DaGoB publication
series 1:2007

Supply Chain Analysis of Dangerous Goods in the Baltic Sea Region

Multiple Case Study of 14 Supply Chains

Project part-financed by the European Union
(European Regional Development Fund) within
the BSR INTERREG III B Neighbourhood Programme

Publication series
1:2007

SUPPLY CHAIN ANALYSIS OF DANGEROUS GOODS IN THE BALTIC SEA REGION

Multiple Case Study of 14 Supply Chains

Authors: Suominen, Mikko; Häikiö, Markku; Lehtinen, Paula; Metso, Lasse; Pernaa, Tuire; Ojala, Lauri

Project part-financed by the European Union (European Regional Development Fund) within the BSR INTERREG III B programme

DaGoB publication series
Editor-in-chief : Lauri Ojala

DaGoB Project Office
Turku School of Economics
Rehtorinpellonkatu 3, FI-20500 Turku
TSE switchboard +358 2 481 481
fax +358 2 481 4640
website: www.dagob.info
e-mail: firstname.lastname@tse.fi
mobile: Sirpa Nummila +358 40 760 9058
Lauri Ojala +358 50 502 7031
Mikko.I.Suominen +358 50 502 7071

Editor : Mikko Suominen

This publication has been produced with the financial assistance of the European Union. The contents of this publication is the sole responsibility of the publisher and can under no circumstances be regarded as reflecting the position of the European Union.

ISBN 978-951-564-414-5

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Objectives of the DaGoB project

DaGoB is an abbreviation for "Safe and Reliable Transport Chain of Dangerous Goods in the Baltic Sea Region" - a project initiated by TEDIM (a joint organ for Ministries responsible for Transport in the Baltic Sea Region) and part-financed by the European Union (European Regional Development Fund) within the BSR INTERREG III B Neighbourhood Programme. The Lead Partner of the project is the Turku School of Economics (TSE).

More than 300,000,000 tonnes of dangerous goods are transported in the Baltic Sea Region (BSR) annually. In spite of formal implementation, there are substantial differences in operational practices between authorities involved in DG transport. There is a vast need to improve the exchange of information between DG authorities and commercial actors, and to coordinate DG processes in the whole Baltic Sea Region.

The DaGoB project aims at improving the co-operation between public and private stakeholders related to DG transport in the BSR, by connecting the stakeholders on different levels, providing up-to-date information on cargo flows, supply chain efficiency and risks related to DG transport. Several partners are participating in the project implementation - three from Estonia, thirteen from Finland, two from Germany, one from Latvia, one from Lithuania, six from Sweden and three from Russia.

This report is part of the DaGoB project and part of Work Package 1. The project is divided into four Work Packages (WP's). WP 1 covers flows, supply chains and risks related to dangerous goods; WP 2 focuses on the co-operation between authorities in DG transport; WP 3 establishes the DaGoB Action Plan and WP 4 disseminates and transfers the knowledge acquired from the project. Besides being the Lead Partner, The Turku School of Economics is also the leader of WP 1.

WP1 comprises a survey of dangerous goods flows in the BSR. It consists of selected DG supply chain cases, which are described and analysed. The analysis is conducted through multiple case studies, using a uniform method to ensure comparable results. Emphasis is placed on the industry sector and the survey covers road, rail and maritime transport. All BSR countries are included as well as various types of goods and transport units. Key problems and development areas are analysed and discussed, and recommendations for remedial actions are made.

The BSR co-operation area consists of Denmark, Sweden, Finland, Germany (North–east), Estonia, Lithuania, Latvia, Poland, Norway, Belarus (North–west) and Russia (North–west & Kaliningrad). DaGoB partners come from seven BSR countries and represent both the public and the private sector. DaGoB partners are listed in Appendix 2.

1.2 Objectives of the study

Current DG supply chains may be very complex involving a great many operators and operations. Although the carriage of DG is heavily regulated, operational practices vary from country to country, between authorities, shippers and logistic operators.

The objective of this multiple case study is to provide an insight into how DG supply chains work, with an overview of problems with which the actors are faced. The research areas include operators and operations, type of goods, documents, time and place, information exchange, operational information, risk analysis, effectiveness and efficiency.

The study aims at providing detailed up-to-date information on the supply chains through the selected 14 cases. Supply chain partners, various operations, liabilities between parties, material flows, information and communication flows are all included in the study. The main emphasis is placed on operations rather than costs. It is essential to find out how smooth, effective, efficient and professional the operations are in the various phases of the supply chain. The goal is to explore, describe and analyse problems between authorities, between commercial operators and between other parties. This study also charts the types of precautions taken against various risks.

The purpose is to collect information on different supply chains: various types of goods (liquid and dry bulk, unitised and general cargo), the most important DG classes, different transport modes (road, rail, maritime) and transport units (container, semi-trailer, road vehicles, rail wagon). The routes are selected so that each supply chain comprises at least two BSR countries.

A detailed process description of each selected DG supply chain is issued. The study aims at providing comparable results, which can be ensured by forming and using uniform metrics and methodology, when analysing the DG supply chains. The conclusion of each of the cases will reveal individual bottlenecks and development areas. Based on these results, recommendations for remedial actions are offered. WP3 will utilise the

recommendations from WP1 – including this case study – and WP2, when establishing the DaGoB Action Plan to be disseminated in the whole BSR.

1.3 Multiple Case Study Methodology

The study is inactive, starting with observations followed by patterns. Inductive reasoning will continue with tentative hypotheses leading to a theory.

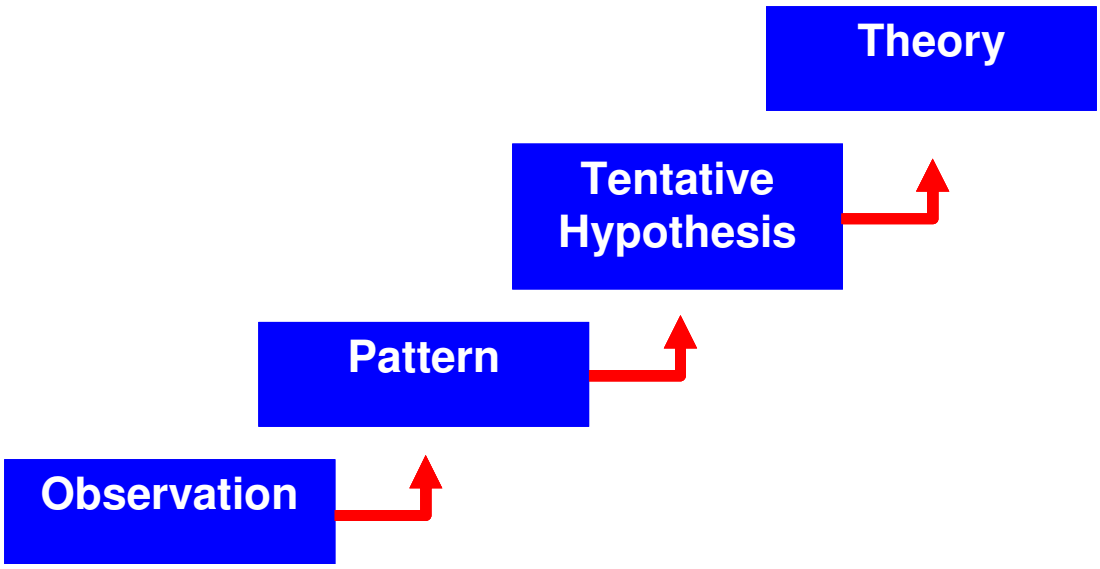


Figure 1 Inductive reasoning[1]

As is common in multiple case studies, the following is very empirical and descriptive. It contains both quantitative and qualitative data. It describes actors in systems. As far as is possible, conclusions present some generalisations. The theory – observation – methodology positioning is in observations.

[1] Trochim, W.M. Cornell University (2006) <http://www.socialresearchmethods.net/kb/dedind.htm>, retrieved 11.9.2006

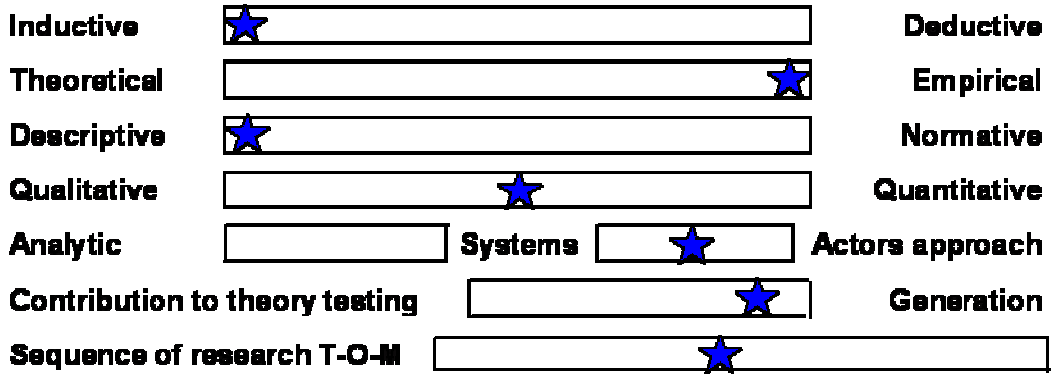


Figure 2 Methodological positioning of the study[2]

As a Multiple Case Study, this study presents the theoretical framework, design and classification of dangerous goods in chapters 1 and 2. After that, single case data collection and single case analysis are presented in chapter 3. Finally, the cross-case analysis is concluded in chapter 4. The single case sections are executed by five students from the TSE. The structure of the multiple case study methodology is shown in table 3.

