TRAVEL DEMAND MODELLING ADAPTED FOR PERSON FLOWS IN PUBLIC BUILDINGS

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Pedestrian flow simulation is an established tool for capacity analysis of pedestrian infrastructure. As in traffic flow modelling travel demand typically is given as an input either from counts or from travel demand models. We describe the two-stage process of planning a new pedestrian infrastructure for the expanded building of a huge library in Stuttgart (Germany). We show the adaption of simulation procedures of a traditional macroscopic demand model as well as the estimation process of person trip demand inside the original and the expanded building. We first designed and evaluated a demand model of the existing building. Based on the results, we adapted this demand model of the library regarding the expansion building in consideration of the changed circumstances. We used a traditional tour-based travel demand model, but modified trip purposes for new activities provided by the modelled building. For the modelling process, VISUM 12.5 including the tour-based demand model VISEM by PTV Group is used. The tour-based model is a disaggregated, behaviour-oriented model, including trip generation, trip distribution and mode choice.

For designing a demand model of the existing building, it is necessary to collect visitor data for the library including the number of visitors, important locations for activities inside the building, and flow profiles for arriving and leaving visitors. To compare the results of the model with reality, visitor flow on the main stairway has been observed. According to German guidelines for traffic surveys, intervals of 15 minutes were defined for counting persons. The survey of incoming and outgoing visitor flows was realized by manual counts for all relevant entries of the building. Questionnaires were used to identify activity locations and activity chains of the visitors. The survey took place during a work day from 8:00 am to 8:00 pm, the business hours of the library. Due to several limitations within the project, the duration of the survey could not be extended to more days. Thus, the data does not fully represent the behaviour of visitors independently from special events. However, the survey day had been chosen with the objective to obtain precise and representative results.

Network models in VISUM consist of zones representing areas of similar use, routes on which traffic moves constisting of nodes and links, and connectors to connect the zones to the link network. The customized network for macroscopic model for persons in a public building has major differences compared to a regular macroscopic model for cars and streets:

- Walking areas instead of directed roads and lanes
- Only one means of transport (walk)
- No controlled intersections
- Multiple levels connected by stairways and elevators

Our model uses virtual traffic links which represent shortest ways. The different levels were transferred in a two-dimensional model by laying them flat next to each other. The connections like stairways and elevators were modelled as links with appropriate parameters, so the behaviour of visitors is comparable to a three-dimensional model. Highly frequented places in the building (point of interests) and the entries are represented by individual zones. Zone attributes exist for each activity and influence the choice of targets. The values of the zone attributes vary for each zone. They are based on observations as well as on constraints such as the number of places in the cafeteria. Three different flow profiles were used for distributing of the visitors over the day in order to allow for evaluations of the peak hours. All flow profiles are in intervalls of 15 min. For the demand model, the activities including the frequencies of the activity chains are put into the VISEM model. Eight activities are used in the activity chains for the library:

1. Information
2. Borrowing / return a book
3. Learning
4. Cafeteria/Catering
5. Wardrobe
6. Exhibition
7. Computer
8. Arriving / Leaving

Our final model calculates trip generation, trip distribution and mode choice, although only one mode exists; the mode choice has to be done because it is part of the software routine. Traffic assignment is realized by calculating a stochastic equilibrium to get a distribution to several routes, although the volumes are far below capacity of most links. The assigned volumes are compared to the counts on selected stairways and fit very well. As an example, figure 1 shows the number of persons using the main stairway compared to the calculated number.

