Development of a Dwell Time Calculation Model for Timetable Planning
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Background
The number of passengers on Switzerland’s 8 S-Bahn Systems has increased significantly due to more attractive services - on certain lines more than 100% during the last 15 years. Besides, new stations have been added on already heavily used infrastructure to connect new areas to public transport. Therefore, relevant operational process times - especially station dwell times - exceeded planned values. This led to delays and risk of network operational instability. In order to improve reliability of S-Bahn trains, a (more) precise time table planning is needed. For this reason Swiss Federal Railways (SBB) ordered a dwell time calculation model.

Project Goals
The main goal of the project are the development of the dwell time calculation model and its implementation in an user-friendly EXCEL-tool. The tool allows the prediction of station dwell time (in seconds) for S-Bahn and regional trains based on the following input parameters:
- Type of rolling stock (number, width and level of doorways)
- Infrastructure (platform level)
- Demand (number and distribution of passengers)
The relevant steps of the project are described in the following paragraphs.

Dwell Process Analysis
In order to completely understand the different influences on dwell time, a process analysis has been made: Station dwell time is given by the interaction of passengers, vehicle and train driver.

Evaluation of Passenger Distribution
Boarding/alighting time is nearly proportional to the maximum number of passengers per door, which is determined by the distribution of passengers along the train. To quantify the influence on dwell time, a detailed analysis of passenger distribution has been made.

Automatic Data Collection
The statistical quantification of these sub-processes asked for a solid data basis: Therefore, the SBB’s on-board automatic passenger counting system was configured to accurately measure these sub-processes. Therewith, the number of passengers at each door and the begin/end of each sub-process is recorded. During eight months over three million measurements were made on five different vehicle types and twenty different lines.

Modelling of Sub-Process Times
Based on this measurement data, the statistical distributions of sub-process times were analyzed in consideration of the relevant influence factors.

Figure 1: Process Modell of Dwell Time Calculation

Figure 2: Passenger Flow Rate at Vehicle Doors (FLIRT): Measurements (data points), Mean (cont. line), Mean - 2 sigma, Mean + 2 sigma (dotted line) of Normal distributed Passenger Flow Rate

Figure 3: Passenger Distribution along the Train (Mean of all Stops)

Tool Development
The models of sub-process times and passenger distribution were implemented in a user-friendly calculation tool.

Client
SBB, Passenger Traffic Division

IVT Contributions
Dwell Process Analysis, Measuring and Modelling of Sub Processes, Tool Development

Applied Methods
Automatic Passenger Counting

Contact
Stefan Buchmüller, Institute for Transport Planning and Systems, ETH Zürich, 8093 Zürich, Switzerland
buchmueller@ivt.baug.ethz.ch
www.ivt.ethz.ch
Phone: +41 44 633 66 89
Fax: +41 44 633 10 57