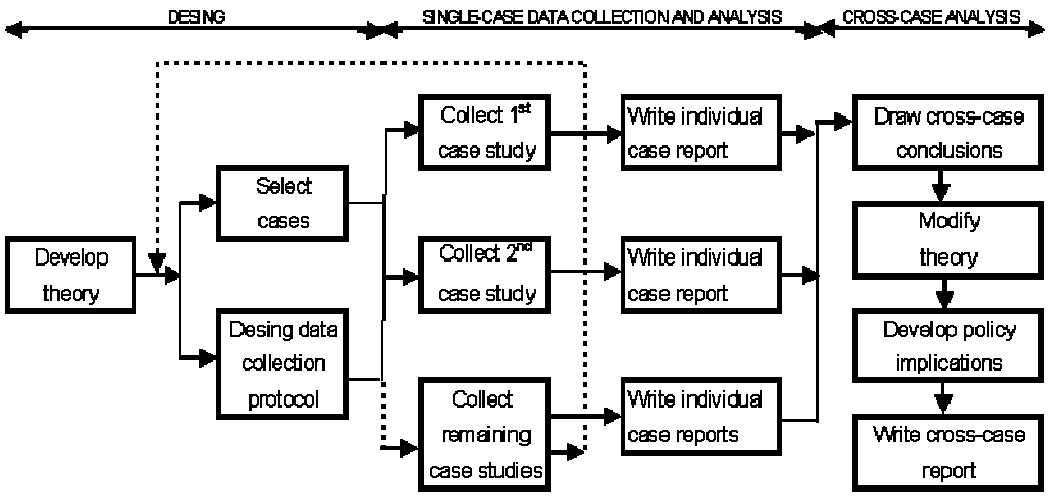


Figure 3 Multiple case study methodology[3]

1.4 Analytical frame of the study

The supply chain of DG involves a number of commercial actors. A supply chain is initiated by a consignor and ends up with a consignee. A number of

[2] Arbnor,I – Bjerke, B (1997) *Methodology for Creating Business Knowledge* (2nd ed.). Sage Publications: London.
[3] Yin, R.K. (1994) *Case Study research, Design and Method, Second Edition.* Applied Social Research Methods Series, Vol. 5: Sage Publications, Thousand Oaks, CA

transport- and terminal-related service providers are involved in the middle of a DG supply chain. The nodes in between the commercial actors are called interfaces. The number of interfaces varies from case to case. These interfaces are addressed from 1 to 4, where 2 and 3 have sub-addresses from 1 to n.

The interest areas of the study are, A communication process, B authority involvement, C document process, D liability process, and E time consumption. The nodes in between the interfaces and the interest areas are thus addressed in matrix. Questions in every addressed node shall be directed both upstream and downstream of the supply chain, in order to get measurable deviations in between actors.

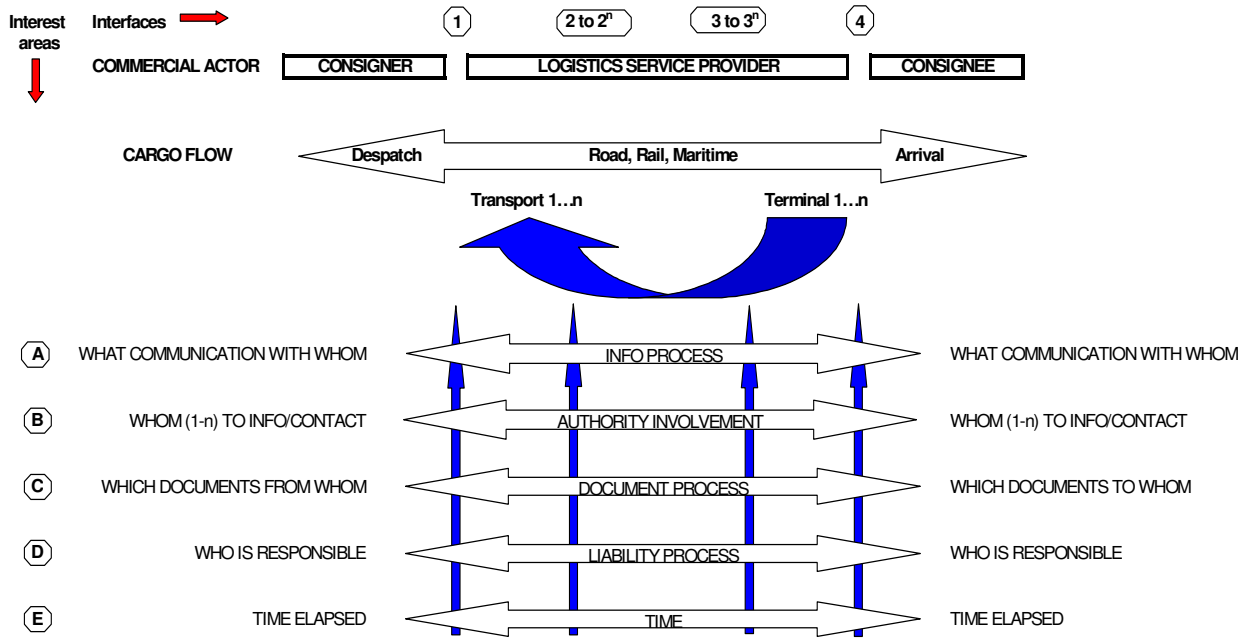


Figure 4 Analytical frame of the study

2 CONTEXT OF THE STUDY

This chapter is based upon the two previous DaGoB publications – DaGoB publication series 2:2006 & 3:2006 – which introduce (i) the classification of dangerous goods and (ii) the regulations involved in DG transport.

2.1 The classification of dangerous goods

The following definitions of Dangerous Goods classes have been taken from the Recommendations on the Transport of Dangerous Goods, published by the United Nations (2005).

2.1.1 Class 1 - Explosives

2.1.1.1 Definitions and general provisions

Class 1 comprises:

a) Explosive substances (a substance which is not itself an explosive, but which can form an explosive atmosphere of gas, vapour or dust is not included in Class 1), except those that are too dangerous to transport, or those where the predominant hazard is appropriate to another class;
b) Explosive articles, except devices containing explosive substances in such quantity or of such a character that their inadvertent or accidental ignition or initiation during transport shall not cause any effect external to the device, either by projection, fire, smoke, heat or loud noise; and
c) Substances and articles not mentioned under (a) and (b), which are manufactured with a view to producing a practical, explosive or pyrotechnic effect. Transport of explosive substances, which are unduly sensitive or so reactive as to be subject to spontaneous reaction, is prohibited.

For the purposes of these Regulations, the following definitions apply:

a) An explosive substance is a solid or liquid substance (or a mixture of substances), which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a

speed as to cause damage to the surroundings. Pyrotechnic substances are included even when they do not evolve gases;

b) A pyrotechnic substance is a substance or a mixture of substances designed to produce an effect by heat, light, sound, gas or smoke or a combination of these as the result of non-detonative self-sustaining exothermic chemical reactions;

c) An explosive article is an article containing one or more explosive substances.

2.1.1.2Divisions

Class 1 is split into six divisions as follows:

a) Division 1.1 Substances and articles, which have a mass explosion hazard (a mass explosion is one which affects almost the entire load virtually instantaneously);

b) Division 1.2 Substances and articles, which have a projection hazard but not a mass explosion hazard;

c) Division 1.3 Substances and articles, which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard. This division comprises substances and articles: (i) which give rise to considerable radiant heat; or (ii) which burn one after another, producing minor blast or projection effects or both;

d) Division 1.4 Substances and articles, which present no significant hazard. This division comprises substances and articles, which present only a small hazard in the event of ignition or initiation during transport. The effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire shall not cause virtually instantaneous explosion of almost the entire contents of the package;

e) Division 1.5 Very insensitive substances, which have a mass explosion hazard. This division comprises substances, which have a mass explosion hazard but are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions of transport;

f) Division 1.6 Extremely insensitive articles, which do not have a mass explosion hazard. This division comprises articles, which contain only extremely insensitive detonating substances, and

which demonstrate a negligible probability of accidental initiation or propagation.

2.1.2 Class 2 - Gases

2.1.2.1 Definitions and general provisions

A gas is a substance, which:

a) at 50 °C has a vapour pressure greater than 300 kPa; or
b) is completely gaseous at 20 °C at a standard pressure of 101.3 kPa.

The transport condition of a gas is described according to its physical state as:

a) Compressed gas – a gas, which, when packaged under pressure for transport, is entirely gaseous at -50 °C; this category includes all gases with a critical temperature less than or equal to -50 °C;
b) Liquefied gas – a gas, which, when packaged under pressure for transport, is partially liquid at temperatures above -50 °C. A distinction is made between high pressure liquefied gas – a gas with a critical temperature between -50 °C and +65 °C, and low pressure liquefied gas – a gas with a critical temperature above +65 °C;
c) Refrigerated liquefied gas – a gas, which, when packaged for transport, is made partially liquid because of its low temperature; or
d) Dissolved gas – a gas, which, when packaged under pressure for transport, is dissolved in a liquid phase solvent.

The class comprises compressed gases, liquefied gases, dissolved gases, refrigerated liquefied gases, mixtures of one or more gases with one or more vapours of substances of other classes, articles charged with a gas and aerosols.