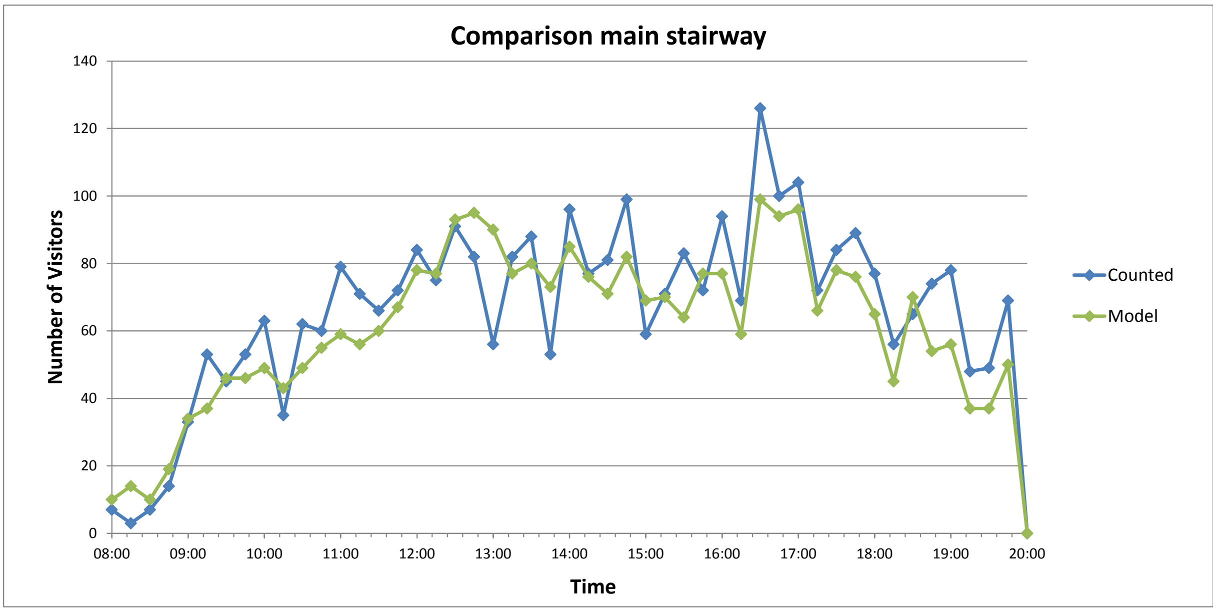

Figure 1: Number of visitors counted and calculated at the main stairway of the building

The demand model of the expanded library includes changed circumstances like an increase of visitors and the restructuring of the existing building. We designed two cases representing the user behaviour for two models of different utilisation patterns in the expansion building, which were defined in the expension project.

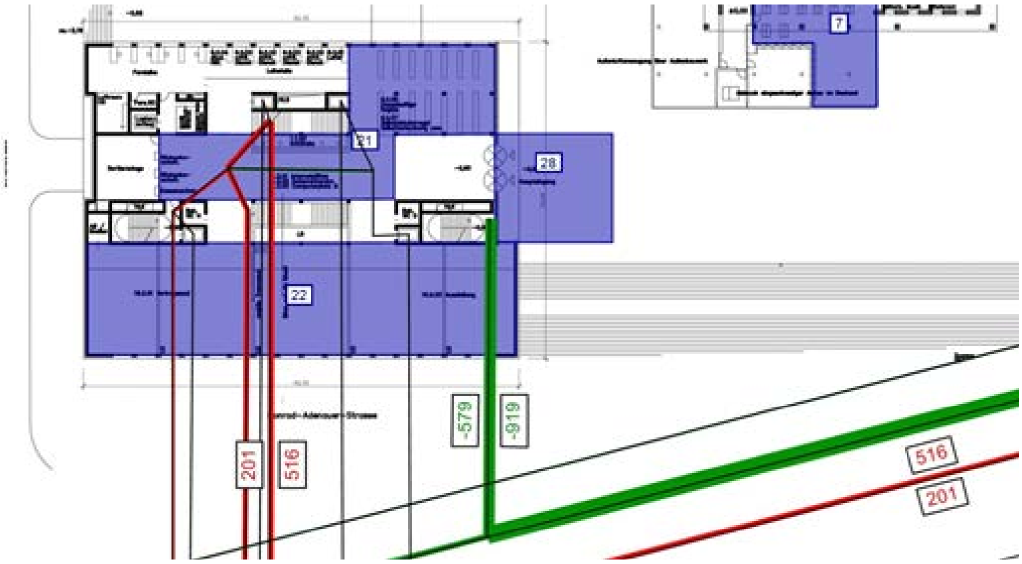

Figure 2: Entry area of the expansion building, difference in the number of visitors on the links comparing the two model cases

Using the results of the model, we show that the planned capacity of the pedestrian infrastructure of the extended building is sufficient. Our project also shows that modelling of person flows in buildings is useful for analysis and description of user behaviour inside buildings. Especially as part of planning processes for existing or new buildings, traditional tour-based travel demand models can be adjusted to compare different patterns of utilisation. In combination with a microscopic flow model, it is useful for the design of key elements regarding the needed capacity in peak hours.