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Large scale multi-modal simulation of pedestrian traffic

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Abstract

For the planning of large events the crowd management is of key importance. This comprises the direction, management, and guidance of pedestrian movement. This contribution deals with the planning of the "Eidgenössisches Schwinger- and Älplerfest" (ESAF) that took place in Burgdorf, Emmental, Switzerland in 2013. To this end, simulations were performed to identify congestion and potential "hot spots", to estimate the time it takes to evacuate the arena, to estimate the time it takes for the visitors to leave the festival and to get onto their train home.

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Keywords: crowd management; event planning; pedestrian planning; visitor flow; event safety; public transport

1. Introduction

For the ESAF 2013†, different simulations were performed prior to the event. The festival itself took place on August 31st and September 1st 2013 in Burgdorf, Switzerland. Burgdorf itself is a small town with approximately 15,000 inhabitants. Consequently, the infrastructure, especially the public transport system is not dimensioned for such a large event. The overall number of visitors was estimated to be 250,000 for three days and 120,000 on Sunday. The athletic part of the festival, the national Swiss wrestling tournament, ends on Sunday evening with the final and most visitors are assumed to leave immediately afterwards. Three scenarios were investigated by means of capacity analysis in combination with pedestrian flow simulations:

- Evacuation of the Arena
- End of the festival and departing traffic (pedestrian flow)

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† Information on the festival can be found at http://de.wikipedia.org/wiki/ESAF (in German, also available in French and Dutch).

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- Capacity of the train station

The capacity of the public transport system, i.e. the train station and the train schedules in combination with the capacities of the cars, was compared to the estimated demand. A similar investigation was performed for car traffic but is not the focus of this contribution, apart from the fact that it of course influences the modal mix. The traffic demand was initially estimated to be 48,000 for public transport. Since the festival ended on Sunday evening and the next day was a working day, the visitors were assumed to leave immediately after the final round. Based on those assumptions, simulations were performed for the departing pedestrian flow. These simulations showed considerable congestion, especially at the entry points to the trains station and on the platforms. The considerations and suggestions derived from the simulations were implemented on spot. This lead to a considerable decrease of congestion in reality compared to the prognosis based on the simulation. Furthermore, the traffic demand was overestimated and the reaction time span for leaving the festival underestimated prior to the event. In addition to the ex-ante simulations used for crowd management planning, an ex-post analysis and simulation was performed in order to reflect the observed parameters (reaction time-span, route choice, modal mix). The simulation results for the calibrated parameters were in good agreement with the observations. For the ex-ante analysis, the number of persons leaving by train was decreased to 30,000 and the reaction time span was increased to a range from 0 to 1.5 hours (the ex-ante simulations were based on immediate reaction, i.e. 0 to 10 seconds, which is the worst case in the sense that it leads to the highest demand and most severe congestion, compared to a longer reaction time span.

The outline of the remaining part of this paper is as follows: the assumptions made for the simulations and calculations are presented in the next section. The results of these calculations and simulations are presented in section 3. Section 4 deals with the observations made in Burgdorf during the festival on Sunday, September 1st 2013. These were used to adapt the parameters and the ex-ante simulation results are shown in section 5. Section 6 summarizes the results and concludes with the major findings, lessons learned and an outlook into their future use.

2. Assumptions concerning Traffic Demand

The traffic demand estimation was based on the overall number of visitors, the modal split, and the visitors behavior. The capacity of the train station used in Table 1 is based on the minimum of the capacity of the pedestrian path elements (stairs, ramps, tunnels, etc.) of the train station and the capacities and schedules of trains. The latter was the decisive limitation in our case. In summary, a total number of 15,000 persons could leave the train station at maximum per hour. The total capacity of the train station is based on the total number of trains per hour. However, for an uneven distribution of the traffic demand (e.g., if certain directions of travel are more frequent) the capacity will be lower than that. This is illustrated in the following table, where 70% of the visitors are assigned to platform 2/3 (which serves the trains to Basel). The train station has 5 tracks in total. The departure time is 5.5 hours for the public transport based on the assumptions made for this calculation. The bottleneck in this case is the capacity of the train system, i.e. the number of trains that can leave certain tracks per hour.

Table 1. Traffic demand for the festival.

	Arrival					Departure			
Sunday	Total	MIT	PT/SBB	Bus	Other	Total	MIT	PT/SBB	Bus
6 hrs	35,000	16,000	14,000	5,000					
7 hrs	40,000	24,000	16,000						
8 hrs	10,000	6,000	4,000						
9 hrs	10,000	6,000	4,000						
10 hrs	10,000	6,000	4,000						
11 hrs	5,000	3,000	2,000						
12 hrs	5,000	3,000	2,000						
13 hrs	5,000	3,000	2,000						
18 hrs						120,000	67,000	48,000	5,000
Sum	120,000	67,000	48,000	5,000					