2.1.2.2 Divisions

Substances of Class 2 are assigned to one of three divisions based on the primary hazard of the gas during transport.

a) Division 2.1 Flammable gases. Gases, which, at 20 °C and a standard pressure of 101.3 kPa: (i) are ignitable when in a mixture

of 13 per cent or less by volume with air; or (ii) have a flammable range with air of at least 12 percentage points regardless of the lower flammable limit. Flammability shall be determined by tests or by calculation in accordance with methods adopted by ISO (see ISO 10156:1996). Where insufficient data is available to use these methods, tests by a comparable method recognised by a national competent authority may be used;

b) Division 2.2 Non-flammable, non-toxic gases. Gases, which: (i) are asphyxiant - gases, which dilute or replace the oxygen normally in the atmosphere; or (ii) are oxidising - gases which may, generally by providing oxygen, cause or contribute to the combustion of other material more than air does; or (iii) do not come under the other divisions;
c) Division 2.3 Toxic gases. Gases, which: (i) are known to be so toxic or corrosive to humans as to pose a hazard to health; or (ii) are presumed to be toxic or corrosive to humans, because they have an LC50 value equal to or less than 5000 ml/m3 (ppm).

Gases and gas mixtures with hazards associated with more than one division take the following precedence:

a) Division 2.3 takes precedence over all other divisions;
b) Division 2.1 takes precedence over Division 2.2.

Gases of Division 2.2, other than refrigerated liquefied gases, are not subject to these Regulations, if they are transported at a pressure less than 280 kPa at 20 °C.

2.1.3 Class 3 - Flammable Liquids

2.1.3.1 Definition and general provisions

Class 3 includes the following substances:

a) Flammable liquids
b) Liquid desensitised explosives

Flammable liquids are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (for example, paints, varnishes, lacquers, etc., but not including substances otherwise classified on account of their dangerous characteristics), which give off a flammable vapour at temperatures of not more than 60 °C in a closed-cup test, or not more than

65.6 ℃ in an open-cup test, normally referred to as the flash point. This class also includes:

a) liquids offered for transport at temperatures at or above their flash point; and
b) substances that are transported or offered for transport at elevated temperatures in a liquid state, and which give off a flammable vapour at a temperature at or below the maximum transport temperature.

Liquids with a flash point of more than 35 ℃, which do not sustain combustion, need not be considered as flammable liquids for the purposes of these Regulations. Liquids are considered to be unable to sustain combustion for the purposes of these Regulations (i.e. they do not sustain combustion under defined test conditions) if: (a) they have passed a suitable combustibility test, (b) their fire point according to ISO 2592:2000 is greater than 100 ℃; or (c) they are water-miscible solutions with a water content of more than 90% by mass. Liquid desensitised explosives are explosive substances, which are dissolved or suspended in water or other liquid substances, to form an homogeneous liquid mixture to suppress their explosives properties.

Table 1 Hazard grouping based on flammability

Packing group	Flash point (closed-cup)	Initial boiling point
I	--	≤ 35 ℃
II	< 23 ℃	> 35 ℃
III	≥ 23 ℃ ≤ 60 ℃	> 35 ℃

2.1.4 Class 4 - Flammable Solids

2.1.4.1 Definitions and general provisions

The official full name of the class 4 is Flammable Solids; Substances Liable to Spontaneous Combustion; Substances, which in Contact with Water, Emit Flammable Gases. This class is divided into three divisions as follows:

a) Division 4.1 Flammable solids. Solids which, under conditions encountered in transport, are readily combustible, or may cause or contribute to fire through friction; self-reactive substances, which

are liable to undergo a strongly exothermic reaction; solid desensitised explosives, which may explode if not diluted sufficiently;

b) Division 4.2 Substances liable to spontaneous combustion. Substances, which are liable to spontaneous heating under normal conditions encountered in transport, or to heating up in contact with air, and then being liable to catch fire;
c) Division 4.3 Substances, which in contact with water, emit flammable gases. Substances, which, through interaction with water, are liable to become spontaneously flammable, or to give off flammable gases in dangerous quantities.

2.1.4.2 Division 4.1 - Flammable solids, self-reactive substances and solid desensitised explosives

Division 4.1 includes the following types of substances:

a) Flammable solids
b) Self-reactive substances and
c) Solid desensitised explosives.

2.1.4.2.1 Division 4.1 Flammable solids

Flammable solids are readily combustible solids, and solids, which may cause fire through friction. Readily combustible solids are powdered, granular, or pasty substances, which are dangerous if they can be easily ignited by brief contact with an ignition source, such as a burning match, and if the flame spreads rapidly. The danger may come not only from the fire but also from toxic combustion products. Metal powders are especially dangerous because of the difficulty of extinguishing a fire, since normal extinguishing agents such as carbon dioxide or water can increase the hazard.

2.1.4.2.2 Division 4.1 Self-reactive substances

For the purposes of these Regulations: Self-reactive substances are thermally unstable substances liable to undergo a strongly exothermic decomposition, even without the participation of oxygen (air). Substances are not considered to be self-reactive substances of Division 4.1, if:

a) they are explosives according to the criteria of Class 1;
b) they are oxidising substances according to the classification procedure for Division 5.1, except that mixtures of oxidising

substances, which contain 5.0% or more combustible organic substances shall be subjected to the classification procedure defined in Note 3;

c) they are organic peroxides according to the criteria of Division 5.2;
d) the heat from their decomposition is less than 300 J/g; or
e) their self-accelerating decomposition temperature (SADT) is greater than 75 ℃ for a 50 kg package.

The decomposition of self-reactive substances can be initiated by heat, contact with catalytic impurities (e.g. acids, heavy-metal compounds, bases), friction or impact. The rate of decomposition increases with temperature and varies with the substance. Decomposition, particularly if no ignition occurs, may result in the evolution of toxic gases or vapours. For certain self-reactive substances, the temperature shall be controlled. Some self-reactive substances may decompose explosively, particularly if confined. This characteristic may be modified by the addition of diluents or by the use of appropriate packagings. Some self-reactive substances burn vigorously.

2.1.4.2.3 Division 4.1 Solid desensitised explosives

Solid desensitised explosives are explosive substances, which are irrigated with water or alcohols or are diluted with other substances, to form a homogeneous solid mixture to suppress their explosive properties. Substances that: (a) have been provisionally accepted into Class 1 according to Test Series 1 and 2 but exempted from Class 1 by Test Series 6; (b) are not self-reactive substances of Division 4.1; and (c) are not substances of Class 5, are also assigned to Division 4.1.

2.1.4.3 Division 4.2 - Substances liable to spontaneous combustion

Division 4.2 includes: (a) Pyrophoric substances, including mixtures and solutions (liquid or solid), which, even in small quantities, ignite within five minutes of coming in contact with air. These are the Division 4.2 substances that are the most prone to spontaneous combustion; and (b) Self-heating substances, other than pyrophoric substances, which, when in contact with air without an energy supply, are prone to self-heating. These substances will ignite only when in large amounts (kilograms) and after long periods of time (hours or days). Self-heating of substances, leading to spontaneous combustion, is caused by reaction of the substance with oxygen (in the air), and the heat developed not being conducted away rapidly enough to the

surroundings. Spontaneous combustion occurs when the rate of heat production exceeds the rate of heat loss and the auto-ignition temperature is reached.

2.1.4.4 Division 4.3 – Substances, which, in contact with water, emit flammable gases

Certain substances in contact with water may emit flammable gases that can form explosive mixtures with air. Such mixtures are easily ignited by all ordinary sources of ignition, for example naked lights, sparking handtools or unprotected light bulbs. The resulting blast wave and flames may endanger people and the environment. The test method referred to in 2.4.4.2 is used to determine whether the reaction of a substance with water leads to the development of a dangerous amount of gases, which may be flammable. This test method shall not be applied to pyrophoric substances.

2.1.5 Class 5 - Oxidising Substances and Organic Peroxides

2.1.5.1 Definitions and general provisions

Class 5 is split into two divisions as follows:

a) Division 5.1 Oxidising substances. Substances, which, while in themselves not necessarily combustible, may, generally by yielding oxygen, cause, or contribute to, the combustion of other material. Such substances may be contained in an article;
b) Division 5.2 Organic peroxides. Organic substances, which contain the bivalent -0-0- structure and may be considered derivatives of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals. Organic peroxides are thermally unstable substances, which may undergo exothermic self-accelerating decomposition. In addition, they may have one or more of the following properties: (i) be liable to explosive decomposition; (ii) burn rapidly; (iii) be sensitive to impact or friction; (iv) react dangerously with other substances; (v) cause damage to the eyes.

2.1.5.2Division 5.1 – Oxidising substances

2.1.5.2.1 Oxidising solids

Solid oxidising substances are assigned to a packing group according to the test procedure in the Manual of Tests and Criteria, in accordance with the following criteria:

a) Packing group I: any substance, which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time less than the mean burning time of a 3:2 mixture, by mass, of potassium bromate and cellulose;
b) Packing group II: any substance, which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time equal to or less than the mean burning time of a 2:3 mixture (by mass) of potassium bromate and cellulose, and the criteria for packing group I are not met;
c) Packing group III: any substance, which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time equal to or less than the mean burning time of a 3:7 mixture (by mass) of potassium bromate and cellulose, and the criteria for packing groups I and II are not met;
d) Not Division 5.1: any substance, which, in both the 4:1 and 1:1 sample-to-cellulose ratio (by mass) tested, does not ignite and burn, or exhibits mean burning times greater than that of a 3:7 mixture (by mass) of potassium bromate and cellulose.

