Autonomous Vehicles

Seminar on Digitalisation and the Rebound Effect

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28.11.2019

Current Road Usage

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- One billion vehicles

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- Driven by one person
- Designed for a broad use

Some Numbers

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- Polluting
- Inefficient
- Dangerous toward users
- Dangerous toward bystanders

Outline

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Definition[1]: An autonomous vehicle (AV) is a vehicle that is capable of sensing its environment and safely moving through it with no human input.

[1] Definition based on my understanding of the domain

Levels of Autonomy[2]

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- Level 0: No Assistance

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Levels of Autonomy[2]

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- Level 0: No Assistance
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- Level 3: Eyes Off

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- Level 5: Steering Wheel Optional

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Example of Level 2 Automation

Figure 1: Tesla Autopilot

Example of Level 4 Automation

Figure 2: Autonomous mini bus in Zug

Available Technology (1)[3]

[3] Lawrence D. Burns. A vision of our transport future, Nature 497, pp. 181-182, 2013

Available Technology (1)[3]

- Connected Vehicles
  - GPS + IoT
  - OnStar, Android Auto, CarPlay

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- Coordinated Vehicles
    - IoT communication
    - Routing apps (Waze, Google Maps)
    - Parking apps (ParkingPay, EasyPark, Parknow)

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- Driverless Vehicles
  - Waymo
  - Mobility

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- Electric Vehicles
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- Tailored Vehicles
  - Current vehicles are over-specified and under-utilized
  - More efficient due to beign lighter
  - Longer distances on smaller batteries

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Legal Landscape[4]

[4] Federal Roads Office FEDRO (2019), *Rechtliche Situation*

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- Driver not exempted of their obligations and responsibilities

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Regulations and Guidelines

World Forum for Harmonization of Vehicle Regulation has released a Framework Document[5] to guide the work in AV.

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- Functional requirements of automated/autonomous vehicles
- New assessment and test method
- Cybersecurity and software updates
- Data storage system and event data recorder

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Case Study: Mobility Preferences in the Future[6]

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Case Study: Mobility Preferences in the Future - Results

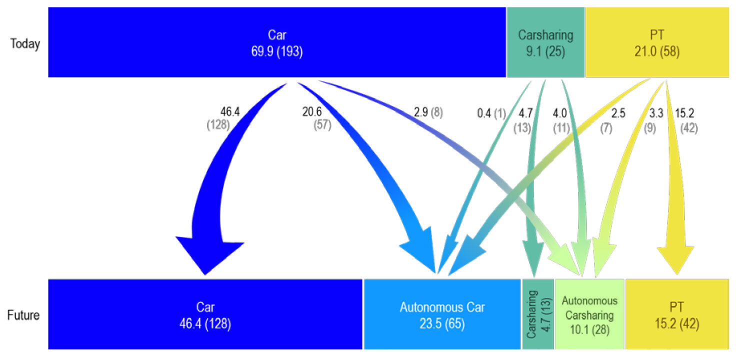

Figure 3: Preference migration results

Case Study: Mobility Preferences in the Future - Conclusion

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- Public Transport must improve in order to remain competitive against carsharing

Case Study: Simulation of City-Wide Autonomous Vehicle Network Deployement[7]

[7] Joschka Bischoff and Michal Maciewski. Simulation of City-wide Replacement of Private Cars with Autonomous Taxis in Berlin, Procedia Computer Science, 83, pp. 237–244, 2016

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- Goal: find optimal fleet size to provide high quality service

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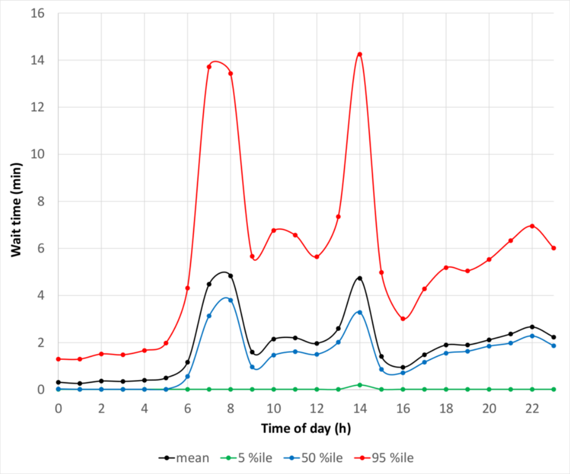

Figure 4: Passenger wait times for each hour

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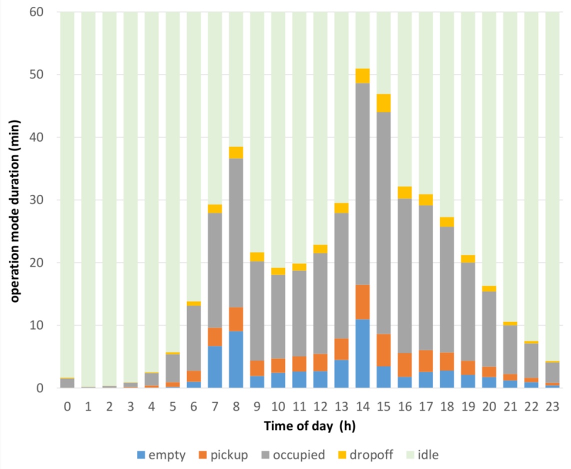

Figure 5: Average operation mode split for each hour

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- Fleet size determined by peak hours
- Drive time increases by 17% due to empty runs

Case Study: Autonomous Taxis could greatly reduce GHG emissions[8]

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Positive vs. Rebound Effect[9]

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Positive vs. Rebound Effect[9]

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- Public transport popularity decrease

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Outline

State of the Art

Remaining Work

Rebound Effects

Conclusion

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- Building blocks are available for AV networks

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- Total impact depends on adoption rate

Discussion

Thanks for listening! Do you have any questions?

Case Study: Estimating Potential Increase in Travel with Autonomous Vehicles[10]

- Studies potential increase in total vehicle distance travelled
- Increase due to senior citizens, non-drivers, and users with prohibiting medical conditions.
- Estimated 14% increase in total distance driven, due to increase in mobility of non-driving demographic

[10] Corey D. Harper, Chris T. Hendrickson, Sonia Mangones and Constantine Samaras. Estimating potential increases in travel with autonomous vehicles for the non-driving, elderly and people with travel-restrictive medical conditions, Transportation Research Part C: Emerging Technologies, 72 (1), pp. 1-9, 2016