Autonomous Driving – Transport, Accessibility & Land Use
(1) Introduction / Initial situation: Transport, Accessibility & Land Use – Interaction

(2) Problem definition: Autonomous Driving within the Interaction of Land Use and Transport

(3) Transport and Spatial Impacts
(1) Introduction / Initial situation:
Transport, Accessibility & Land Use – Interaction
Introduction / Initial situation I

- Urban and settlement development closely linked to transport and the development of new technological innovations in mobility ever since

Source: Kagermeier 1997: 25; Lehner 1964: 22f
Introduction / Initial situation II

Source: Bloomberg Philanthropies 2017: 74; Shiomo Angel et al. 2012
Interaction of Land Use and Transport

Transport supply → Accessibility → Land Use

fast → fast

Source: Wulfhorst 2003: 16; Wegener & Fürst 1999: 5f
Accessibility is influenced by Land Use and...
.... density, mixture, location, attractiveness, etc.
.... by the transport supply.
.....time, costs, comfort etc.
Interaction of Land Use and Transport

Transport supply → Accessibility → Land Use

fast → slow → fast

long-term decisions (location choice, purchase of a vehicle etc.)

Source: Wulfhorst 2003: 16; Wegener & Fürst 1999: 5f
“Those who love the countryside could not get away from it. At least not with the bus.”
Interaction of Land Use and Transport

Transport supply → fast → Accessibility → slow → Land Use

Transport demand ← fast ← Activities ← fast ← Accessibility

Source: Wulfhorst 2003: 16; Wegener & Fürst 1999: 5f
Accessibility as a requirement for activities.
Interaction of Land Use and Transport

Transport supply → Accessibility → Land Use

Transport demand ← Activities ← Land Use

slow ← fast ← fast

slow → fast → slow

long-term decisions (location choice, purchase of a vehicle etc.)

everyday behaviour (activities, means of transport, distances etc.)

Source: Wulfhorst 2003: 16; Wegener & Fürst 1999: 5f
Transport demand and transport supply are interdependent.
Interaction of Land Use and Transport

Transport supply \[\rightarrow\] Accessibility \[\rightarrow\] Land Use

Transport demand \[\leftarrow\] Activities \[\leftarrow\] Land Use

slow \[\uparrow\] fast \[\downarrow\] fast \[\downarrow\] fast \[\downarrow\] fast
slow \[\downarrow\] fast

Source: Wulfhorst 2003: 16; Wegener & Fürst 1999: 5f

long-term decisions (location choice, purchase of a vehicle etc.)
everyday behaviour (activities, means of transport, distances etc.)
(2) Problem definition:
Autonomous Driving within the Interaction of Land Use and Transport
Problem definition

• Automated / autonomous Driving (AV) as a new technological innovation in mobility

• Different transport supply with changes in Transport demand (Alessandrini 2015: 148; Friedrich & Hartl 2016: 7, European Commission 2016: 1)
Automated / Autonomous Driving (AV)

Transport supply \(\xrightarrow{\text{fast}}\) Accessibility \(\xrightarrow{\text{fast}}\) Land Use

Transport demand \(\xrightarrow{\text{fast}}\) Activities \(\xrightarrow{\text{fast}}\) Accessibility

Accessibility \(\xleftarrow{\text{fast}}\) Land Use \(\xleftarrow{\text{fast}}\) Transport demand

long-term decisions (location choice, purchase of a vehicle etc.)
everyday behaviour (activities, means of transport, distances etc.)

Source: Wulfhorst 2003: 16; Wegener & Fürst 1999: 5f
Changes of the Transport Supply

- Pod Car
- Autonomous Shuttle
- Autonomous Bus
- Autonomous Taxi
- Autonomous Shared Taxi
- Private Autonomous Vehicle

- Regarding:
  - Comfort
  - Time (e.g. driving time, time for accessing and egressing the vehicle)
  - Reliability

- Costs / operating costs €
- Safety

dependent on the different Use Cases AV
## Examples

<table>
<thead>
<tr>
<th></th>
<th>Pod Car</th>
<th>Autonomous Shuttle</th>
<th>Autonomous Bus</th>
<th>Autonomous Taxi</th>
<th>Autonomous Shared Taxi</th>
<th>Private Autonomous Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>reduction of the time for accessing and egressing the vehicle(^1)</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>++</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>increase in comfort due to permitting other activities during driving(^2)</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>++</td>
</tr>
</tbody>
</table>

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- low relevance
- medium relevance
+ medium to high relevance
++ high relevance

