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Far far away: driving HMI requirements towards the comfortable range in Electric Vehicles

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SEVENTH FRAMEWORK
PROGRAMME

EVs: "How far does it go?"

- EVs are one of the most feasible alternatives to traditional Internal Combustion Engine (ICE), but some concerns for consumers have been identified:

- limited driving range ;
- long charging time;
- high purchase price.

EVs: purchasing attitude

- In particular, from consumers' evaluations it emerges that **EVs' limited driving range might represent the main obstacle to purchase intentions.**

- Nevertheless some recent researches state that people were willing to pay a significant amount to reduce emission and save on gas.

EVs: the comfortable range

- The comfortable range refers to the range that users really utilize.

- This can be defined as the highest trip distance between two charging opportunities or the lowest remaining range status, which a user experiences as comfortable.

- This definition attempts to merge absolute value range buffer decision variables with the broadly defined concept of range anxiety in terms of a "fear of becoming stranded"

The RESOLVE project

- The Resolve - Range of Electric SOlutions for L-category Vehicles project is a three years research project co-funded by the European Commission within the H2020 program, started the 1st May 2015.

- The Resolve consortium is made of 14 partners, including PIAGGIO and KTM that are the two largest LV producers in the EU

The RESOLVE project

RESOLVE project aims at:

- enabling the development of a range of **cost-effective,
  energy efficient** and **comfortable** ELVs;
- making advancements to the **handling** and **stability** of ELVs together with **improving the user interface** that will assuage range anxiety and other driver concerns, such as **safety** and **comfort**.

EV customer identification

Being younger or middleage	Likely to buy a hybrid gasoline vehicle on their next purchase
Having a BA or higher degree	Having a place they could install an EV electrical outlet at home
Expecting higher gasoline prices in the next 5 years	Likely to buy a small or medium-sized passenger car on next purchase
Having made a shopping or lifestyle change to help the environment in the last 5 years	Having a tendency to buy new products that come on to the market
Taking at least one drive per month longer than 100 miles	

* Hidrue, M. K., Parsons, G. R., Kempton, W., & Gardner, M. P. (2011)

RESOLVE project – The survey

Designing the HMI for EVs, the **questions** that designers try to answer to are:

1. What relevant parameters should be displayed in an EV?

2. How should the driver be informed about these important parameters?

RESOLVE project – The survey

- In order to identify the **main HMI requirements for EVs** in general, **a survey for domain experts was set up**

- Experts belongs to the **ergonomics, human factors and engineering domains**, since final users may not have an in-depth knowledge of the whole range of in-vehicle HMI functions for the automotive domain generally, and for the EVs domain specifically

RESOLVE project – The survey

The survey encompassed three different sections:

A. Sample profile
B. Functions for Evs
C. Interaction modalities

RESOLVE project – The survey

- 74 experts

- mainly 25-34 years aged (52.7%)

- male (82,4%)

- with a master degree (68,5%)

7 questions were provided to evaluate **which kind of HMI functions should be available on an EV**:

	Disagree	Agree	No opinion
Available range estimation to reduce "range anxiety"	0%	99%	1%
Energy used (spent/recovered)	10%	89%	1%
Suggestions on how to improve driving style in terms of energy consumption (e.g. improving regenerative braking)	12%	86%	1%
Suggestions on how to improve driving style in terms of safe riding	49%	46%	6%
Availability of charging infrastructures in the surroundings	0%	96%	4%
In-deep data about vehicle and driving status (e.g. consumption based on routing, diagnostics)	21%	78%	1%
In-deep data about route (e.g. navigation, traffic)	10%	90%	0%
Other (please specify in next row)	8%	41%	51%

RESOLVE project – The survey

5 questions were provided to evaluate **which kind of HMI interaction modality is most suitable for an EV**:

	Disagree	Agree	No opinion
All information to be provided through On-board system	18%	82%	0%
Additional data to be provided through mobile device (e.g. app for energy consumption trends)	28%	72%	0%
Driving data to be communicated using visual and auditory channels	25%	72%	3%
Critical information to be highlighted through haptic/tactile channels (e.g. for safety)	8%	84%	8%
Interface should be configurable to cope with different users needs (e.g. bigger size fonts for elderly users)	6%	94%	0%

RESOLVE project – User needs

Basing on the evidences of the survey, **it is possible to classify the HMI functions into 6 categories** and related subcategories:

- *Range*
  - Consumptions
  - Range
  - Energy used

- *Driving style*
  - Suggestions on how to improve driving style in terms of energy consumption
  - Eco-info

- *Recharge*
  - Availability of charging infrastructures in the surroundings
  - Instructions for recharging
  - Status of battery – Battery health status
  - Remaining charging time

RESOLVE project – User needs

- *Route*
  - Navigation
  - Traffic
  - Weather information

- *Vehicle info*
  - Diagnostics
  - Suggestions on how to improve driving style in terms of safe riding
  - Consumption based on routing
  - Data download for offline analysis of actual performance compared to prediction

- *Personal settings*
  - Functions customization
  - Vehicle customization
  - Info displaying customization

RESOLVE project – Final considerations

What comes into evidence is the importance of **delivering to the users the information about the factors that increase the efficiency of EV range use,** in order to cope with the accompanying stressfulness of such range utilizations.

RESOLVE project – Final considerations

HMI has to provide suitable means to cope with range anxiety by:

– adopting fallback options in terms of recharging opportunities

– increasing user awareness of his/her driving style

– incorporating information related to confidence in displayed remaining range estimations

– adding navigational references

RESOLVE project – Final considerations

Future works within RESOLVE project will encompass the exploration of different HMI architectures in order to **maximise the ease of use**, **intuitiveness**, and **ad-hoc controls** that will enable the driver to have **better, safer and more effective interactions with the ELV.**

Thank you for your attention!