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Improving the resilience of metro vehicle and passengers for an effective emergency response to terrorist attacks

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ABSTRACT

In the framework of the European FP7 project SecureMetro, the authors have studied the occurrences of terrorist attacks against rail-based vehicles, in particular Underground trains, with the goal to reduce the number of attacks by making transport systems a less attractive target. Many counter-measures have already been implemented in a multi-layered manner to increase the resilience to terrorism, such as depot security, detection of explosives or passenger screening. The SecureMetro project adds another layer aimed at mitigating the effects of an attack to the vehicles, should the other layers fail to avoid it. The case of interest, a metro train blocked in a tunnel due to a bombing, has been chosen as representative of the attacks perpetrated in the recent years, and of the most difficult case to cope with. Based on the experience of the 7/7 London bombings and other emergency situations, as well as the currently admitted behaviour models, this paper identifies critical systems and proposes improvements to the design of metro coaches, in order to improve the management of the emergency situation, assist the evacuation and rescue to passengers.

1. Introduction

Considerable effort is being devoted by the researchers and stakeholders in order to improve the safety of metro transport systems with respect to such incidents as terrorist attacks. The issue has been addressed by many researchers, taking into account the bow-tie model of safety management, in which the node is the terrorist attack, with on one side the causes of the attack (e.g. political issues, and technical weaknesses), and on the other side the consequences (human, organisational, and economical). The general goal is to devise and implement a line of defence to isolate these causes and consequences, in order to prevent the attack from occurring and, should it happen, to mitigate its consequences as much as possible (Khoudour et al., 2011).

Several research projects have addressed specific elements, or full sets of integrated solutions implementing technological and organisational measures to increase the effectiveness of this line of defence. Among others, current projects are SECUR-ED (http://www.secur-ed.eu) which aims at providing a full, interoperable set of tools, and demonstrating them in four major European cities, Protectrail project (http://protectrail.eu) which aims at designing a scalable solution integrating a modular set of sub-mission protection tools (e.g. passenger clearance control, electrical or communication systems) for railway security, and MODsafe project (http://www.modsafe.eu) which focuses on the establishment of a common European strategy, integrating a common approach to safety and security measures.

In this scheme, our goal is to improve the preparedness by mitigating the consequences of an attack to metro vehicles, which we show to be a particularly sensitive target in terms of both attractiveness and consequences. In the framework of the European FP7 project SecureMetro (http://www.securemetro.com/), researchers from different fields and countries are studying various improvements to metro vehicles in order to improve the resilience and survivability of the vehicle, its passengers, and the transport system as a whole, in order to minimise the material and human damage caused by a bomb or a fire, to improve the capacity to resume normal operation, and thus to make public transport systems a less attractive target for terrorist attacks. A notable part of the efforts is

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devoted to improving the immediate response after the blast, in order to ensure the capacity of the survivors to alleviate fear, avoid panic, facilitate rescue, and more generally to improve the crisis management.

In this general framework, the work described here aims to take into account the existing knowledge gathered during bomb attacks and more generally emergency situations involving aspects similar to a bomb attack in a closed place, such as building or train fires, and stampedes, to identify the critical features of the design of a metro vehicle that are susceptible to play a role in the way the survivors tackle with the situation and are able to cope with it in the best possible way, in order to ensure their survivability, ease the rescue and evacuation. Longer-term effects, such as post-traumatic stress disorder, are out of the scope of this study.

2. Nature and evolution of terrorist acts

Over the last decades, the number and the nature of terrorist attacks in rail-based transports appear to have evolved in considerable proportions. An exhaustive survey, based on two databases covering the 1960–2010 period (Database of Worldwide Terrorism Incidents; Global Terrorism Database), has found that in 50 years 833 attacks killed about 3500 persons and injured more than 15,000. Moreover, the number of both attacks and victims have known a sharp increase since around 1980 (Fig. 1).

The mode of perpetration is of particular importance to devise ways to mitigate the effects of the attack, so the survey concentrated on classifying the tactics used. Out of the 833 attacks in the data bases, bombing is used in 57% of the cases, followed by sabotage (20%), armed attacks (7%), arson (5%), and threat (5%). The other types of attacks are marginal (Fig. 2). These proportions do not seem to have evolved significantly over the last decade.

