
SN->SN4	fixed	-	0.00		
SN->SN5	1.037***	11.951	0.00		
Environmental Concern (EC)					
EC -> EC1	fixed	-			
EC-> EC2	1.335***	12.9	0.00		
EC-> EC3	1.332***	13.64	0.00	0.86	0.86
Attitude towards EV adoption behavior (ATB)					
ATB->ATB1	fixed	-			
ATB->ATB2	0.92***	17.55	0.00		
ATB->ATB3	0.92***	15.65	0.00		
Adoption Intention (AI)					
AI->EVNO1	fixed	-			
AI->EVNO2	1.179***	12.23	0.00		
AI->EVNO3	1.087***	11.31	0.00		
Structural Model					
PBC->EVNOI (DE)	0.24***	5.017	0.00		
SN->EVNOI (DE)	-0.012	0.248	0.80		
EC -> EVNOI (DE)	0.18**	2.43	0.01		
ATB->EVNOI (DE)	0.58***	8.28	0.00		

Table 6: Estimated SEM path model (non-EV owners/users)

*DE= direct effects on latent construct EVNOI

Path model for EV owners

SEM estimates for focused group – EV owner.
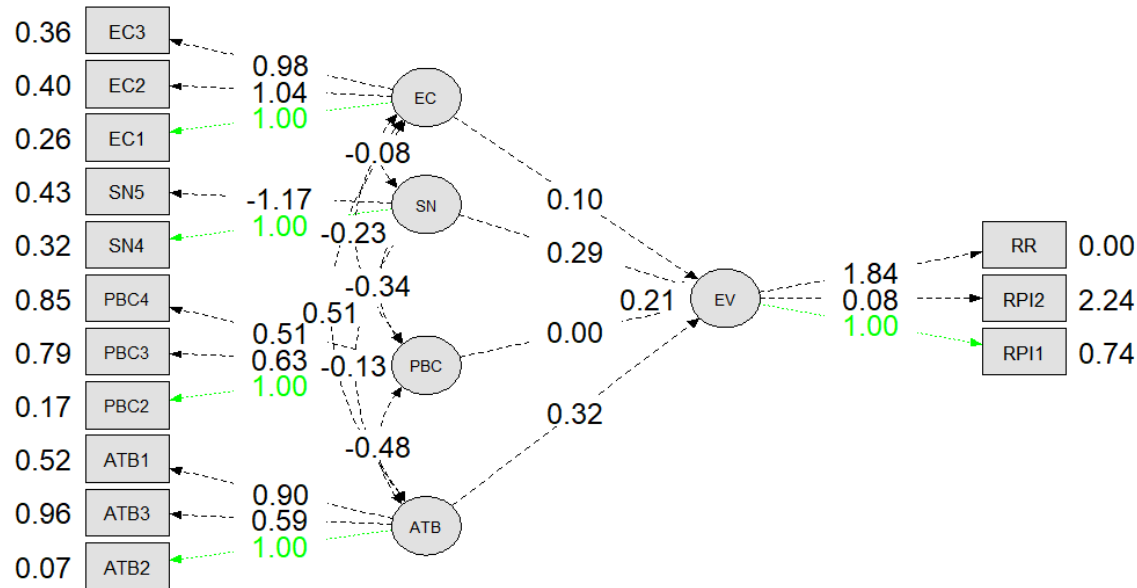
Model Estimates	Estimates	Z- value	P-value	Cronbach's Alpha (α)	KMO (overall Sampling adequacy)
Perceived barriers (PBC)					
Measurement Model					
PBC->PBC2	fixed	-	0.00		
PBC->PBC3	0.63***	4.22	0.00		
PBC->PBC4	0.51***	3.64	0.00		
Subjective Norms (SN)					
SN->SN4	fixed	-	-		
SN->SN5	-1.2***	4.045	0.00		
Environmental Concern (EC)					
EC -> EC1	fixed	-			
EC-> EC2	1.043***	5.20	00.00		
EC-> EC3	0.98***	5.17	0.00	0.74	0.5 (Miserable)
Attitude towards EV adoption					
behavior (ATB)					
ATB->ATB2	fixed	17.55	0.00		
ATB->ATB1	0.90***	5.599	0.00		
ATB->ATB3	0.58***	2.997	0.00		
Repurchase Intention (AI)					
RI->RRI1	fixed	-			
RI->RPI2	0.084	0.21	0.829		
RI->RRI3	1.845*	2.635	0.008		
Structural Model					
PBC->EVO (DE)	0.003	0.032	0.98		
SN->EVO (DE)	0.321*	1.65	0.09		
EC -> EVO (DE)	0.102	0.245	0.806		
ATB->EVO (DE)	0.321	0.747	0.455		