2.1.5.2.2 Oxidising liquids

Liquid oxidising substances are assigned to a packing group according to the test procedure in the Manual of Tests and Criteria, in accordance with the following criteria:

a) Packing group I: any substance, which, in the 1:1 mixture, by mass, of substance and cellulose tested, spontaneously ignites; or the mean pressure rise time of a 1:1 mixture, by mass, of substance and cellulose is less than that of a 1:1 mixture, by mass, of 50% perchloric acid and cellulose;
b) Packing group II: any substance, which, in the 1:1 mixture, by mass, of substance and cellulose tested, exhibits a mean pressure rise time less than or equal to the mean pressure rise time of a 1:1 mixture, by mass, of 40% aqueous sodium chlorate solution and cellulose, and the criteria for packing group I are not met;

c) Packing group III: any substance which, in the 1:1 mixture, by mass, of substance and cellulose tested, exhibits a mean pressure rise time less than or equal to the mean pressure rise time of a 1:1 mixture, by mass, of 65% aqueous nitric acid and cellulose, and the criteria for packing groups I and II are not met;
d) Not Division 5.1: any substance, which, in the 1:1 mixture, by mass, of substance and cellulose tested, exhibits a pressure rise of less than 2070 kPa gauge; or exhibits a mean pressure rise time greater than the mean pressure rise time of a 1:1 mixture, by mass, of 65% aqueous nitric acid and cellulose.

2.1.5.3 Division 5.2 - Organic peroxides

Organic peroxides are liable to exothermic decomposition at normal or elevated temperatures. The decomposition can be initiated by heat, contact with impurities (e.g. acids, heavy-metal compounds, amines), friction or impact. The rate of decomposition increases with temperature and varies with the organic peroxide formulation. Decomposition may result in the evolution of harmful, or flammable, gases or vapours. For certain organic peroxides the temperature shall be controlled during transport. Some organic peroxides may decompose explosively, particularly if confined. This characteristic may be modified by the addition of diluents or by the use of appropriate packaging. Many organic peroxides burn vigorously. Contact of organic peroxides with the eyes is to be avoided. Some organic peroxides will cause serious injury to the cornea, even after brief contact, or will be corrosive to the skin.

2.1.6 Class 6 - Toxic and Infectious Substances

2.1.6.1 Definitions

Class 6 is divided into two divisions as follows:

a) Division 6.1 Toxic substances. These are substances liable either to cause death or serious injury, or to harm human health if swallowed or inhaled, or by skin contact;
b) Division 6.2 Infectious substances. These are substances known or reasonably expected to contain pathogens. Pathogens are defined

as micro-organisms (including bacteria, viruses, rickettsiae, parasites, fungi) and other agents such as prions, which can cause disease in humans or animals.

2.1.6.2Division 6.1 - Toxic substances

For the purposes of these Regulations:

- LD50 (median lethal dose) for acute oral toxicity is the statistically derived single dose of a substance that can be expected to cause death within 14 days in 50 per cent of young adult albino rats, when administered by the oral route. The LD50 value is expressed in terms of mass of test substance per mass of test animal (mg/kg).
- LD50 for acute dermal toxicity is that dose of the substance which, when administered by continuous contact for 24 hours to the bare skin of albino rabbits, is most likely to cause death within 14 days in one half of the animals tested. The number of animals tested shall be sufficient to give a statistically significant result, and be in conformity with good pharmacological practice. The result is expressed in milligrams per kg body mass.
- LC50 for acute toxicity on inhalation is that concentration of vapour, mist or dust which, when administered by continuous inhalation to both male and female young adult albino rats for one hour, is most likely to cause death within 14 days in one half of the animals tested. A solid substance shall be tested if at least 10% (by mass) of its total mass is likely to be dust in a respirable range, e.g. the aerodynamic diameter of that particlefraction is 10 microns or less. A liquid substance shall be tested if a mist is likely to be generated in a leakage of the transport containment. Both for solid and liquid substances, more than 90% (by mass) of a specimen prepared for inhalation toxicity shall be in the respirable range as defined above. The result is expressed in milligrams per litre of air for dusts and mists or in millilitres per cubic metre of air (parts per million) for vapours.

Substances of Division 6.1, including pesticides, are allocated among the three packing groups according to their degree of toxic hazard in transport as follows:

a) Packing group I: Substances and preparations presenting a very severe toxicity risk;

b) Packing group II: Substances and preparations presenting a serious toxicity risk;
c) Packing group III: Substances and preparations presenting a relatively low toxicity risk.

In making this grouping, account shall be taken of human experience in instances of accidental poisoning and of special properties possessed by any individual substance, such as liquid state, high volatility, any special likelihood of penetration, and special biological effects. In the absence of human experience, the grouping shall be based on data obtained from animal experiments. Three possible routes of administration shall be examined. These routes are exposure through:

a) oral ingestion;
b) dermal contact; and
c) inhalation of dusts, mists, or vapours.

When a substance exhibits a different order of toxicity by two or more of these routes of administration, the highest degree of danger indicated by the tests shall be assigned. The criteria to be applied for grouping a substance according to the toxicity it exhibits by all three routes of administration are presented in the following paragraphs. The grouping criteria for the oral and dermal routes as well as for inhalation of dusts and mists are as shown in the following table.

Table 2 Grouping Criteria for Administration through Oral Ingestion, Dermal Contact and Inhalation of Dusts and Mists

Packing group	Oral toxicity LD50 (mg/kg)	Dermal toxicity LD50 (mg/kg)	Inhalation toxicity by dusts and mists LC50 (mg/l)
I	≤ 5.0	≤ 50	≤ 0.2
II	> 5.0 and ≤ 50	> 50 and ≤ 200	> 0.2 and ≤ 2.0
III	> 50 and ≤ 300	> 200 and ≤ 1000	> 2.0 and ≤ 4.0

2.1.6.3Division 6.2 - Infectious substances

For the purposes of these Regulations:

- Infectious substances are substances which are known or are reasonably expected to contain pathogens. Pathogens are defined as micro-organisms (including bacteria, viruses, rickettsiae,

parasites, fungi) and other agents such as prions, which can cause disease in humans or animals.

- Biological products are those products derived from living organisms, which are manufactured and distributed in accordance with the requirements of appropriate national authorities, which may have special licensing requirements, and are used either for prevention, treatment, or diagnosis of disease in humans or animals, or for developmental, experimental or investigational purposes related thereto. They include, but are not limited to, finished or unfinished products such as vaccines.
- Cultures are the result of a process by which pathogens are intentionally propagated. This definition does not include human or animal patient specimens.
- Patient specimens are human or animal materials, collected directly from humans or animals, including, but not limited to, excreta, secreta, blood and its components, tissue and tissue fluid swabs, and body parts being transported for purposes such as research, diagnosis, investigational activities, disease treatment and prevention.
- Genetically modified micro-organisms and organisms are micro-organisms and organisms, in which genetic material has been purposely altered through genetic engineering in a way that does not occur naturally.
- Medical or clinical wastes are wastes derived from the medical treatment of animals or humans or from bio-research.

2.1.7 Class 7 – Radioactive Material

2.1.7.1 Definition

Radioactive material means any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified. The following radioactive materials are not included in Class 7 for the purposes of these Regulations:

a) Radioactive material that is an integral part of the means of transport;

b) Radioactive material moved within an establishment which is subject to appropriate safety regulations in force in the establishment and where the movement does not involve public roads or railways;
c) Radioactive material implanted or incorporated into a person or live animal for diagnosis or treatment;
d) Radioactive material in consumer products which have received regulatory approval, following their sale to the end user;
e) Natural material and ores containing naturally occurring radionuclides which are either in their natural state, or have only been processed for purposes other than for extraction of the radionuclides, and which are not intended to be processed for use of these radionuclides provided the activity concentration of the material does not exceed 10 times the values specified;
f) Non-radioactive solid objects with radioactive substances present on any surfaces in quantities not in excess of the limit set out in the definition for “contamination”.

2.1.8 Class 8 – Corrosive Substances

2.1.8.1 Definition

Class 8 substances (corrosive substances) are substances, which, by chemical action, will cause severe damage when in contact with living tissue, or, in the case of leakage, will materially damage, or even destroy, other goods or the means of transport.

Substances and preparations of Class 8 are divided among the three packing groups according to their degree of hazard in transport as follows:

a) Packing group I: Very dangerous substances and preparations;
b) Packing group II: Substances and preparations presenting medium danger;
c) Packing group III: Substances and preparations presenting minor danger.

Allocation of substances listed in the Dangerous Goods List to the packing groups in Class 8 has been made on the basis of experience, taking into account such additional factors as inhalation risk and reactivity with water (including the formation of dangerous decomposition products). New

substances, including mixtures, can be assigned to packing groups on the basis of the length of time of contact necessary to produce full thickness destruction of human skin in accordance with the criteria. Liquids, and solids, which may become liquid during transport, and are judged not to cause full thickness destruction of human skin, shall still be considered for their potential to cause corrosion to certain metal surfaces in accordance with the criteria.

A substance or preparation meeting the criteria of Class 8, having an inhalation toxicity of dusts and mists (LC50) in the range of packing group I, but toxicity through oral ingestion or dermal contact only in the range of packing group III or less, shall be allocated to Class 8.

Packing groups are assigned to corrosive substances in accordance with the following criteria:

a) Packing group I is assigned to substances that cause full thickness destruction of intact skin tissue within an observation period of up to 60 minutes, starting after an exposure time of three minutes or less;
b) Packing group II is assigned to substances that cause full thickness destruction of intact skin tissue within an observation period of up to 14 days, starting after an exposure time of more than three minutes but not more than 60 minutes;
c) Packing group III is assigned to substances that: (i) cause full thickness destruction of intact skin tissue within an observation period of up to 14 days, starting after an exposure time of more than 60 minutes but not more than 4 hours; or (ii) are judged not to cause full thickness destruction of intact skin tissue, but which exhibit a corrosion rate on steel or aluminium surfaces exceeding 6.25 mm a year at a test temperature of 55 °C.