Bombing thus appears to be by far the prominent method of attack. This result is further reinforced in the number of victims, with 70% of the fatalities (2541 out of 3457) and 77% of the injuries (7832 out of 10,682) during the considered period, making bombing the deadliest type of attack. Again, the trend remains stable in the recent period, which leads to expect a continuing increase of the number of attacks, with a vast majority of acts and victims caused by bombings. We therefore chose to concentrate our efforts on this type of attack.

3. Data sources for case analysis

It is worth noting here that, although we strove to base our work on case studies, a lot of first-hand data is unavailable due

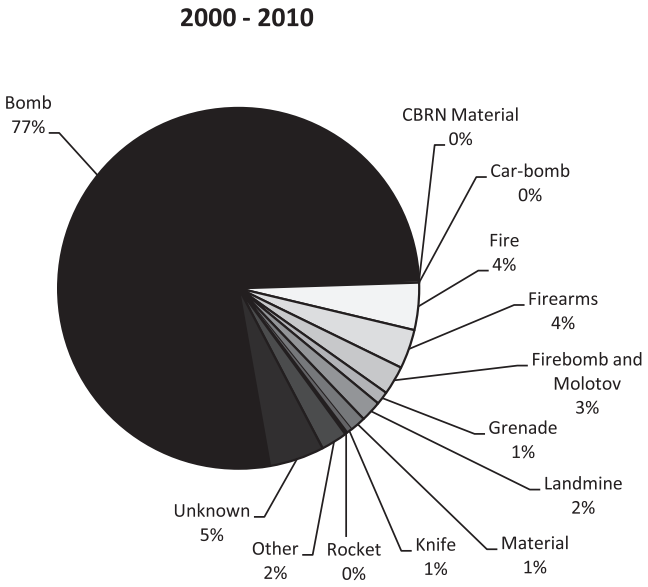

Fig. 2. Weapons used to carry out attacks.

to the policy of some countries to classify information related to terrorism. It is in particular the case of France, where the data regarding attacks led against RER (regional express rail network) in 1995 would be of interest but cannot be used due to the obvious difficulties of obtaining classified information and disseminating conclusions without being able to mention how they are justified. However our discussions with people involved in the French attacks led us to conclude that there is no significant difference between the mechanisms observed in France and in other countries, so we chose to base our work on the available data in countries where the secrecy policy is less stringent, and consider that our conclusions are valid in France too since RATP, the Paris Underground operator participating in the SecureMetro project, read our conclusions and did not raise objections.

A particularly rich source of information is the bombings attack that took place in London on July 7th, 2005, in three different Underground trains and in a bus, both for their representativeness with regard to bombing in underground trains as being the most deadly type of attack in the foreseeable future, and for the amount of information that was gathered and made available. Substantial direct accounts of survivors are available, in particular in the minutes of the public investigation carried out by Greater London Authority (2006a,b,c). These direct accounts are of exceptional interest to our work, allowing to better understanding the context

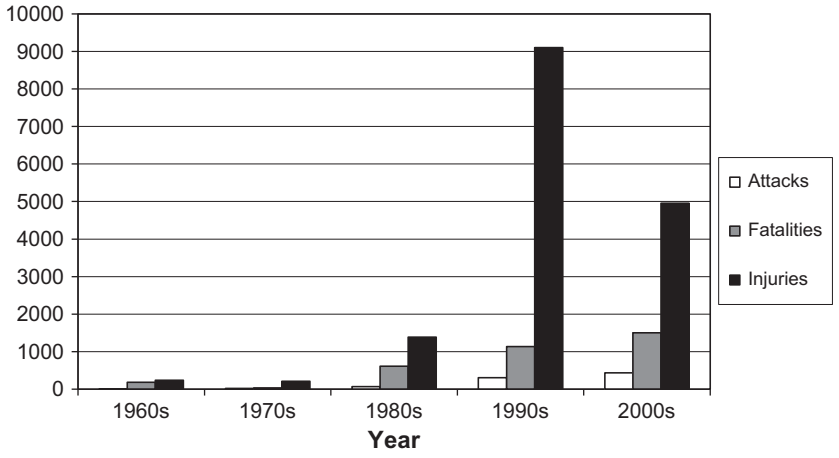

Fig. 1. Historical evolution of attacks, fatalities and injuries.