

Part One
Introductory Section

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Editorial Introduction*Luca Zamparini and Genserik Reniers*

The last decade has witnessed an increasing worldwide concern for security-related issues. Terrorist attacks have hit several regions of the world (the United States, Great Britain and Spain in Europe, Indonesia and so on) and this has raised the interest towards security in a dramatic way at all levels of government (local, national, and international). In this context, it is important to consider that it has been computed that, between 1970 and 2010, about 6% of all terrorist attacks have targeted transport means and infrastructures¹⁾. It then becomes relevant that the improved security in transport represents one of the key topics in the agendas of counterterrorist agencies worldwide. In the United States, for example, one of the first actions undertaken soon after the 9/11 attacks was the creation of the Transportation Security Administration as an agency of the US Department of Homeland Security.

At the European Union level, the strategy to augment the security of transportation has mainly been based on a series of regulations, directives, and proposals aimed at enhancing the security levels of the various transport modes and infrastructures. On the Asian continent, international policies related to security have mostly taken the form of agreements on themes as transit of goods and people and on more general security cooperation issues.

This increased political concern on transportation security has been somewhat matched by researchers in various disciplines (among them, economics, law, engineering, political science) that have tried to analyze the current security systems and devices and the transport networks at the local, national, and international scales to propose viable alternatives to strengthen the security procedures, without hampering in a marked way the need for seamless and efficient transport flows.

One of the basic issues that part of the literature has been trying to clarify is the conceptual heterogeneity between safety and security in transportation. The first term refers to the absence (or, more properly, the minimization) of all dangers,

1) See the Global Terrorism Database at <http://www.start.umd.edu/gtd/features/GTD-Data-Rivers.aspx> (accessed 11 July 2011).

risks, injuries, and fatalities that may depend on accidental and unintended events related to inadvertent or hazardous behavior. On the other hand, security can be defined as the prevention of and protection against deliberate actions that aim at generating (mass) fatalities, disruption of services, and economic and social distress. From the scientific viewpoint, the main difference between safety and security is represented by the fact that the former can be analyzed by means of statistical and probabilistic techniques, while the latter (given its very low frequency and the fact that terrorist acts are intentional) cannot be treated with the same tools and requires, for example, the use of cost–benefit analyses in order to estimate the economic and social incentives to raise the level of security, and, for example, of game theory to mimic the strategic interactions between people and organizations planning and executing terrorist actions and counterterrorist agencies.

A segment of the transport sector that is particularly prone to the generation of mass fatalities in the case of a terrorist attack and that requires particular strategies, actions, and protocols in order to guarantee its degree of security is definitely represented by the hazardous materials (so-called “hazmat”) business. The large quantities of explosives and of chemical, radioactive, and poisonous goods that are shipped every day within and among countries represent both a necessity for the productive sector and a concern for security agencies and personnel. In this context, the efficiency and the security of transport do not seem to represent a trade-off but rather a conjoint necessity and goal. Particular care has to be paid to the planning, implementation, and monitoring of hazmat transport activities both at the company and at the Government level. Routes have to be selected with particular care in order to minimize the possible effects of terrorist acts given that shipments of hazardous materials can represent both targets and weapons of mass destruction. Moreover, the security of the transport nodes (ports, warehouses, logistic platforms, and so on) is probably even more important than the monitoring of transport flow (Lewis, 2008). It is thus relevant to consider the hazmat transportation not just as a series or set of unimodal activities but rather as an integrated multimodal system.

By taking into consideration all of the above-mentioned topics, the present book, whose structure is sketched in Figure 1.1, aims at covering both the unimodal and the multimodal issues related to hazmat transportation. The first introductory section will provide a description of the history and importance of hazmat transportation and of the main economic themes and models that have been proposed in the literature in order to analyze this sector. The second section, in line with a part of the traditional literature on hazmat transportation, will analyze the various transport modes that are concerned with hazmat transportation (road haulage, railways, inland waterways, and pipelines) from a unimodal perspective. The third section will offer a multimodal perspective both in terms of formal models and of empirical evidence. The fourth section will present a series of country case studies (Italy, The Netherlands, the United States, and Iran) in order to ascertain the similarities and homogeneities in several geographic regions around the world, subject to different economic and social contexts.

