Does preparation matter? Influence of pre-evacuation activities on regional evacuations

Pre-evacuation activities are one major influence in the evacuation process analysis and simulation. In general, the overall time for the evacuation of a building, venue, or region can be divided into several parts:
$t_{evac} = t_{detection} + t_{alarm} + t_{preparation} + t_{movement}$

The time $t_{detection}$ denotes the time needed to detect the threat. The time actually needed to detect a threat depends on the situation. The determination of this time, however, is not part of this study. Once the threat is detected an alarm might be triggered. In this scheme the time t_{alarm} also comprises the time it takes to come up with the decision whether or not to evacuate, i.e. disseminate a warning and request the population to evacuate a certain area.
For the case of a building, this decision is sometimes automated, if there are no risks connected to an evacuation. In such a case, the detection of a threat like smoke automatically leads to an alarm and $t_{alarm}=0$. This is not the case for a regional evacuation or the evacuation of a large venue like an arena. In this case, there are considerable efforts necessary to provide safe places of refuge or there is a considerable risk for the evacuees during the evacuation. Therefore, the decision is not automated but will be taken by a crisis management group.

On the level of the persons being requested to evacuate, there are also two time components: preparation time and movement time. The first takes into account all pre-movement or pre-evacuation activities (on the personal scale). The second one is the time it takes to move from the current location to a safe place of refuge.

In recent years there have been some studies investigating the preparation times for evacuees under various conditions mainly for evacuations on building level. From these studies one not only learns about the distribution of the preparation times but also about the peoples' willingness to evacuate. The willingness to evacuate is in particular an issue when it comes to regional evacuations (e.g. in the case of a hurricane or a tsunami) since studies have shown that the willingness to evacuate is often lower than expected. Once the preparation is finished the evacuees start to evacuate.
The simulation and optimization of the evacuees' movement is no new topic in research. There is a more than 30 years long history on evacuation simulation and optimization research. However, so far only little has been done to investigate the relation of preparation time and movement time. At least there is a study that investigates the relation between preparation time and movement time in the case of a fire related building evacuation. If the preparation time increases the smoke becomes denser and thus, the evacuees' walking speed decreases which in turn leads to longer movement times.
When it comes to regional evacuations, which are usually performed by car the distribution of the preparation times also influences the occurrence of

congestions on the streets. It is obvious that a simultaneous start of all evacuees will lead to more congestion compared to a situation where the starting times are stretched over a long period. To the authors best knowledge there has been no study that investigates the relation between preparation time and movement time for regional evacuations.

This contribution focuses on the personal decisions by the evacuees, i.e. the third and fourth time component, specifically on the preparation or pre-movement time.
The importance of that component becomes very clear when taking into account the option of "not evacuating at all" that is a realistic one for many persons. The preparation time also depends heavily on the individual situation, preferences, socio-economic status, etc. This might lead to a wide variation in this parameter.

With the help of multi-agent traffic simulations based on the tool MATSim (www.matsim.org), we will investigate the results of those variations for the overall evacuation time t_evacuation and the formation of traffic jams during the evacuation process.

The hypothesis is that for an evacuation process determined by bottlenecks, a wide range of individual evacuation times (say in the order of 10 minutes to three hours) might not result in a drastically increased total time compared to an instant response (say 10 to 20 minutes).
On the other hand, if the time frame for a successful evacuation is short (i.e. less than two or three hours) than such a long preparation time endangers the success of the whole process.

Therefore, the consequence of an analysis like the one presented in this paper might also be to determine the maximum preparation time. The focus is then on the communication between the authorities and the population in case of an emergency. Different channels for disseminating the warning message and the specific content of the warning and individual messages might well help to decrease preparation time and therefore contribute to a successful evacuation process.