2.1.9 Class 9 – Miscellaneous Dangerous Substances and Articles

2.1.9.1 Definitions

Class 9 substances and articles (miscellaneous dangerous substances and articles) are substances and articles, which, during transport present a danger not covered by other classes. Genetically modified micro-organisms (GMMOs) and genetically modified organisms (GMOs) are micro-organisms

and organisms in which genetic material has been purposely altered through genetic engineering in a way that does not occur naturally.

Class 9 includes, inter alia:

a) environmentally hazardous substances, which are not covered by other classes;
b) elevated temperature substances (i.e. substances that are transported or offered for transport at temperatures equal to or exceeding 100°C in a liquid state or at temperatures equal or exceeding 240°C in a solid state);
c) GMMOs or GMOs, which do not meet the definition of infectious substances, but which are capable of altering animals, plants or microbiological substances in a way not normally the result of natural reproduction. They shall be assigned to UN 3245. GMMOs or GMOs are not subject to these Regulations when authorised for use by the competent authorities of the Governments of the countries of origin, transit and destination.

2.1.10 Environmentally hazardous substances (aquatic environment)

Environmentally hazardous substances include, inter alia, liquid or solid substances pollutant to the aquatic environment, and solutions and mixtures of such substances (such as preparations and wastes). The aquatic environment may be considered in terms of the aquatic organisms that live in the water, and the aquatic ecosystem of which they are a part. The basis, therefore, of the identification of the hazard is the aquatic toxicity of the substance or mixture, although this may be modified by further information on the degradation and bioaccumulation behaviour.

The basic elements for classification of environmentally hazardous substances (aquatic environment) are:

- acute aquatic toxicity;
- potential for or actual bioaccumulation;
- degradation (biotic or abiotic) for organic chemicals; and
- chronic aquatic toxicity.

While data from internationally harmonised test methods are preferred, in practice, data from national methods may also be used where it is considered as equivalent. In general, freshwater and marine species toxicity data can be considered as equivalent data and is preferably to be derived

using OECD Test Guidelines or their equivalent, according to the principles of Good Laboratory Practices (GLP). Where such data is not available, classification shall be based on the best available data.

2.2 The regulations involved in the transport of dangerous goods

Like transport law in general, the carriage of dangerous goods in various modes of transport is often governed by separate legal acts, and the scope of the provisions has to be studied each time to verify their application in the context of multimodal transport.

All European Union countries except Ireland are parties to the European agreement concerning the international **carriage of dangerous goods by road**. The ADR Agreement applies to international carriage of dangerous goods by road, and its provisions do not usually differ much from domestic regulations. Pursuant to the Agreement, it is possible to conclude multilateral agreements on particular issues between individual parties to the agreement.

According to section 1.9 of the Agreement, the Competent Authority of an adherent state has to notify its domestic restrictions on the transportation of dangerous goods to the UNECE Secretariat in situations specified in the above section. The Secretariat then has to inform other parties to the Agreement of these restrictions.

The European Union has also regulated the carriage of dangerous goods by road through a directive that is based on the ADR Agreement. This Directive was followed by another directive regarding uniform procedures for checks on the transport of dangerous goods by road. The Directives have given the European Commission the right to make regular changes to the technical provisions, or to grant exceptions.

In the **international carriage of dangerous goods by rail,** the international RID provisions (*Ordnung für die internationale Eisenbahnbeförderung gefährlicher Güter*) are applicable. As a rule, these provisions do not differ from domestic regulations. Russia and Estonia do not apply the RID provisions. The carriage of dangerous goods by rail has also been regulated by the European Union, and the European Commission has likewise been vested the right to amend the technical provisions and grant certain exceptions.

The SOLAS Convention has been amended by the INF Code relating to radioactive cargo. The entire name of the INF Code is the International Code

for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships.

The carriage of **dangerous cargo in bulk** is governed by Chapter VII of the SOLAS Convention and there are codes specifying requirements for the construction and equipment of ships involved in the transport of dangerous liquid and gas cargoes in bulk.

Eight countries surrounding the Baltic Sea have concluded a Memorandum of Understanding regarding the transportation of packed general goods on board **roll on-roll off (ro-ro) vessels in the Baltic Sea**. The Memorandum has been subject to yearly amendments, all of which have entered into force on January of the subsequent year. The ship owner can apply the rules of the Memorandum in the Baltic Sea including the Gulf of Bothnia, the Gulf of Finland and the entry to the Baltic Sea in short-sea ro-ro traffic, where the requirement established in the Memorandum regarding such matters as the training of the crew and personnel are satisfied. The Memorandum contains special provisions relating to the carriage of dangerous goods within the scope of the ADR Agreement and the RID provisions. The Memorandum allows the carriage of dangerous goods on designated routes.

In **air transport**, the ICAO-TI, namely the Technical Instructions for the Safe Transport of Dangerous Goods by Air (2005-2006 Edition), (Doc 9284-AN/905) as well as the IATA-DGR, namely IATA Dangerous Goods Regulations) are applicable.

An integral part of the legislation of the EU countries relating to the carriage of dangerous goods is the function of the safety adviser. The relevant Directive provides that undertakings, the activities of which include the transport, or the related loading or unloading, of dangerous goods by road, rail or inland waterway, each appoint one or more safety advisers for the transport of dangerous goods, responsible for helping to prevent the risks inherent in such activities with regard to persons, property and the environment.

The EU has also regulated transportable pressure equipment by a Directive. The purpose of this Directive is to enhance safety with regard to transportable pressure equipment approved for inland transport by road and rail, and to ensure the free movement of such equipment within the Community, including its placing on the market, repeated putting into service and repeated use aspects.

Transportable pressure equipment envisaged in the Directive shall bear a phi-mark as proof that the equipment meets the requirements put forward by

the rules applicable to the carriage of dangerous goods by road or rail. The recognition and verification issued in one Member State shall be recognised reciprocally in all EU and EEA states.

The multitude of legal regimes applicable to the transport of dangerous goods is, however, alleviated by the fact that the United Nations issues substance-specific Recommendations on the Transport of Dangerous Goods, which set the basic requirements for all modes of transport. Known as the Orange Book, this directory provides an extensive list of dangerous goods and their control in transport by air, rail, road, sea and inland waterways. It covers classification and definitions of all dangerous substances; packaging, labelling and relevant shipping documentation; and the training of transport workers.

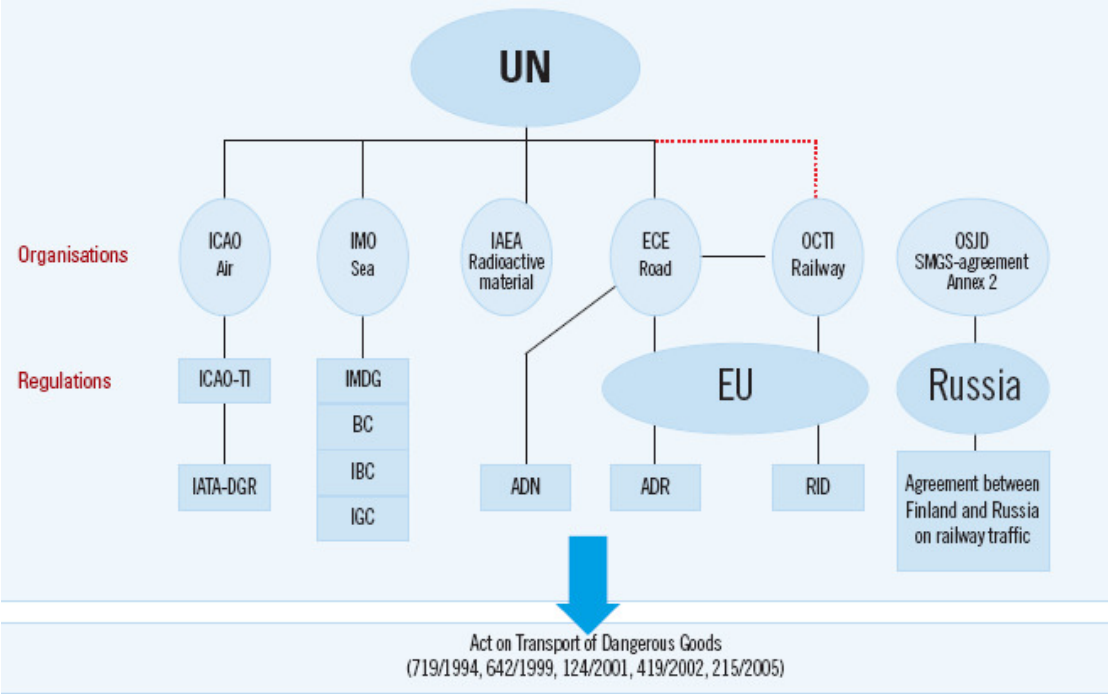


Figure 5 International organisations and agreements for DG transport[4]

2.2.1 The case of Finland

Each of the states around the Baltic Sea has its own transport law, but the international legal framework (or patchwork) described above determines the principal contents of the legislation. It has been suggested that the relevant authorities should be contacted to see how the international framework has been implemented and what the precise procedures and bodies in each

[4] Finnish Ministry of Transport and Communications – DG strategy 2006 – 2015

country are. In many countries, the relevant provisions are shown on a government website.

The highest level of management and guidance in the supervision compliance with the Act on Transport of Dangerous Goods and provisions and regulations issued thereunder belongs to the Ministry of Transport and Communications. In matters concerning the transport of dangerous goods, the Ministry shall be assisted by an Advisory Board, which has been provided for in a Government Decree.

