System dynamics modelling to assess transport demand and economic viability of autonomous shuttles for rural public transport

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Background

Rural Transport Gap

- 70% of trips are made by car in the peripheral districts of Austria (Tomschy et al., 2016), due to a lack of coverage with public transport
- Current demand responsive services provide solutions for last mile but reach limits due to accessibility and cost issues (Eckhardt et al., 2018)
- Public transport with autonomous (i.e. self-driving) vehicles considered as more cost-effective solution

Autonomous Public Transport Vehicles in Rural Areas

- Less complex traffic environment than in urban areas and fewer conflicts between vehicles
- Lower level of service of road infrastructure, partially single lane roads
- Low density of demand, investments in infrastructure less economically justifiable, linited potential for shared services, last mile most important to cover
- Fewer real-world applications on suitability and acceptability

Objectives Digibus® Austria

- Research and test methods, technologies and **models for proofing a reliable** and traffic-safe operation of autonomous shuttles **on open roads in mixed traffic** in a regional driving environment on automated driving level 3 and creating foundations for automation level 4.
- **Real-world testing** on non-public test tracks (level 4) and on public roads in 2 different settings: rural (Koppl), urban (Wiener Neustadt), level 3
- **Use cases** with respect to
  - User groups (local residents, tourist, regional and interregional commuters…)
  - Operation (with/without operator, fixed schedule / on-demand)

Digibus® Austria

Coordinator: salzburgresearch

Partners: virtual vehicle, kapsch, PRISMA solutions, COMEO, BOKU, LAND SALZBURG, AIT, UNIVERSITÄT SALZBURG, HERRY, FACTUM, ÖBB, easymile, Fluidtime, FFG

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Digibus® Demand Model

- **Aim**: identify the suitable area of application for autonomous shuttles
- **Outcome**: integrated simulation model for possible Digibus® use cases regarding the requirements and framework conditions for the transport system, the spatial environment and the effects on transport demand, economic efficiency and social benefits
- **Input**: Impact relationships used determined from literature and expert knowledge, variables from pilots and secondary data from sociodemographic data and existing transport models; data from pilot tests limited (short operation time due to COVID)

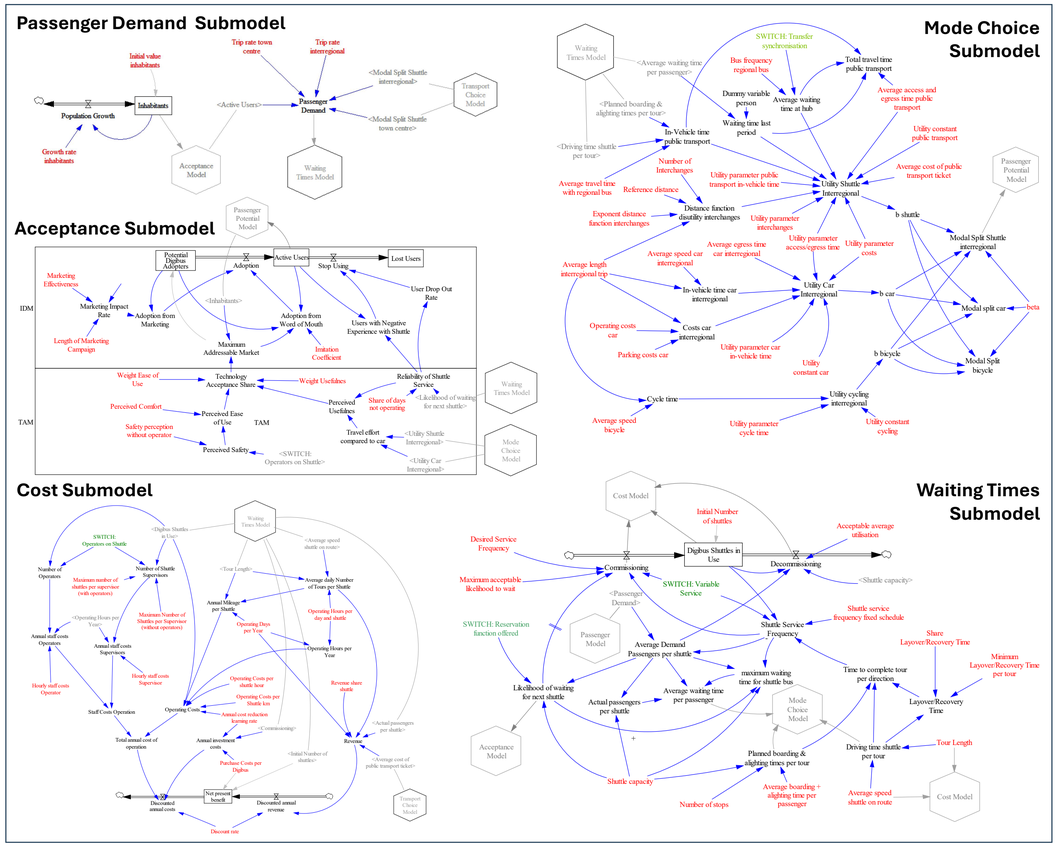

Figure 1:Digibus Demand Model

Conclusion and Outlook

- Sensitivity tests demonstrate importance of key variables such as waiting times and the perceived utility of the services
- Revenues from ticket sales did not cover the full cost of operation of the shuttle, consistent with findings from the pilot operation, i.e. need for subsidies
- Further sensitivity tests and calibration to real-world data needed

Preliminary Results

- Earlier development of a CLD revealed three major loops (Gühnemann et al., 2019): Word of Mouth (R), Crowding (B), Waiting Times (B)
- A Stock-Flow-Model consisting of five submodels (see figure 1) has been implemented for Kopplcase study based on data from literature
- Extreme value tests provided results within realistic bandwidths
- Sensitivity tests wee carried out for mode choice model parameters and impacts of high/low demand and fixed/variable service (see figure 2)

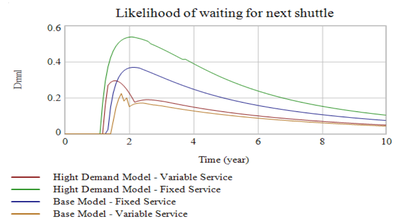

Figure 2: Impact of variable compared to fixed service on likelihood of overcrowding in the base model

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