TECHNISCHE UNIVERSITÄT CHEMNITZ

# Can I reach this destination? Factors affecting comfortable range in battery electric vehicle (BEV) usage

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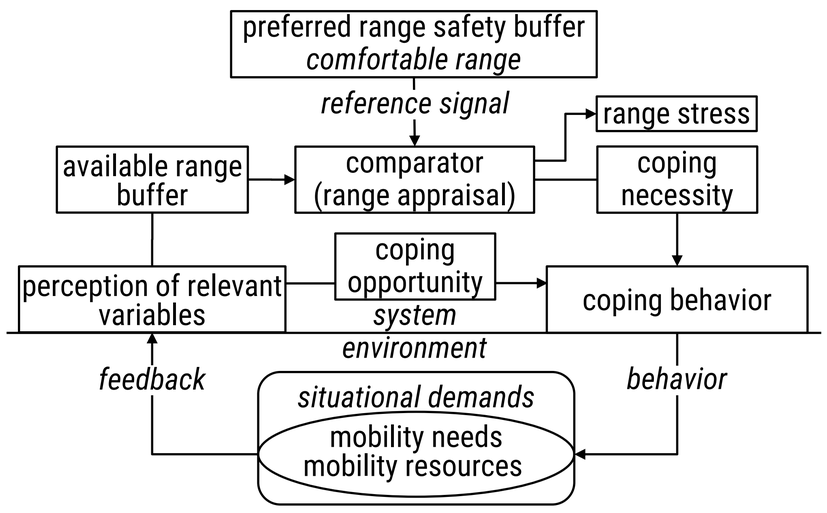
## User-Range Interaction

*Can I reach my destination? Or do I already have to charge?*

- Advancing BEVs: Not only ↗ battery capacity ➔ key design goal ↗ *usable* range
  - Address human factors of range & enable optimal utilization of range
  - Essential for developing sustainable electric mobility systems [1][2]
- Prerequisite: understanding user-range interaction
  - Dealing with BEV range = control task – ACOR model [3][4]




- Individual comfortable range = actual usable range = target for system design
  - Key task: understanding dynamics (variance) in comfortable range

**Research questions:**

**(Q1)** Transfer of resource interaction styles from combustion vehicle to BEV?
**(Q2)** Level of practical experience vs. comfortable range?
**(Q3)** Relevance of comfortable range for BEV acceptance?

## Method

**Field trial setup & BEV**

- BEV field trial focused on user-range interaction [5]
- Data collection before (T0), after 6 weeks (T1), after 12 weeks (T2)
- BMW ActiveE (130-160 km range)

**Participants**

- People applied for three-month lease (370-450€ per month, $N$ = 673 applicants)
- Requirement: mobility profile leading to frequent interaction with range
- $N$ = 74, $M_{age}$ = 43.4 years ($SD$ = 9.3), 16% female, 58% university degree

**Scales and measures**

Comfortable range scenario task - CRST (label: *ComfRange-BEV*) [T0,T1,T2]

- Assesses preferred proportional comfortable range utilization (+ score values = + comfortable range = – range safety buffers)
- Standardized scenario & special response grid to identify threshold value [6]

Comfortable range indicator combustion vehicle (label: *ComfRange-CV*) [T0]

- Minimalistic CRST: standardized scenario & 2 items from CRST = range experience given certain available range buffer, Cronbach's α = .71

General low-range aversiveness CV (label: *LowRangeAverse-CV*) [T0]

- 4 items (e.g. "I always want to have a fuel reserve in the tank."), α = .81

BEV Acceptance (label: *Accept-BEV*) [T2]

- 9-item scale of Van der Laan, Heino, & De Waard, 1997 [7]
- Sub-scales satisfaction (α = 83) & usefulness (α = .78), all items α = .88

## Results

**(Q1) Transfer of resource interaction from combustion vehicle (CV) to BEV**

- ComfRange-CV (T0) vs. ComfRange-BEV (T0,T1,T2):
  - T0-T0: $r$ = .43, $p$ < .001
  - T0-T1: $r$ = .48, $p$ < .001
  - T0-T2: $r$ = .22, $p$ = .042
- LowRangeAverse-CV (T0) vs. ComfRange-BEV (T0,T1,T2):
  - T0-T0: $r$ = .32, $p$ = .004
  - T0-T1: $r$ = .30, $p$ = .006
  - T0-T2: $r$ = .06, $p$ = .304

**(Q2) The role of practical experience for comfortable range**

- Total distance driven with BEV (T1,T2) vs. ComfRange-BEV (T1,T2):
  - T1-T1: $r$ = .33, $p$ = .004
  - T2-T2: $r$ = .34, $p$ = .004

**(Q3) Relevance of comfortable range for BEV acceptance**

- ComfRange-BEV (T2) vs. …
  - … general BEV satisfaction (T2): $r$ = .39, $p$ = .001
  - … general BEV usefulness (T2): $r$ = .33, $p$ = .004
  - … composite BEV acceptance (T2): $r$ = .41, $p$ < .001

## Conclusions

- **(Q1)**: Results indicate considerable **transfer of resource interaction styles**
  - Notable: ComfRange-CV not only accounts for T0-ComfRange-BEV (i.e., drivers without BEV experience)
  - CV comfortable range predicts usable range after first adaptation to BEV (T1)
  - However: weak effect for T2 – further research into adaptation process needed
- **(Q2)**: Higher levels of **practical experience** related to higher comfortable range
  - Adds to body of evidence showing relevance of practical experience [3][6]
  - Comfortable range is not only a function of habits from CV usage
- **(Q3)**: Higher **comfortable range** positively related to general BEV acceptance
  - Remarkable given many other possible predictors of BEV acceptance
- Results in perspective: one step in the agenda of developing a comprehensive understanding of user-range interaction = user interaction with limited resources
  - Contribution to knowledge related to human factors in low-resource systems [8]

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