Compliance with the Act and provisions and regulations issued on the basis of the Act are monitored by the Finnish Maritime Administration, the Finnish Civil Aviation Administration, the Customs Administration, the police authorities, the Finnish Rail Administration, the Border Guard, port authorities, the Safety Technology Authority, the Vehicle Administration Centre, the Finnish Centre for Radiation and Nuclear Safety and the labour protection authorities, each in its own field of activity, as covered by this Act and further by government decree. The other duties of these authorities relating to the transport or temporary storage of dangerous goods, to their fields of activity and to the co-operation between national and foreign authorities shall be covered by this Act and, where necessary, also by government decree.

The duties of other authorities in the field of ensuring the safety of the transport of dangerous goods may also be provided for by a governmental decree.

Finland recognises foreign supervision, which is based on the law of another EU Member State, or which is based on an international agreement that Finland has entered into.

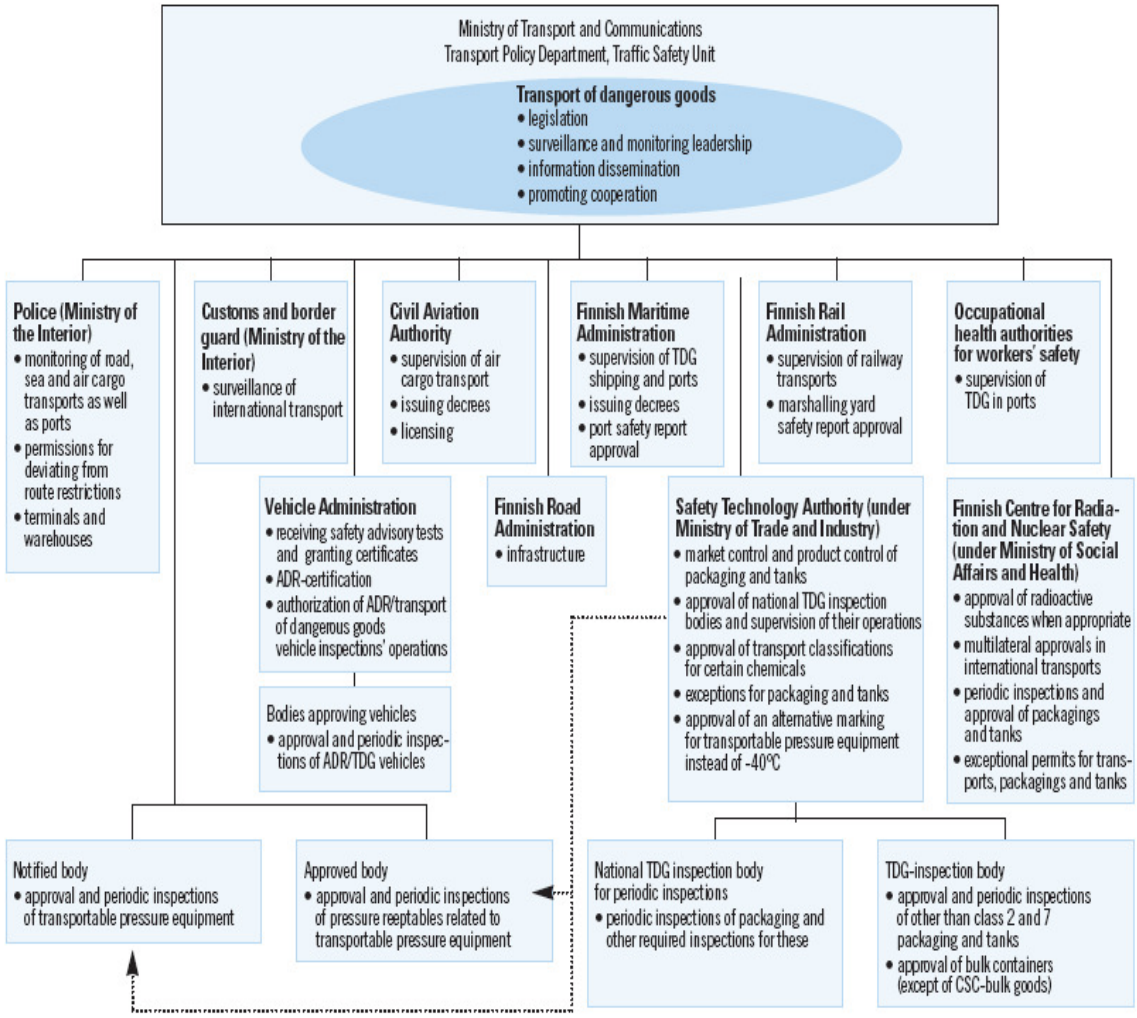


Figure 6 Authorities involved in DG transport in Finland[5]

[5] Finnish Ministry of Transport and Communications – DG strategy 2006 – 2015

3 SINGLE CASE DESCRIPTIONS

In this report, we have analysed several Dangerous Goods transport cases, and produced a synthesis report based on these transport chain descriptions. An identification of the key problems or bottlenecks has also been produced. In the 'key findings' chapter, we will give some recommendations concerning remedial actions.

Table 3 Dangerous Goods transported in the selected cases

Case	Name	IMDG Class	UN no.	Packing group
1	Hydrogen	2.1	1049	-
2	Methane	2.1	1972	-
3	Argon Nitrogen Oxygen	2.2 2.2 2.2 (5.1)	1951 1977 1073	- - -
4	Cereclor	3 (6.1)	1993	III
5	Paratoluen sulphonic acid	8	2586	III
6	Mixed cargo	--	--	--
7	Printing ink	3	1210	II
8	Printing ink	3	1210	II
9	Paint Paint Tripropyleneglycol diacrylate	3 3 9	1263 1263 3082	II III III
10	Paint Paint Zinc oxide	3 3 9	1263 1263 3082	II III III
11	Paint Paint Isophoronediamine Epoxy resin (mw < 700)	3 3 8 9	1263 1263 2289 3082	II III III III
12	Ammonia, anhydrous	2.3 (8)	1005	-
13	Fluorosilicic acid	8	1778	II
14	Ammonium nitrate based fertiliser	9	2071	III

This chapter introduces all the 14 different transport cases analysed, presented one by one. The cases are divided according to the transport modes and the transportation routes used, as well as according to the DG classes involved.

3.1 Case 1, Hydrogen by multimodal transport from Finland to Estonia

A full six-meter container load (equal to 180 bottles) of hydrogen is filled by the lorry driver at the production site, approximately 200 km inland from the Port of Hanko, Finland. Drivers are trained by the supplier to fill the containers themselves. The supplier utilises three logistics providers.

The order from Estonia has been received by the company's traffic office on the south coast of Finland. After the filling, the lorry drives to the Port of Hanko, where the load must arrive one hour prior to the ship's departure. The voyage from Hanko to Paldiski (46 nm) takes approximately four hours.

At the Port of Paldiski, there is an empty hydrogen container lorry docking with the filled lorry exiting the ship. The containers are changed in the port area. This is because the ship is staying in port for only two hours. The timetable does not permit the trailer to be driven straight to the client. Thus instead of having just one lorry on the move, the company needs separate lorries in Finland and Estonia. The empty lorry then returns to Finland by the same vessel.

Annual deliveries of hydrogen comprise some 15 containers. The supplier has not utilised a documented and signed process for monitoring the quality of the service, but the information system allows full reporting of supply chain operations. The supplier also systematically audits operators in the supply chain. In addition, meetings are organised, where efficiency, targets and development programmes are discussed. These meetings are also attended by management.

(A) Communication process: The order from the Estonian client is received by the supplier's Estonian office. The Estonian office submits the order to the traffic office in Finland, which then informs the selected logistics provider. The Estonian organisation is responsible for delivering an empty trailer to the Port of Paldiski. The Estonian organisation is also responsible for the delivery to the client.

In case of a supply problem, which is rare, the Estonian organisation can supply by individual bottles. In case of a long-term break in supply, the Finns can supply individual bottles to Estonia through the ports of Helsinki and Tallinn. One unit weighs 1,000 kg. Nine therefore weigh 9,000 kg, which is less than the 10,000 kg DG limit in the Port of Helsinki.

(B) Authority involvement: Customs the ports of Hanko and Paldiski need to receive all documents. The shipping company handles all operations with the maritime authorities. The police are active only in case of a roadside inspection. Border guards normally play a passive role. The logistics provider is responsible for ARD licences. The supplier has to guarantee that the containers have been inspected by Inspecta and accepted by the Finnish security authority, TUKES. There is a difference of standards between Baltic Countries and Finland – П-marked Baltic bottles are inspected down to a temperature of -20°C and similar Finnish bottles down to -40°C.

(C) Document process: The Finnish supplier is responsible for the required waybill, multimodal dangerous goods form (MDGF) and the material safety data sheet MSDS. The Estonian organisation guarantees that the docking Estonian lorry has the MSDS in the Estonian language. All lorries must be properly DG flagged.

(D) Liability process: The production site is liable for all filling operations. After deplugging the filling pipe, the supplier organisation is liable up to docking in the Port of Paldiski and back to Finland. As it is the consignor, the same organisation is liable for all the documents. The Estonian organisation is liable for all Estonian activities.

Logistics providers are liable in road transportation, according to road transportation regulations in Finland and in Estonia. In case of problems, an investigation is conducted to find the responsible party. Supply chain phases are not documented and signed separately.

(E) Time: The total throughput time – including the 24-hour period before arriving at port – is 35 hours. The supplier is responsible of the transportation for a total of eight hours. In case of non-DG, the total throughput time would be four hours less.

3.2 Case 2, Methane by multimodal transport from Finland to Sweden

The case company's Swedish organisation, or its Swedish client, places an order to the Finnish organisation on the south coast of Finland. The order is then passed to the supplier's traffic office. The filling takes place at the same supply site from where the orders are sent. Trailer tanks are filled by the

drivers working for the logistics provider. They are trained to load and unload the cargo by the Finnish organisation of the supplier.

