A mixed-methods approach to derive vehicle concepts for urban mobility

Gerhard Kopp, Institute of Vehicle Concepts, DLR, Germany
Matthias Klötzke, Institute of Vehicle Concepts, DLR, Germany
Laura Gebhardt, Institute of Transport Research, DLR, Germany
Horst E. Friedrich, Institute of Vehicle Concepts, DLR, Germany
Analyze of the proportion of vehicle classes according to population density*

*Proportion of vehicle classes in new registrations for M1 vehicles in Germany 2016 according to population density
(Source: Own description according to approval data; M. Klötzke)

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Research question

- Why are these vehicles used?
Research question

- Why are these vehicles used?
- Which requirements must vehicles fulfil in urban areas?
Research question

- Why are these vehicles used?
- Which requirements must vehicles fulfil in urban areas?
- How can a mixed-methods approach be used to derivate vehicle concepts for urban mobility from the user's point of view?
Methodological approach

1. Stakeholder analysis
   - User analysis, derivation of functional and non-functional requirements

2. User analysis, derivation of functional and non-functional requirements

3. Vehicle- and technology analysis

4. Development of user types / user groups

5. Product structure, parameters

6. Focus group discussions

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(Functional) Requirements

Vehicle analysis and parameters

(2)

Vehicle Parameters

Total vehicle parameters

Vehicle Concept

Admission / Legislation

- Construction / Body
- Interior
- Exterior
- Powertrain
- Storage
- Chassis
- Electric / Electronic

Transport tasc

9
Environmental sustainability

"Living sprace / workspace"

7

Reliability, quality, "robustness"

Experience mobility, driving pleasure

example values

Safety

Comfort

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## User types / Focus groups (4, 6)

<table>
<thead>
<tr>
<th>User Group</th>
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</table>
| Requirement | **Dimensions:** Small / Adaptable  
**Capacity:** 2 - 6 persons  
**Parking Space:** Solution: Sharing | **Dimensions:** Adaptable  
**Capacity:** 1 - 2 persons + luggage space or add. persons  
**Parking Space:** Small | **Dimensions:** Very small  
**Capacity:** 1 - 2 persons  
**Parking Space:** Very small | **Dimensions:** Adaptable  
**Capacity:** 1 – x persons  
**Parking Space:** Solution: Sharing |

### Diagrams
- Transport taxic (4, 6)
- Environmental sustainability
- Safety
- Comfort
- "Living space / workspace"
- Reliability, quality, "trustworthiness"
- Experience mobility, driving pleasure
- Noise, Pro-Bik
- Green foot-print
- Care, Sustainable
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<td><img src="image4" alt="Image" /></td>
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<tr>
<td>Concept idea from focus group 2</td>
<td><img src="image5" alt="Image" /></td>
<td><img src="image6" alt="Image" /></td>
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Methodological approach

1. Stakeholder analysis
   - 2. User analysis, derivation of functional and non-functional requirements
   - 3. Vehicle- and technology analysis
   - 4. Development of user types / user groups
   - 5. Product structure, parameters
   - 6. Focus group discussions
   - 7. Conceptual derivation based on Quality Function Deployment (QFD)
   - 8. Detailed vehicle concepts and derivation of "product families" for different user groups
QFD and vehicle concepts (7, 8)

Quantifiable criteria and requirements from user, infrastructure, regulation, operation ...

- Length, width, height
- Range
- Interior layout (seats, trunk)
- Acceleration, Driving dynamics
- Doors and flaps
- Wheels, Turning circle
- Payload
- Legal requirements
QFD and vehicle concepts (7, 8)

Quantifiable criteria and requirements from user, infrastructure, regulation, operation …
QFD and vehicle concepts (7, 8)

- The young inter-modal: example of possible vehicle concept
  
- The (all-purpose) car users: example of possible vehicle concept

- The multi-modal: example of possible vehicle concept

Picture source: DLR, Institute of vehicle concepts
The young inter-modal: example of possible vehicle concept

- Hop-on – hop-off variant
- First concept description (SAE Lev. 5)

Battery electric vehicle (app. 150 km range)

2 seats in front; entry from the front

2 wheel hub engines (app. 2*15 kW)

Max. 4 standing places or seats; entry from the rear

Barrier-free entrance

By-wire front steering system

Max. length 2,5 m; parking crosswise
Transfer of the approach to concepts for public transport

- User types
  - Senior citizens
  - Mobility-restricted people
  - Regular bus users
  - Regular private car users

- Concept ideas from the groups
Transfer of the approach to concepts for public transport

- User types
  - Senior citizens
  - Mobility-restricted people
  - Regular bus users
  - Regular private car users

- Examples of possible vehicle concept
  - Max. 12 seats
  - Barrier-free entrance
  - Battery electric vehicle
  - SAE Lev. 5
  - ...
Transfer of the approach to concepts for public transport

- **Vehicle Concept**

  - **Topic vehicle architecture**
    - V1
    - V2
    - Vn

  - **Topic body**

  - **Topic interieur / exterieur**

  - **Topic Powertrain / Chassis**

  - Masse Batterie
  - Volumen Batterie

Source: DLR, Institute of vehicle concepts and HS Esslingen
Conclusion and outlook

- A systematic approach was presented about how future vehicle concepts for urban mobility can be derived in conjunction with a wide range of requirements and influencing factors.
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- This approach is characterised in particular by the strong involvement of the user with the help of the persona method and the use of the QFD approach for the derivation of new vehicle concept.
Conclusion and outlook

- A systematic approach was presented about how future vehicle concepts for urban mobility can be derived in conjunction with a wide range of requirements and influencing factors.
- This approach is characterised in particular by the strong involvement of the user with the help of the persona method and the use of the QFD approach for the derivation of new vehicle concept.
- By utilising the application of the methodology in the area of private car use and the derivation of demand-oriented bus concepts, a systematic addition to the product development process could be presented.
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) - Institut für Fahrzeugkonzepte
Abteilung Fahrzeugarchitekturen und Leichtbaukonzepte
Pfaffenwaldring 38-40, 70569 Stuttgart, Germany

Dr.-Ing. Gerhard Kopp
Gruppenleiter Leichtbaukonzepte und Methoden Straßenfahrzeuge
Phone 0711 6862-8307, gerhard.kopp@dlr.de, www.DLR.de