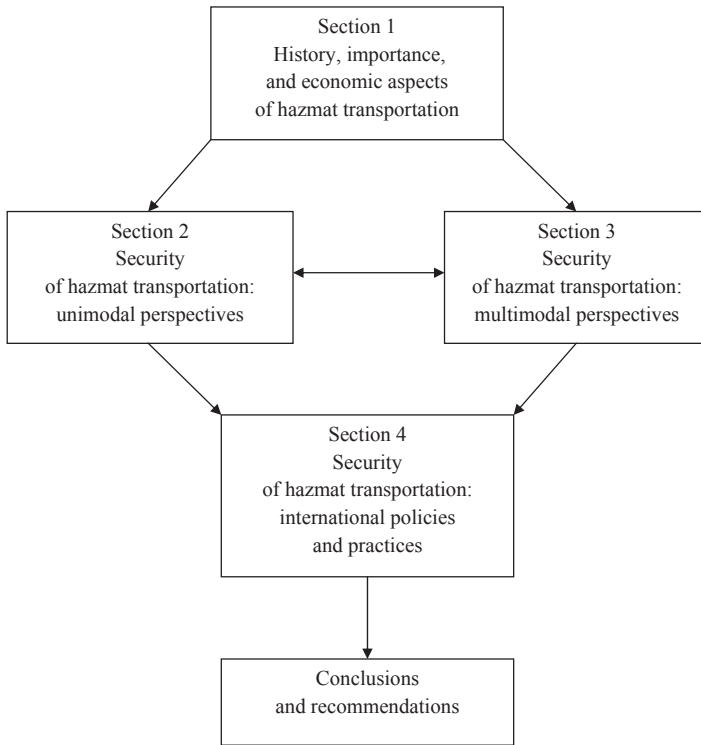


Figure 1.1 Structure of the book.

The next paragraphs will offer an outlook of the fourteen contributions that constitute the various sections of the book. In order to provide an introduction to the various chapters, a description of the main themes that are dealt with in each one will be given. Moreover, the main topics that constitute the book (security, efficiency, unimodal and multimodal approaches) will be highlighted.

1.1

History, Importance, and Economic Aspects of Hazmat Transportation

This first, introductory, section is constituted by two contributions. The first one, *History and Importance of Hazmat Transportation*, clarifies what are the categories of hazardous materials and their paramount importance for the competitiveness and development of both the industrial and the service sector. In this respect, the operational risks that characterize hazmat transportation and the implied difficulties in their planning are discussed jointly with the need for collaboration among security experts and transport specialists. The chapter also sketches a chronology of the main hazmat transport accidents since the late 1970s and the role played

by security issues, especially after 9/11, for a renewed interest in hazmat-transport-related research and indicates sustainability as the other key issue. After proposing the latest security-related events, the chapter concludes by mentioning the economic relevance of some terrorist attacks, the benefit in terms of advancement in technology that can spur from security-related research.

The second contribution of this section, *Economic Issues in Hazmat Transportation*, provides a brief description of the relevance of the hazmat transport market both in the US and in the European Union in order to highlight the relevance of the hazmat-transport market, where the diffusion of multimodal transport is still limited. Moreover, it surveys recent models that have been proposed in order to analyze the risk assessment, the routing/scheduling, and the allocation problem in the case of hazardous materials where heterogeneous analytical settings are discussed and the scarcity of models considering security is underscored.

1.2

Security of Hazmat Transportation: Unimodal Perspectives

The second section of the book is composed of four chapters. The first one, *Security of Hazmat Transports by Road*, pinpoints the large heterogeneity that exists in terms of road haulage of hazardous materials. It also describes the various possible truck types that can be used for hazmat. It then analyzes the various responsibilities that pertain to motor carriers in terms of general security issues, risk assessment, attack profiles, and training of personnel. The chapter also lists and considers all possible threats that may be related to unauthorized access (in loading docks, storage facilities, vehicles, and so on) and all possible profiles of *en route* security. Lastly, it describes the technologies that can be usefully employed to counter intended unlawful acts with a particular emphasis on the Hazmat Transport Vehicle Tracking System introduced in Singapore in 2005.

The second chapter of this section, *Security Aspects of Hazmat Transport Using Railroad*, discusses the reasons why security is very relevant in the case of rail transport, given the degree of interconnectivity of its arcs and nodes and the large number of entry points for perspective terrorists. Coherently with the previous chapter, it then proposes all possible sources of risk. Moreover, it stresses the importance in identifying the critical points in the railway system, the route risks, and the probabilities and consequences of attacks. The chapter then comments on the adopted steps in risk-management strategies (information sharing and coordination, policing and surveillance and routing of hazmat) and on the necessity to implement further steps (interdiction models, tank car design, and placement of hazmat railcars).