Table 7. Estimated SEM path model (EV owners/users)

*DE= direct effects on latent construct (EVO)

*CFI= 0.93, *TLI = 0.92

Choice experiment

	Option 1	Option 2	Option 3
Distance of charging station	500m	1000m	1500m
Reservation time	For 30 Minutes	For 15 Minutes	Not possible
Charging speed	Fast	Moderat	Rapid
Monthly price	75€	95€	55€
	Select	Select	Select

Attributes	Levels
Distance of stations	500m,1000m,1500m
Reservation time	No, 15min ,30min
Charging speed	Moderate, Fast, Rapid
Monthly Price	**55€, 75€, 95€**

Power	Item	Up to 80% Charging
Moderate	Charging Time (min)	400
	3 times monthly Price in (€)	(400 * 0.06) * 3= 72 ~ **75**
Fast	Charging Time (min)	90
	3 times monthly Price in (€)	(90 * 0.35) * 3= 94.5 ~ **95**
Rapid	Charging Time (min)	50
	3 times monthly Price in (€)	(50* 0.35) * 3= 52.5 ~ **55**

moderate =11 – 12 KW, approx. **4 - 6 hours** to recharge 80% of the battery.

Fast= 50 – 75 KW, approx. **1 - 1.5 hours** to recharge 80% of the battery.

Rapid= > 75 KW, takes about **45 minutes - 1 hour** to recharge 80% of the battery.

Attribute Importance
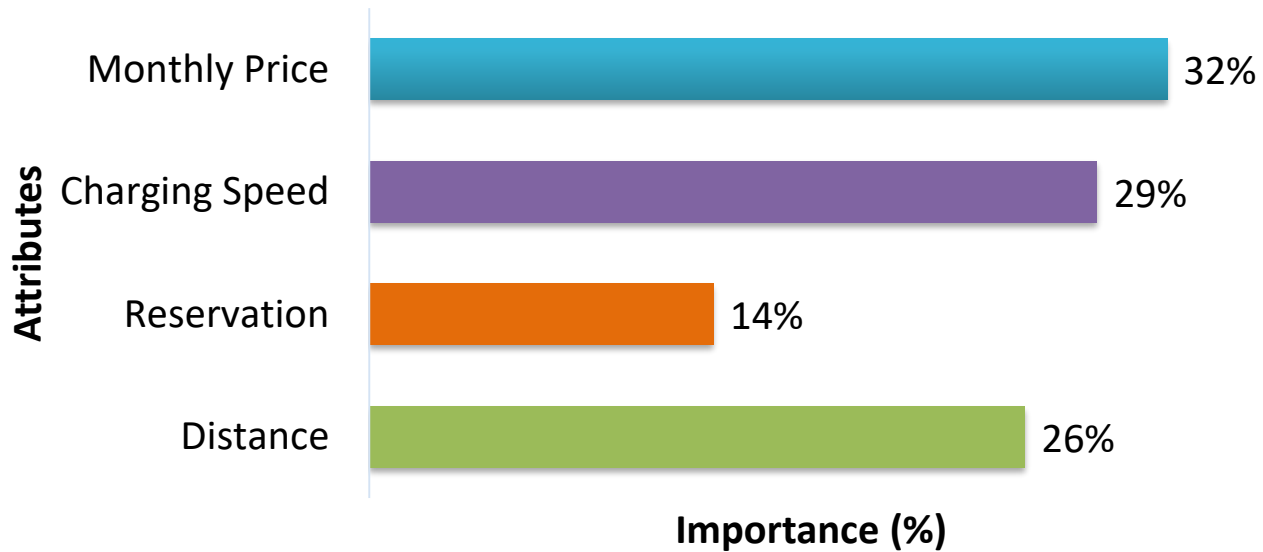
Attributes	Level	Utility
Distance	500 m	0.82
	1000 m	-0.12
	1500 m	-0.70
Reservation	Not possible	-0.39
	15 minutes	0.14
	30 minutes	0.25
Charging Speed	Moderate	-0.72
	Fast	-0.15
	Rapid	0.87
Monthly Price	55 Euro	0.78
	75 Euro	0.16
	95 Euro	-0.95