The lorry drives some 200 km to the Port of Naantali. There the logistics provider organises the ship's position. The distance from there to Kapellskär, Sweden, is 113 nm. After arrival at Kapellskär, the trailer continues to the client in Sweden. The driver unloads the cargo at its destination.

Clients in Sweden are situated (with one exception) between 300 and 400 km from the Port of Kapellskär. This means that the same driver is capable of returning on the same day within working hours. This is possible when there are three ships rotating between the ports of Naantali and Kapellskär. It would be an advantage to the company, if it could transport the trailer without a driver. However, this is not possible as the Port of Naantali has cancelled the service.

(A) Communication process: The order from Sweden to Finland is sent via e-mail, either from the client or through the company's Swedish organisation. The information is then transmitted to the logistics provider, which books the shipping and informs the lorry driver.

In case of a problem, for example an unconfirmed order, the client calls the supplier. In case of a maritime strike, supplies will not be able to meet the required quantities due to lack of trailers. The case company's Swedish organisation must prioritise the clients' needs. There is a route available from Sweden to the Baltic, but this particular route is not yet utilised by the company. Overall, most of the problems have been minor ones.

(B) Authority involvement: Customs at the ports of Naantali and Kapellskär must receive all the required documents. The shipping company handles all operations with the maritime authorities. The police are active only in case of a roadside inspection or accident. Border guards normally play a passive role. The logistics provider is responsible for the ARD licences. The supplier must guarantee that the containers have been inspected by Inspecta and accepted by the Finnish security authority, TUKES.

(C) Document process: The Finnish supplier is responsible for the required waybill, multimodal dangerous goods form (MDGF) and the material safety data sheet MSDS. All the lorries have to be DG flagged.

(D) Liability process: The supplier in Finland is liable throughout the supply chain, from departure to return. Responsibility begins when the order is received. Every transaction is documented and signed.

(E) Time: The total throughput time – including the 24-hour pre warning – is 41 hours and 30 minutes. The supplier is responsible for the transport for a total of 38 hours. In the case of non-DG substances, the throughput time would be the same.

3.3 Case 3, Oxygen, nitrogen and argon by road from Finland to Russia

The case company's Russian organisation informs the Finnish supply site, on the south coast, of a pick-up loading. It is the responsibility of the Russians with hauling equipment to handle the pick-up. This means that the consignee is in charge of naming the logistics provider. The Russian organisation of the case company then informs the traffic office of its Finnish counterpart. The driving planner arranges the Finnish documents, but all Russian documents are arranged by a freight forwarding company. The documents arrive at the driving centre by Post. These documents are then stamped by the lorry drivers on behalf of the company's Russian and Finnish organisations. The drivers handle the filling of the containers as well. All Russian and Finnish drivers are trained to load and unload the cargo properly.

The transportation distance from the filling centre to Vaalimaa, Finland is approximately 150 km. The lorry has the right to bypass other vehicles at the border, and then it will wait for customs in the customs area. After Finnish customs involvement, the lorry continues to the border, where the requested Russian payments take place. The lorry then drives on 61 km to Vyborg, Russia, where the Russian customs are based. The lorry has the right to wait in the customs area. After Russian customs involvement, the lorry drives either 150 km to St. Petersburg or 650 km to Moscow.

The quantity of air gases transported was approximately 10,000 tonnes in 2006. This quantity is expected to double in 2007.

(A) Communication process: The case company's Russian organisation informs the Finnish filling centre of a pick-up. After the pick-up is confirmed, the Russian organisation informs their drivers. Training and guidance takes place in Finland, organised by the Finnish filling centre organisation. There is

a language barrier – an interpreter is needed for the training because the Russian drivers only speak Russian.

In case of a problem in daily operations, the only person in the Russian organisation capable of communicating in English is the managing director in Moscow. Therefore, in case of an emergency, he must be contacted by phone or e-mail for interpretation. Difficulties appear every now and then in situations such as the changing of the filling point.

(B) Authority involvement: Finnish customs is involved at the Vaalimaa border station and Russian customs is involved at Vyborg. In addition, border guards control the crossing of the border. The logistics provider is responsible for the ARD licenses. The supplier has to guarantee that the containers are inspected by Inspecta and accepted by the Finnish security authority TUKES.

(C) Document process: The waybill, material safety data sheet (MSDS) and DG instruction cards are required. The Finnish supplier arranges the Finnish documents and the logistics forwarder arranges the Russian documents. The Russian documents are posted to the supplier's traffic office. The required supplier- and receiver stamps are received at the traffic office. Lorry drivers are trained and authorised to use these stamps. The whole supply chain is operated under ADR regulations, and therefore lorries have to be DG-flagged.

(D) Liability process: As consignor, the Finnish supplier is liable for the documents. For all other processes, the Russian organisation is liable.

(E) Time: The total throughput time to St. Petersburg, including pre-warning, varies from 44 hours to 58 hours, depending on how long the lorry waits at Russian customs. The total throughput time to Moscow could not be determined.

3.4 Case 4, Cereclor by multimodal transport from France to Finland

Cereclor is a class 3 flammable liquid, which is not considered as an extremely dangerous substance. This substance is being exported from France to Finland by an industry chemical company, located in Helsinki. The

annual amount imported is approximately 35,000 kg. Cereclor is loaded into trailers in Verdun, north-east France, and the trailers are then transported to the Port of Lübeck by road. From Lübeck, the goods are bound for the Port of Helsinki, and from there transported by road to their final destination – the case company's warehouse in the Port of Kotka, south-east Finland.

The case company utilises a single lead logistics partner (LLP), which is responsible for all Cereclor transportation throughout the supply chain. The case company's warehouse in Kotka is also outsourced to a specialised Finnish logistics service provider. The case company has not utilised a documented and signed process for monitoring the quality of the service, and the information system does not allow full reporting of different supply chain operations. However, the importing case company systematically audits the supply chain operators, utilising a database of errors and reclamations. In addition, meetings are organised, where efficiency, targets and development programmes are discussed. These meetings are also attended by company managers.

(A) Communication process: The order is placed by the case company and sent directly to the consignor in France. Immediately after confirmation by the consignor, the transportation request is sent to the LLP. This must be done immediately because the LLP needs time to arrange proper DG transportation. The LLP then confirms the request to the case company. As soon as the goods arrive in Finland, the case company is notified by the LLP. The consignee (warehouse) is also notified by the LLP when the shipment reaches its destination. Finally, the consignee informs the case company that the goods are available at its warehouse facility.

(B) Authority involvement: This supply chain contains no key authority involvement. All the participating countries are members of the European Union and therefore no real border inspections exist. The national police, customs, border guard and maritime administration conduct inspections during transport if necessary.

(C) Document process: The consignor arranges all the appropriate documents for the shipment and provides appropriate DG labelling for the product. The required documents include the consignment note, MDGF and the DG instruction card. The LLP receives all these documents with the shipment. The LLP is then responsible for the required ADR and IMDG documents, and the proper labelling of utilised vehicles. Finally, the

warehousing service provider is responsible for proper DG certification of the warehouse.

(D) Liability process: The consignor is responsible for supplying the exact ordered product in the required packaging, with the required documents and proper labelling. The LLP is responsible for the loading and transportation of the shipment throughout the supply chain. The consignee is responsible for the unloading and proper warehousing of the product.

In case of some type of problem, an investigation is performed by the case company to find out the responsible party.

(E) Time: The overall throughput time of the supply chain – from order to delivery – is 312 hours (13 days). The total transit time – from the beginning of the transportation to the consignee – is 168 hours (7 days). For non-DG substances, the overall throughput- and transit time is the same.

3.5 Case 5, Paratoluen sulphonic acid by multimodal transport from France to Finland

This case company is a Finnish-based chemical group operating mainly in northern Europe with a wide range of products. The transported substance in this case is a class 8 corrosive acid. The transport route begins from the consignor in northern France and ends up at the case company's facilities in central Finland. The goods are first transported from France to a port in the Netherlands in a tank container on a lorry. After that, the tank container is put on a ship from the Netherlands to a port in Finland, where it is again transported by lorry to Central Finland.

The distances en route are as follows: from the origin in France to the port in Netherlands approximately 400 km, from the port in Netherlands to the Port of Helsinki 1,300 nautical miles, and from the Port of Helsinki to central Finland approximately 200 km. The estimated quantity of dangerous goods annually transported on this route is 350 tonnes.

The major problem on the route is, without doubt, the availability of suitable heated tank containers needed to transport such a dangerous cargo. Apparently, it is not known exactly how many heated tank containers are available at any one time in the warehouse of the logistics provider, in France or Netherlands. Delays of many days may occur due to poor tank container

situations. This can make it difficult for the case company to manage its stock levels.

(A) Communication process: The case company receives the confirmation of the arrival time of the shipment by communicating with a Finnish freight forwarder company, hired by the consignor. In addition, the Finnish lorry driver contacts the case company concerning the specific arrival time of the shipment, so that there will be no delays when unloading the cargo. This is done because not everyone working in the warehouse is trained to unload dangerous goods.

If problems occur on the way, the freight forwarder is responsible for contacting the case company. No specific audits or evaluations of other supply chain operators are conducted by the case company, in this case, the consignee. More extensive communication and feedback takes place only when there have been some problems in the supply chain. Other communication concerning the supply chain takes place when negotiating contracts, etc.

(B) Authority involvement: As the case company is the consignee and the transportation takes place on Schengen territory, no key authorities are normally involved. One problem that arose in the discussions was the difference in road regulations between France and other Member States. It seems to be that, in France, lorries are permitted to carry less weight than in other countries on the route.

