Impact assessment of autonomous Demand Responsive transport (DRT) systems

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Motivation

- Developments in AV technology may sooner or later lead to new taxi-like services using Shared Autonomous Vehicles

- But what’s the impact on smaller cities?
  - City of Cottbus as an example

- City of 100,000 inhabitants in Southern Brandenburg
  - Roughly 100km SE of Berlin

- Germany’s smallest metropolitan area, 80th biggest city by population size
Transport in Cottbus

- Public transport network consists of
  - 5 tram lines
  - 11 bus lines
- Headways of 20-30 minutes during weekdays, with reduced frequency during nighttimes and on weekends
- Modal share of public transport is rather low
- Roughly 30,000 trips per day
- Most distances can easily covered by bike and walk
- City does not suffer from congestion
Methodology: MATSim

- MATSim allows the simulation of agents along their daily activity chains
- Open source, written in JAVA and well-documented
- Multiple iterations with behavioral changes in between allow agents to maximize their utility
- Dynamic modes, such as (shared) taxis directly operate within the traffic simulation runtime
Simulation experiments

- Based on an existing multi-modal MATSim model for Cottbus
- Reference year 2010

- Three different experiments:
  1. **Base Case:**
     - Uses current public transport Schedule
  2. **Door to Door Scheme**
     - DRT vehicles pick up and drop off passengers at their activity locations
  3. **Stop based service**
     - Passengers need to walk to and from designated stops
     - 400 Stops clustered using k-means approach

- Eight seat vehicles, No pre-bookings of vehicles, maximum detour of 1.5x direct trip, less than 1% of trips should be rejected
Results: Fleet size

• Based on the defined service criteria:
  • 550 vehicles for door to door service
  • 250 vehicles for stop based service

(Current fleet: 48 busses, 21 trams)
Travel times

- Per person travel times may be significantly reduced
- In vehicle travel time reduces by 50%
- Average waiting time for DRT vehicles of around 5 minutes
- Stop based mode: Vehicle is only called once passenger reaches stop → Room for improvement
- Waiting time of pt trips neglected (including for transfers) in figure below
Cost analysis

- Cost models for SAV are available
- Based on Bösch, et al, 2017: 0.25 € / pkm (incl. procurement)
- For public transport: 2,38 € / km (operational value from Potsdam; pure operational costs)

Daily operational costs

- Stop-based: €27,134
- Door to door: €46,793
- Public transport: €42,840
Conclusion

• Automated Demand Responsive Transport may be a viable alternative to Schedule based public transport systems in smaller cities

• DRT systems will reduce travel times for a majority of users

• Their operation may be cheaper than classical transport systems in those areas, if stops are used for bundling

• A combination of stops and door to door may increase ridership even further

• Mode choice experiments should be made
Thank you for your attention!

Questions?

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