The third chapter of this section, *Security of Hazmat Transports by Inland Waterways*, introduces the most important legislation that is related to this segment of the transport market and describes the causes that can lead to a lack of safety of a vessel in navigation, emphasizing the security-related ones (terrorism, vandalism, pilferage). It also proposes the current regulations and practices enacted in order to increase security. Moreover, it proposes the strategy to further improve

inland waterways transportation security suggested by the “International Ship and Port Facility Security Code in Inland Waterways” and its three levels of operations (vessels, organizations, and ports) and other connected initiatives (as container monitoring).

The last contribution of this section, *Security of Hazmat Transports by Pipeline*, proposes an outlook of the hazmat pipeline infrastructure around the world, specifying the regional shares and the transported materials. It then describes the security risks to hazmat pipelines and, especially, the commodity thefts and the global terrorist attacks and incidents in the last decade. Moreover, it estimates the costs and impacts of pipeline security incidents and the range of measures that have been implemented by pipeline operators and government agencies. The second part of the chapter describes the US strategy and security programs in the last decades and emphasizes the need for international cooperation and exchange of available sensitive information.

1.3

Security of Hazmat Transportation: Multimodal Perspectives

The third section of the book is constituted by four chapters. The first chapter, *Multimodal Transport: Historical Evolution and Logistics Framework*, constitutes a general introduction to the multimodal perspectives discussed in this section. It describes the trends in multimodal transport in the European Union, in the United States, and in the ASEAN (Association of South-East Asian Nations) region, providing the economic rationale for its diffusion and the likely future trends in the next decades. The chapter also proposes a logistics model that provides a standard framework and the important variables that have to be taken into account in the choice among several multimodal transport alternatives.

The second contribution of this section, *Multimodal Analysis Framework for Hazmat Transports and Security*, proposes a review of the literature related to hazmat transport emphasizing the role of multicriteria analysis and of multicriteria routing models to analyze this market. It then proposes a model for the calculation of multimodal hazmat-transport risk and considering the probability of occurrence of a catastrophic incident as the result of combination of a general probability and of a locality parameter. It also considers the impact of these events on the basis of the involved transport mode. The chapter then shifts its attention to intended incidents due to terrorists or activists, and proposes a model that considers security as one of the most relevant parameters for modal choice.

The following chapter of this section, *Metaheuristics for the Multimodal Optimization of Hazmat Transports*, introduces the metaheuristics technique and clarifies the rationale for its use in the case of multimodal hazmat transportation optimization problems. In this context, it discusses the role of multilevelness and multi-objectivity, and surveys the contributions that have used metaheuristics for multimodal transportation in general and for hazmat transportation in particular. Lastly, it proposes a peculiar metaheuristic for hazmat transportation in the case of an intermodal network.

The last chapter of this section, *Freight Security and Livability: US Toxic and Hazardous Events from 2000 to 2010*, is based on the previous contributions and discusses the implications of transport consolidation and distribution strategies on the local communities that live around important hazmat-transportation hubs. It also discusses the interactions and relationships among land use, infrastructure location, and industrial organization. The chapter then tests these assumptions on the basis of the events that have occurred in the last decade in California and relates them to the location of multimodal hub facilities. It then compares the evacuation, the environmental damage, the time loss, and the total damage on the basis of the transport mode and of the hazardous materials class in terms of response, property and remediation costs.

1.4

Security of Hazmat Transportation: International Policies and Practices

The fourth section of the book is based on four contributions. The first one, *Security of Hazmat Transport in Italy*, ascertains the economic significance of hazmat transport in Italy with a set of statistics related to the last decade. It also describes the Italian legal framework on hazmat security for the various transport modes and provides the list of the most relevant and recent cases where the security measures have been effective. The second chapter, *Security of Hazmat Transport in the Netherlands from a Security Practitioner's Point of View*, discusses the peculiarities of The Netherlands' stance on security and the role played by its infrastructure as a possible risk factor. It then analyzes the security issues that pertain to transport and logistics in this country, and discusses the network of private and public organizations that are involved in the degree of security in the country. The third contribution, *Safeguarding Hazmat Shipments in the US: Policies and Challenges*, compares the pre-9/11 and the post-9/11 situations and policies, and provides detailed statistics of the magnitude of the hazmat-transport business in the US. It then examines the vulnerabilities of the rail sector and the envisaged policies, protocols and emergency planning and response. It further analyses the role and the interactions among the federal government, the local governments and the private sector, and the situation and issues related to road haulage. The last contribution of this section, *Security of Hazmat Transports in Iran*, provides a description of the most relevant hazmat-transport-related accidents in the last decade, and proposes and discusses a list of all the strengths and weaknesses related to this sector and the optimal policies to implement in order to increase the security level.

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