\(^1\)(Heinrichs 2015: 229)
\(^2\)(Friedrich & Hartl 2016: 7)
Impacts within the Interaction of Land Use and Transport I

• Change of Accessibility and Transport demand:

  • Fast: impacts on everyday mobility: activities, number of journeys, length of journeys, choice of means of transport (and decision of purchasing a vehicle)

  • Slow: possible impacts on the location choice of households, firms and public institutions and hence the settlement structure
Impacts within the Interaction of Land Use and Transport II

• Moreover influence of:
  • Individual characteristics and needs of persons, households and firms like e.g. household formation, generation of property etc.
  • Area attractiveness and Land availability / supply of dwellings
  • Politics (e.g. Mobility politics, Spatial politics)
  • Accompanying technological developments (Bertolini 2012: 20)
Impacts within the Interaction of Land Use and Transport III

• Simultaneously, impacts of a potential conversion of parking spaces due to AV on the availability of land and the construction activity of investors and therefore the supply (and prices) of dwellings (Moreno 2017: 5)
(3) Transport and Spatial Impacts
Transport and Spatial Impacts - Research

- Current international discourse on AV focusses mainly on the field of technology

- Transport and spatial impacts are hardly part of studies (Gertz & Dörnemann 2016: 6; Milakis et al. 2017: 40)

- Existing investigations by simulations on the basis of different scenarios or assumptions regarding the composition of the transport supply (Truong et al. 2017: 2)
## Transport Impacts

(Several...)

<table>
<thead>
<tr>
<th>Settlement structure/type</th>
<th>rather monocentric, compact</th>
<th>rather disperse</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Share of Ridesharing</strong></td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td><strong>Vehicle miles/kilometers travelled</strong></td>
<td>-11% - +44%</td>
<td>+11% - +60%</td>
</tr>
<tr>
<td><strong>Number of vehicles to process the current transport demand</strong></td>
<td>-83% - -66%</td>
<td>-</td>
</tr>
<tr>
<td><strong>Increase in road capacity</strong></td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td><strong>Vehicles miles/kilometers travelled</strong></td>
<td>-</td>
<td>+2% - +4%</td>
</tr>
<tr>
<td><strong>Reduction of the value of time</strong></td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td><strong>Vehicles miles/kilometers travelled</strong></td>
<td>-</td>
<td>+13%</td>
</tr>
</tbody>
</table>

Thereby also reduction of needed parking spaces

ITF 2015; Friedrich & Hartl 2016; Fagnant & Kockelmann 2014; Spieser et al. 2014; Bischoff & Maciejewski 2016; Gucwa 2014; Burns et al. 2013; Childress et al. 2015; Zhang et al. 2015; Boesch et al. 2016; Hörl et al. 2016; Rigole 2014; Llorca 2017
# Spatial Impacts
(few, not transferable...)

<table>
<thead>
<tr>
<th>Share of Ridesharing</th>
<th>Seoul, KOR</th>
<th>Melbourne, AUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>low</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Reduction of the value of time</td>
<td>-</td>
<td>high</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spatial / Settlement development / (spatial) Population development</th>
<th>Seoul, KOR</th>
<th>Melbourne, AUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>considerable dispersed settlement development</td>
<td>-</td>
<td>Increase in areas near to the city centre</td>
</tr>
<tr>
<td>High increase in areas far away from the city centre</td>
<td>-</td>
<td>High decrease in areas far away from the city centre</td>
</tr>
<tr>
<td>High decrease in areas near to the city centre</td>
<td>-</td>
<td>High decrease in areas far away from the city centre</td>
</tr>
</tbody>
</table>

Kim et al. 2015; Thakur et al. 2016
Transport and Spatial Impacts

- Impacts dependent on:
  - Share of ridesharing and maximum waiting time of users
  - Changes in the value of time
  - Increase in road capacity
  - Penetration rate of AV
  - Settlement structure
Transport and Spatial Impacts - Conclusion

- Transport impacts: first investigations in the US, Europe and Asia

- Spatial impacts: only few studies, so far only in South Korea and Australia

- Modelling of possible spatial impacts / impacts on the settlement structure in the context of European cities not conducted so far

- Different results make clear, that impacts are also dependent on the existing spatial / settlement structure
Discussion

• Which use cases for autonomous driving could complement or replace the existing transport supply in different spatial structures?

• How or in what form and for whom does the accessibility change through different use cases? Where do the impacts set in?

• Are changes in settlement structures expected to occur in the long-term, or have other factors a much larger impact? In which form are these conceivable?