Model no. 3 (MNL with SP Covariates)		
Parameters/ Variables (reference level/ordered)	**Estimates**	**‖t.ratio‖**
ASC_1 (reference level)	0	N/A
ASC_2	0.224***	3.37[b]
ASC_3	-0.21***	2.8[b]
Beta speed	0.623***	10.96[b]
Beta reservation time	0.024***	9.2[b]
Beta distance	-0.0016***	15.46[b]
Beta cost	-0.047***	3.52[b]
Interaction with monthly cost at charging station		
Employment Status (Student)	-	-
Full time x Price	0.016**	9.2[b]
Part Time x Price	-0.012*	2.4[b]
Self Employed x Price	0.0317**	2.04[b]
Retired x Price	0.015	0.78
Others x Price	-0.0032	0.24
Household size (HHsize1)	-	-
Household size 2 x Price	-0.00082	0.13
Household size 3 x Price	0.005	0.77
Household size 4 x Price	0.007	1.13
Education level (Compulsory School)	-	-
Middle School x Price	-0.0149	0.88
Secondary School/Matura x Price	-0.019	1.56
Technical College /University x Price	-0.016	1.45
EV experience (Continuous)	-	-
EV owners as own Car x Price	0.016**	2.32[b]
Non EV owners as Company car x Price	0.018**	1.98[b]
Age (Ranked [18 -25])	-	-
Age [26 -35] x Price	-0.004	0.94
Age [46 -55] x Price	-0.0114	1.56
Household Income (below average)	-	-
Household Income (average) x Price	-0.0016	0.27
Household Income (above average) x Price	-0.009	1.27
Household Income (other) x Price	-0.0037	0.52
Travel behavior Characteristics [Continuous > 1-3 days /month]	-	-
Car as driver x Price	0.008**	1.9[a]
Car as passenger x Price	-0.0155***	3.7[b]
Car Sharing x Price	0.039***	4.89[b]
Bicycle x Price	0.017***	3.38[b]
Interaction with Distance of Charging Station/ Infrastructure		
No. of Cars in Household (Car == 1)	-	-
Car 2 x Distance	-0.000361**	2.24[b]
EV owners as own Car x Distance	0.000451*	1.8[a]
Non EV owners as Company car x Distance	-0.000615*	1.7[a]

Note: [a] Evaluated at 90% CI (t >1.65), [b] Evaluated at 95% CI (t >1.96)

p value: < 0.01 ***, < 0.05 **, <0.1*‖

Model fit statistics (Model no. 3)	
Sample Size	496
No. of observations	2976
No. of Estimated Parameters	31
LL(start)	-3269
LL(C)	-3259
LL(final)	-1563
Rho-square (0)	0.52
Adj.Rho-square (0)	0.51
Rho-square (C)	0.5204
Adj.Rho-square (C)	0.52
AIC	3188

