Validators, Demonstrators, Facilitators –
The Roles of eHighway Field Tests on the Way to Large-scale Implementation.
ERS – Electric Road Systems 2019, Frankfurt am Main
Manfred Boltze, Technische Universität Darmstadt
Technology Readiness Levels –
General Concept and Status of the eHighway

**TRL 1** – basic principles observed

**TRL 2** – technology concept formulated

**TRL 3** – experimental proof of concept

**TRL 4** – technology validated in lab

**TRL 5** – technology validated in relevant environment (test under lab conditions; start of system integration)

**TRL 6** – technology demonstrated in relevant environment (test under realistic conditions)

**TRL 7** – system prototype demonstration in operational environment (1-5 years)

**TRL 8** – system complete and qualified

**TRL 9** – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies)

Field Tests as Validators and Demonstrators

Testing Under Real Traffic and Real Road Operations

Real traffic and traffic composition
Real road operations
Real environmental conditions
Real incidents
Real constructional conditions …

ELISA: Sample Research Questions
- What are the impacts of the eHighway system on driving behaviour?
- Are there any problems regarding the visibility of traffic signs?
- Are there complications in cleaning traffic signs and cutting the green?
- Are there any impacts on traffic safety?
# Field Tests as Validators and Demonstrators

## Testing with Real Transport Companies and Real Transport Processes

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>ELISA Transport Partner</th>
<th>Vehicle Delivery (Year/Month)</th>
<th>Transported Goods</th>
<th>No. of vehicles in Rhein-Main</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Spedition Hans Adam Schanz GmbH &amp; Co. KG</td>
<td>2019/04</td>
<td>emulsion paint and other Caparol products</td>
<td>9</td>
</tr>
<tr>
<td>02</td>
<td>Ludwig Meyer GmbH &amp; Co. KG</td>
<td>2019/07</td>
<td>consumer goods esp. refrigerated food</td>
<td>80</td>
</tr>
<tr>
<td>03</td>
<td>Contargo GmbH &amp; Co. KG (Rhenus Trucking GmbH &amp; Co. KG)</td>
<td>2020/02</td>
<td>containers</td>
<td>&gt; 1,000</td>
</tr>
<tr>
<td>04</td>
<td>Knauf Gips KG</td>
<td>2020/02</td>
<td>construction materials</td>
<td>40</td>
</tr>
<tr>
<td>05</td>
<td>Merck KGaA</td>
<td>2020/06</td>
<td>liquid sludge</td>
<td>6</td>
</tr>
</tbody>
</table>

**ELISA: Sample Research Questions**

- What are the specific requirements of different types of transport companies on using the eHighway system?
- How can transport companies integrate the eHighway trucks into their daily tours?
- How robust is the eHighway technology under frequent use?
Field Tests as Validators and Demonstrators

Testing with a Real Electric Power System

Real integration into the power grid
Real consumption and recuperation of energy
Real accounting and clearing

ELISA: Sample Research Questions
- How can the eHighway system be integrated into the overall power grid?
- Which impact has a larger number of eHighway trucks on the power supply network?
- How to design the accounting and clearing system for electric energy?
Field Tests as Validators and Demonstrators

Testing Acceptance with Real People

Analyzing acceptance by different stakeholders
Identifying (critical) influencing factors
Analyzing changes of acceptance over time

Relevant stakeholder groups:
- transport companies
- eHighway truck drivers and other truck drivers
- other road users and the general public
- road operators and electricity suppliers
- emergency and rescue service operators
- …

**Forms of Acceptance** (Schweizer-Ries et al. 2008)

- **Endorsement**
- **Support**
- **Rejection**
- **Resistance**

ELISA: Sample Research Questions
- How are different stakeholder groups perceiving the eHighway system?
- Which factors are influencing the acceptance rate?
- How are the acceptance rates changing over time?
Field Tests as Facilitators

Developing Sub-systems

Further development of eHighway vehicles and infrastructure

Development and specification of many processes and procedures to deal with practical aspects of system implementation and operation

ELISA: Sample Sub-System Developments

- Planning, approval and tendering process for the eHighway infrastructure
- Processes for emergency and rescue services
- Software and processes for control center operations
- Specific aspects of formal vehicle registration
Field Tests as Facilitators
Creating Awareness and Acceptance

Supporting the visibility of the system
Create possibilities to see, “feel” and test the system
Clear communication about the reasons for the project
Careful public relations management

ELISA: Sample Activities to Create Awareness and Acceptance
- Information booths and visitor centre at the test track
- Project website, information and marketing materials
- Press conferences, interviews for press and other media
- Targeted stakeholder communication
Field Tests as Facilitators
Disseminating Results

Presentations and publications
Placing the topic in journals and conferences (as editor or organizer)
Contributing to working groups for standardization
National + international exchange
Teaching

ELISA: Sample Activities for Disseminating Results
- Conference presentations: ERS, Hypermotion, DSVK, CIGOS, TRB, ICPLT, ...
- Publications: Book „eHighway Implementation Manual“, various journal articles
- Development of implementation guidelines for specific stakeholder groups
- Bringing the topic into working groups for national standardization (FGSV etc.)
Field Tests as Facilitators

Identifying Needs for System Amendments and Further Potential Users

Analyzing real use cases and user requirements
Identifying needs for system amendments
Identifying further potential users

ELISA: Sample Activities for Identifying Needs for System Amendments
- Questionnaire for Transport Companies on Vehicle Requirements
- Identifying demand for other vehicle types (e.g. 16 t trucks)
- Identifying useful truck equipments (dumper hydraulics, PTO for cooling, …)
- Feasibility Study of eHighway Buses
Field Tests as Facilitators

Providing a Nucleus for Large-scale Implementation

Supporting the development of large-scale implementation strategies

Developing a plan for using the test track after the testing period

Developing a plan for local system expansion

ELISA: Sample Activities for Providing a Nucleus for Large-scale Implementation

- Tool for assessing the eHighway equipment potential of road sections (BeTSIE)
- Optimal allocation of charge-in-motion infrastructure for trucks on German motorways (dissertation Kevin Rolko)
- Planning extension and follow-up use of the test track (e.g. Airliner)
The Roles of eHighway Field Tests

**Validator and Demonstrator**

Testing in a realistic environment:
- Real traffic and road operations
- Real transport companies and transport processes
- Real power supply system
- Real people (Acceptance)

**Facilitator**

Developing sub-systems
Creating awareness and acceptance
Disseminating results
Identifying needs for system amendments and further potential users
Providing a nucleus for large-scale implementation
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Thank you!