DELIVERABLE REPORT

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Executive Summary

According to various sources (for example the report of the intergovernmental panel on climate change(IPCC, 2013), or the Munich Re NatCatService (RE, 2014)), the chance for climate-induced manifestation of natural hazards (like flooding, storms and droughts) has dramatically increased during the last decades and there is strong evidence for this trend to be continued. In addition, parts of Europe are also exposed to hazards based on geophysical incidents like earthquakes and volcanic eruptions (for example the earthquake around L'Aquila, Italy, 2009). Apart from natural disasters, Europe has also faced an increase of terrorist attacks like bombing or arson (for example train bombings in Madrid, Spain, 2004 (CNN, 2015), recently in Paris, France 2016).

The loss generated by the incidents was always a combination of damages to buildings, infrastructures and of course to persons. In most cases it can be shown that damages are mitigated if critical infrastructure is rendered resilient regarding the corresponding hazards (less damage to buildings with smoke sensors and a proper fire alarming system, prevention of terroristic attacks by adequate security measures, fewer fatalities in earthquake-resistant buildings etc.).
Therefore, the overall aim of this paper is to discuss possible countermeasures against hazards and how these methods can be integrated into a best practice approach.

- In contrast to the previous reports in WP3 analyzing hazards, their effects and corresponding countermeasures to buildings themselves, **this time safety perimeters (e.g. sensor techniques**, also for the affected surrounding, including traffic management systems and its control for the entire affected area) will be specified in a first step. These enhanced measures will consist on one hand of principle, static measures. Furthermore, dynamic measures will be specified based on recent sensor informations. Installed surveillance cameras will help to survey the area from a distance and will provide visual onsite information. Smoke and high temperature sensors provide a further source of information about fire and smoke hazards. These measures could be input for intervention forces or to first responders for tactical purpose or even resource planning. Additionally, this dynamic information will be given to a building management system as input providing people inside with actual safety information.
- In a second step, **measurements for preserving, maintaining and restoring safety and security levels in a building** and its surrounding will be discussed. e.g., the traffic flow should bypass the event location and grant first responders fast access to the site. In case of a flooding event, connected (underground) transportation systems need to be evacuated and isolated. A further important measure is the definition of maintenance and service plans to ensure functionality and durability of the infrastructure to protect life and assets in case of an emergency. For this the definition of corresponding flow charts will support these plans and hence the decision making process of building managers and first responders. Moreover, the definition of the scale of impacts to determine priorities for evacuation and rescue measures as well as later reuse of building structures is an important outcome of the definition of safety plans.
- In a third step, **two prototypes** will demonstrate these theoretical findings by real live scenarios:
  - The Crowd Control prototype demonstration in Brussels in January 2015 showed the coupling of real sensor information and the corresponding evacuation simulation for a fire scenario. In this prototype, derived decisions for safe evacuation routes were forwarded dynamically to the building management system adapted from actual sensor information. Based on the findings in this paper, the prototype development will be enhanced to a second prototype demonstration with an extended functionality concerning additional sensor information and more hazard types

coupled to the virtual building management system (taking actions for a dynamic, most favourable evacuation simulation).

- In parallel to that prototype development, a further prototype for a simulation demonstration of an extended hazard and pedestrian stream simulation for a complete environmental scenario (see Figure 1) will be implemented. It will show the effects of hazards and corresponding sensor information on a virtual building management system (vBMS) and its actions. Different simulated evacuation strategies will influence the evacuation time drastically depending on the hazard type and location.

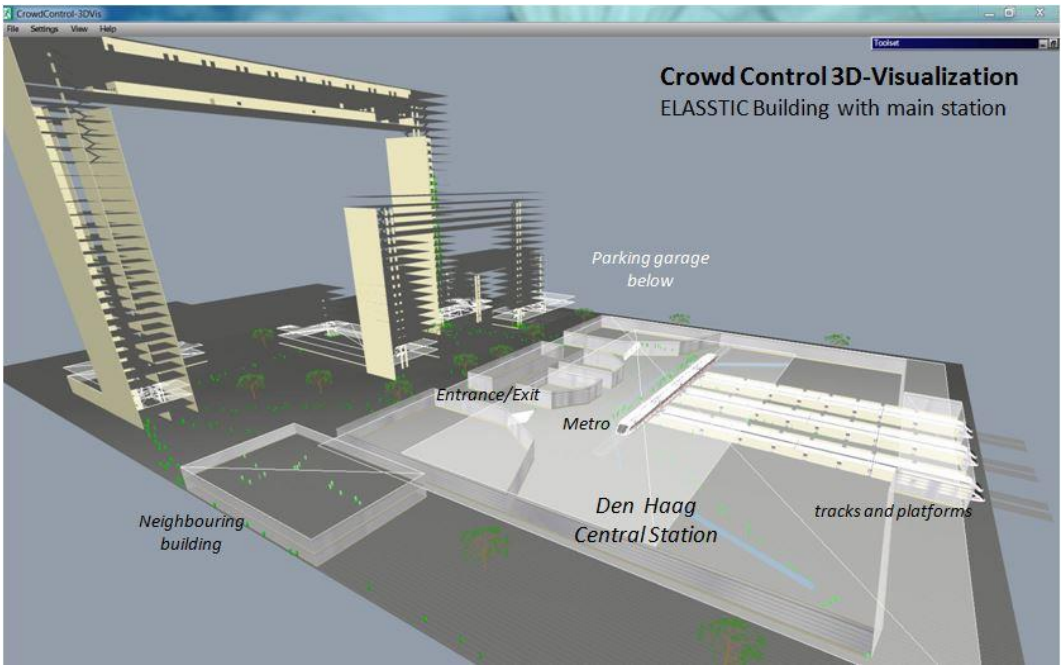

Figure 1: 3D Visualization of the environment of the Ribbon show case building

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