Segmentation

Willingness to pay for charging facilities
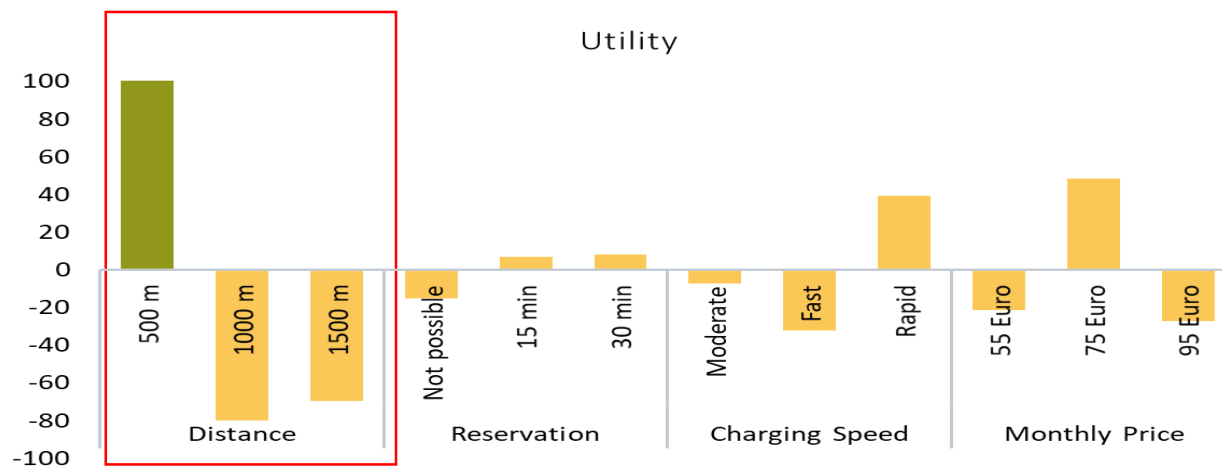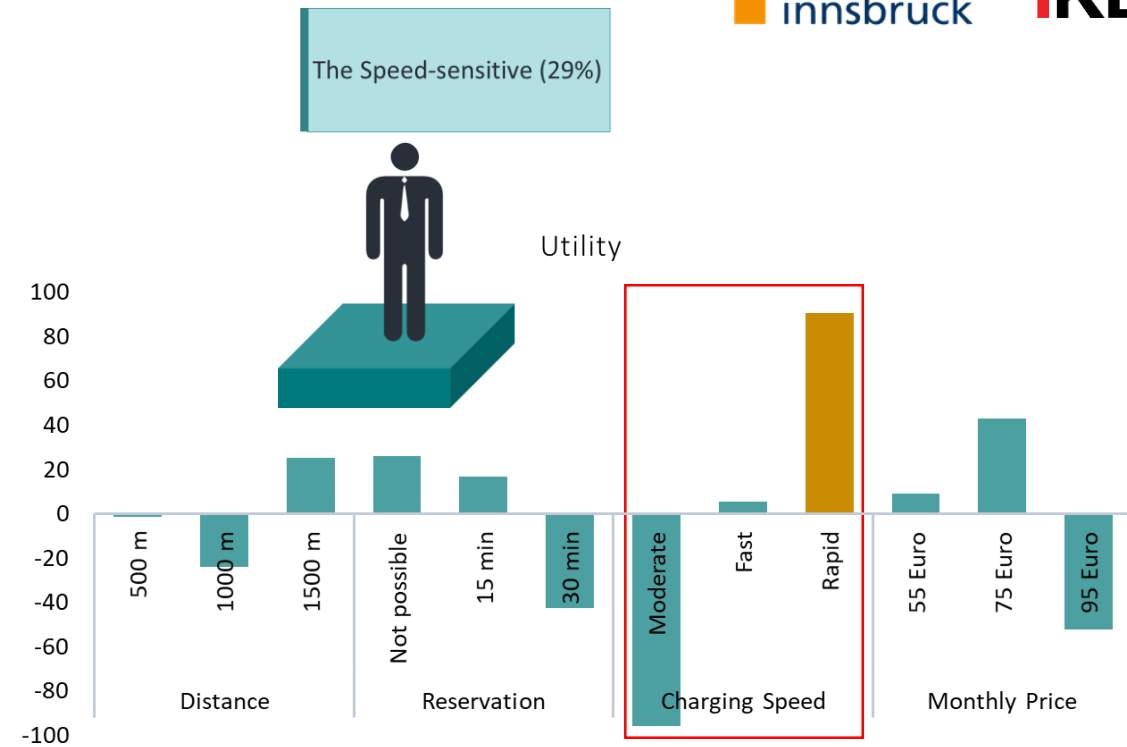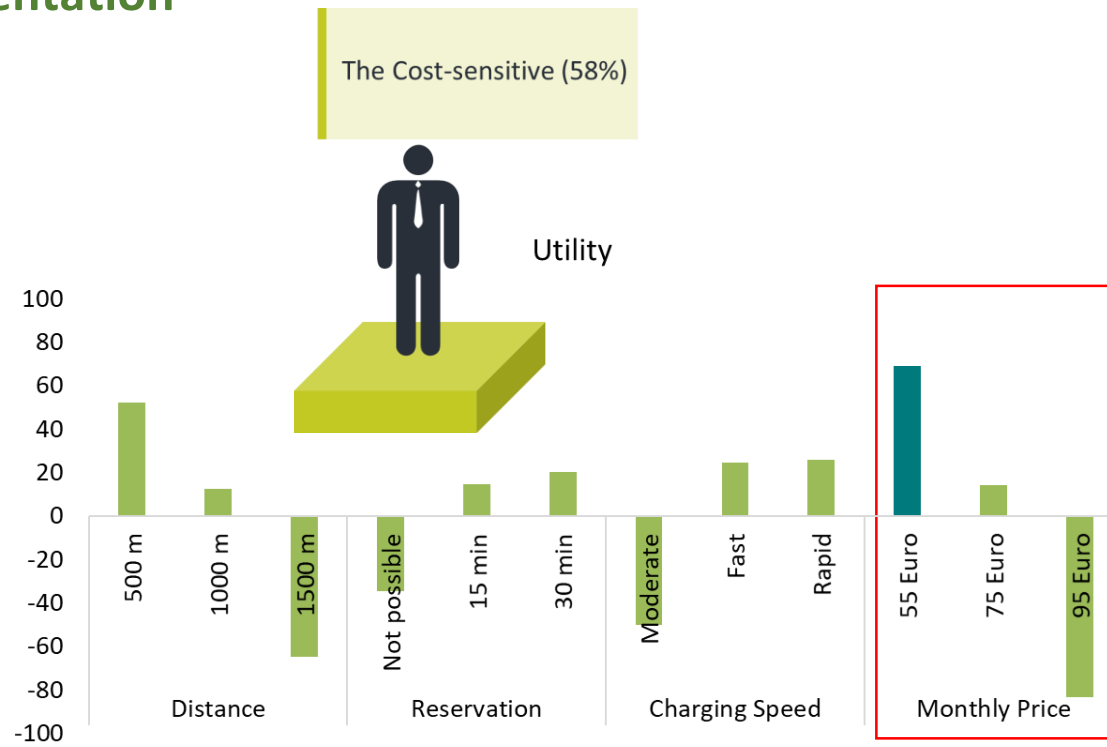
Items	€/min	€/hr.	Robust s.e	Rob t-ratio
WTP= (Beta Charging time/ Beta Cost)-> Slow Charging (11-22KW)	0.05	**2.8**	0.006	7.733***
WTP= (Beta Charging time/ Beta Cost)-> Fast charging (>75KW)	0.07	**4.2**	0.009	7.712***

Willingness to pay for public charging infrastructure (€/hr)

- (Sample) US & Canada: **3.29 €**
- Sample (Germany-Avg): **6.5 €**
- Sample (Innsbruck city-Avg): **3.50 €**

€/hr
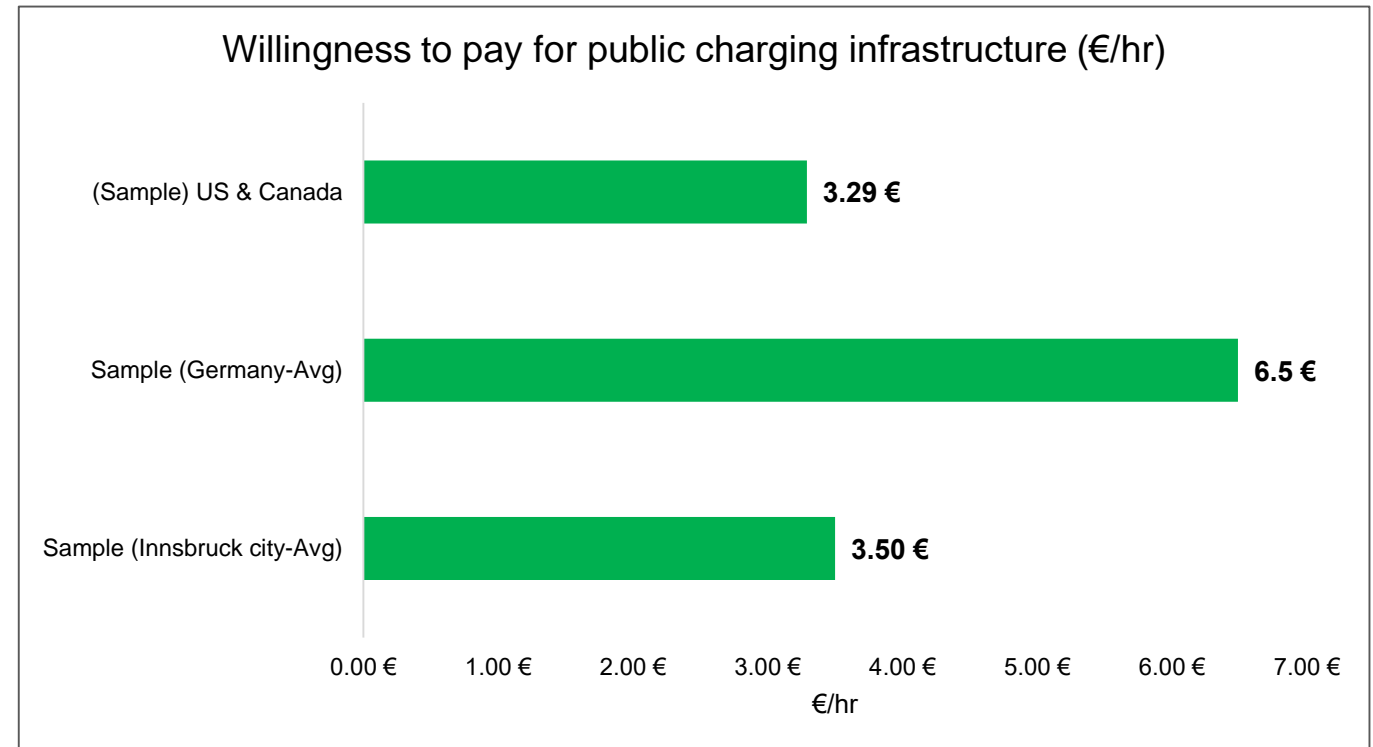
Source: (Plenter et al., 2018) Germany, (Bill LeBlanc, 2020)-US & Canada, (Ensslen et al., 2016) , Germany

- car passengers are more sensitive
+ Shared mode users are less sensitive
+ Additional facilities can increase attractiveness

Efficient Pricing

Reliable coverage
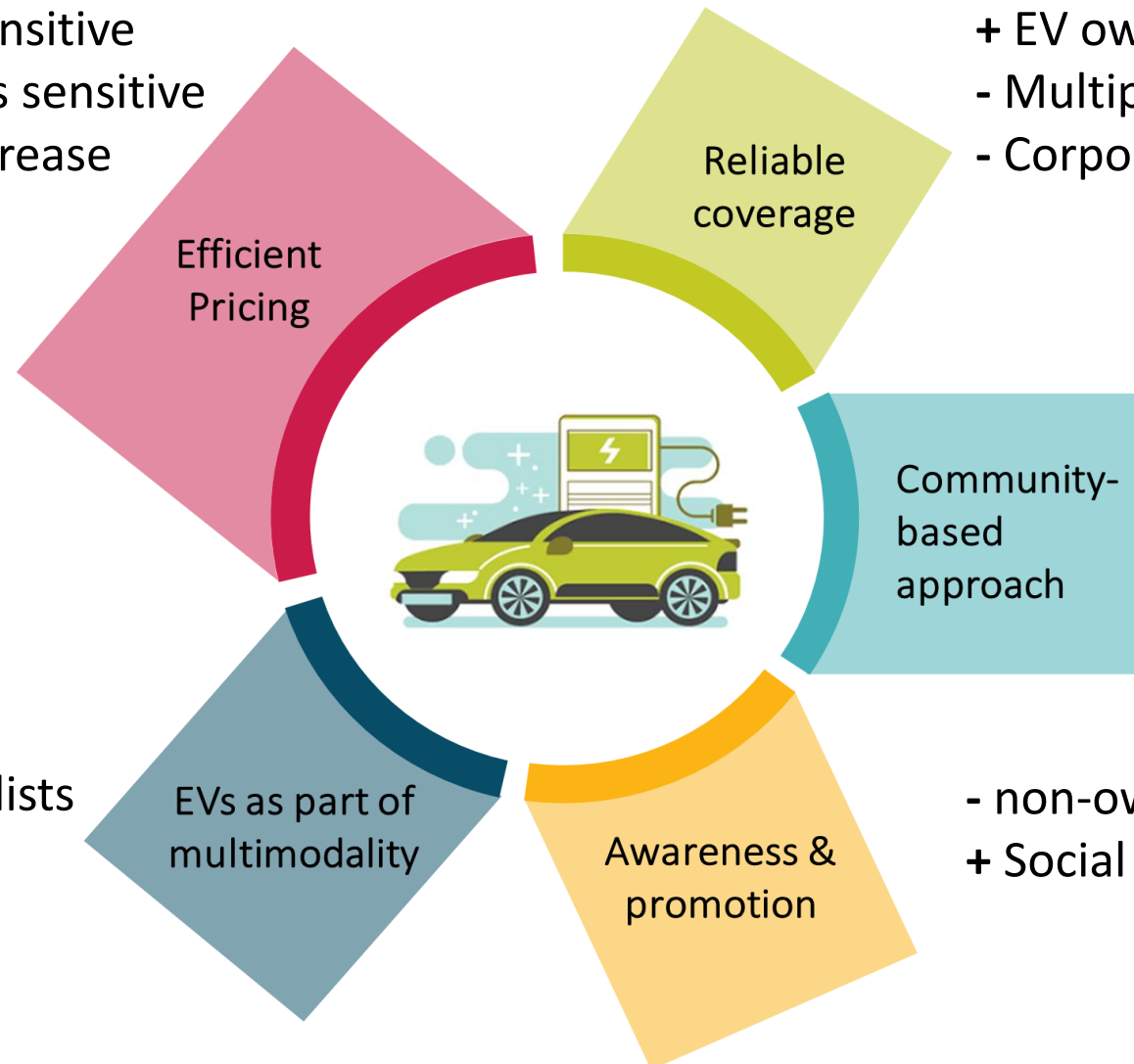
+ EV owners are less distance-sensitive
- Multiple car owners are more sensitive
- Corporate EV users are more sensitive

Community-based approach

• e.g., Smart-Grid (Köstendorf community)

EVs as part of multimodality

Awareness & promotion

+ Shared mode users & cyclists are less price-sensitive

- non-owners perceive higher barriers
+ Social norms influence EV owners

Thank You!

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Email: PeCASO-ivs@uibk.ac.at