(C) Document process: The following documents are required to be with the tank container at all times: order note, order confirmation note, bill for the whole shipment, freight warrant and dangerous goods instructions cards. The order process itself is handled by telefax.

The entire route is driven according to ADR regulations and therefore lorries have to be DG-flagged. IMDG regulations are obtained during maritime transportation.

(D) Liability process: The consignor hires all the necessary operators throughout the supply chain. In this specific case, the consignor hires a local logistics provider, which then arranges the road transport from France to the Dutch port and the maritime transport from the Netherlands to Finland. The local logistics provider is also responsible for the arrangement of the Finnish

road transport and the necessary forwarding agents needed on the way. Incoterm DDU is used throughout.

(E) Time: It takes approximately 1.5 weeks for the goods to arrive from the consignor in France at the destination in Finland. When reviewing the total time the cargo is in transit, there is not necessarily any difference in time between the transportation of dangerous goods and non-dangerous goods. The factors that might influence this difference include the availability of necessary heated tank containers and the short time difference when loading and unloading the dangerous goods cargo. A missing container can cause a delay of one week.

3.6 Case 6, Mixed cargo by multimodal transport from Finland to Estonia

This case company is a Finnish-based chemical group operating mainly in northern Europe with a wide range of products. The transported goods on this route comprise a variety of substances. Approximately one-third of these substances are a variety of different dangerous goods and two-thirds are not classified as dangerous goods.

The transport route begins from the case company's warehouse in central Finland. The cargo is first transported by road to the Port of Helsinki where the lorry continues by ro-ro ferry to Tallinn, Estonia. The goods eventually end up at the premises of the case company's subsidiary in Estonia.

The distances of the route are as follows: from the case company's premises to the Port of Helsinki approximately 200 km, and from the Port of Helsinki to the Port of Tallinn approximately 50 nautical miles. The final destination point is within the close proximity of Tallinn. The estimated amount of dangerous goods annually transported on this route is 1,000 tonnes, and of non-dangerous goods, 2,000 tonnes.

The major problem in the supply chain has been the late decision on whether the ro-ro ship should be labelled as a cargo or passenger vessel, as it also transports people. If it is eventually labelled as a passenger vessel, there will be delays in the supply chain and the goods might even have to spend the night at the seaport.

(A) Communication process: Because both the consignor and the consignee belong to same group, the communication is handled as smoothly

as possible. If there are any problems on the way, the logistics provider will have to contact only one organisation.

A poor flow of information on the new DG maritime packing regulations has caused major problems lately. On some occasions, the information on how to pack the dangerous goods cargo did not reach the consignor, which then caused difficulties and repacking in the Port of Helsinki. Therefore, delays occurred in the whole supply chain process. On another occasion, the whole lorry had to be driven back to central Finland for repacking, because it was not possible to do so at the seaport.

As the consignee is a subsidiary of the consignor, the performance of the supply chain can be quite easily monitored.

(B) Authority involvement: The company responsible for the transportation is also responsible for all authorities. In this case, the responsible partner is the logistics provider.

(C) Document process: The following documents are required to be with the tank container at all times: order note, freight warrant and dangerous goods instructions cards. The order process itself is handled by telefax.

The entire route is driven according to ADR regulations, and therefore lorries have to be DG-flagged.

(D) Liability process: The case company (consignor) hires a logistics provider to handle the transport all the way to its final destination. The logistics provider arranges for maritime transport from Helsinki to Tallinn. The same vehicle is used in both countries.

(E) Time: When considering the total time the cargo is in transit, there is not necessarily any difference in time between the transportation of dangerous goods and non-dangerous goods. However, if only non-dangerous goods are involved, the total transport time is normally 8 hours. Having dangerous goods in the cargo causes the risk of having to wait for a suitable ship for the whole cargo. Therefore, the maximum supply chain time for the shipment might extend to 24 hours.

3.7 Case 7, Printing ink by road transport from Finland to Russia

This case company is a Finnish subsidiary of an international chemical corporation, specialised in certain types of chemicals. The transported substance is a class 3 flammable liquid.

The transport route begins at the case company's premises in central Finland, where the cargo is transported to Russia by road via one of the three Finnish-Russian customs entry points. Freight-forwarder activities and some customs activity are conducted in central Finland, before the cargo is transported to Russia. The cargo ends up either at the premises of the same international group, or sometimes at a selected Russian consignee.

The distances en route are as follows: from the consignor to the border of Russia approximately 400 km, and from the border of Russia to Moscow approximately 700 km. The estimated amount of dangerous goods annually transported on this route is 700 tonnes. For crossing the border, the case company tends to use Imatra rather than Nuijamaa. Vaalimaa is rarely used due to long lorry queues.

Finnish logistics providers are usually utilised on the route. However, when the consignee doesn't belong to the same corporation, it is quite common to utilise a Russian logistics provider, hired and arranged by the Russian consignee. There may occur some problems with the Russian logistics providers. On some occasions, these providers notified their customers only at the last minute of a delay in the arrival time of their lorry of anything from a few days to a week. In these cases, the goods required unscheduled space in the warehouse of the case company.

(A) Communication process: If a Russian logistics provider is utilised on the route, problems may occur when contacting them. A few members of staff of the case company can communicate in Russian, but apparently it is difficult to contact the drivers, or/and the transport company itself, in order to receive the required information. However, these problems do not occur very often. Normally, with a Finnish logistics provider, the case company can receive the current position of its shipment with a one single phone call. If a problem occurs on the way, the lorry driver notifies his superiors, who then notify the case company. This arrangement has functioned very well.

The consignee is part of the same corporation as the consignor. Therefore, the performance of the supply chain can be quite easily monitored. All the supply chain parties and operations are regularly audited.

(B) Authority involvement: As the case company operates inside the EU and the consignee operates in Russia, more contacts with key authorities are involved than there would be in intra-EU trade.

The major problem on this route seems to be the disorganised activity of the border customs, which sometimes seems indiscriminate. It is not unusual for drivers to be asked to change the tariff headings on their customs clearance. The Russian customs change the list of tariffs quite often. The creation of a standard list of tariffs could decrease some problems at the border.

(C) Document process: The following documents are required to be with the lorry at all times: order note, order confirmation note, bill for the whole shipment, freight warrant, multimodal dangerous goods form, TIR-carnet and dangerous goods instructions cards. The entire route is driven according to ADR regulations, and therefore lorries have to be DG-flagged.

(D) Liability process: The consignor hires all the required operators throughout the supply chain. In this specific case, the consignor hired a local logistics provider, which then arranged the road transport to the final destination in Russia. The logistics provider is responsible for all the activities involving customs. Incoterm DDU is used all the way.

(E) Time: It takes approximately 3 days for the goods to arrive from the consignor in Finland at the destination in Russia. When considering the total time the cargo is in transit, there is not necessarily any difference in time between the transportation of dangerous goods and non-dangerous goods.

3.8 Case 8, Flammable liquid by multimodal transport from Finland to Ukraine

This case company is a Finnish subsidiary of an international chemical corporation specialised in certain types of chemicals. The transported substance is a class 3 flammable liquid.

The transport route begins at the case company's premises in central Finland, where the cargo is transported to the Port of Helsinki. The cargo and the original vehicle are transported to Tallinn, Estonia in a ro-ro ferry. The cargo is then transported in the same lorry to Kiev, Ukraine via Latvia, Lithuania and Poland.

The distances en route are as follows: from the consignor in central to the Port of Helsinki approximately 200 km, from the Port of Helsinki to the Port of Tallinn 50 nautical miles, and from Tallinn to Kiev approximately 1,200 km. The estimated amount of cargo annually transported on the route is 450 tonnes, of which the amount of dangerous goods is in the minority.

(A) Communication process: In this case, there seems to be no major problems with communication. Usually a Finnish logistics provider operates the route, and the information throughout the supply chain is sufficiently accurate. If a Ukrainian driver arrives to collect the cargo, some small difficulties in communicating necessary messages may occur. However, Ukrainian lorry drivers usually speak Russian, therefore the communication can be handled in Russian, with the Russian-speaking employees in the case company. If a problem occurs en route, the lorry driver notifies his own superiors, who then notify the case company.

(B) Authority involvement: The whole process normally works without any problems all the way to Lithuania. When crossing the border into Poland, it must be borne in mind that no dangerous goods may be transported on Polish roads on Sundays.

When crossing the border from Poland into Ukraine, extended waiting time may occur.

(C) Document process: The following documents are required to be with the lorry at all times: order note, order confirmation note, bill for the whole shipment, freight warrant, multimodal dangerous goods form, TIR-carnet and dangerous goods instructions cards. The entire route is driven according to ADR regulations, and therefore lorries have to be DG-flagged.

On some occasions, the transportation has got stuck at the border between Poland and Ukraine due to partially missing customs codes, which were supposed to be delivered to the border customs by the customs operating in Kiev.

(D) Liability process: The consignor hires all the required operators throughout the supply chain. In this specific case, the consignor hired a local logistics provider, which arranged the road transport to the destination in Russia. The logistics provider is responsible for customs-related activities. Incoterm DDU is used throughout.

(E) Time: It takes approximately 4 days for the goods to arrive from the consignor in Finland to the consignee in Ukraine. When considering the total time the cargo is in transit, there is usually a small time benefit of a couple of hours for DG-goods when compared to non-DG goods. This is because the passage of dangerous goods is prioritised at the Poland – Ukraine border.

3.9 Case 9, Mixed cargo by multimodal transport from Finland to Estonia

This case concerns a mixed cargo of 17 tonnes, of which 6 tonnes are dangerous goods and the rest are non-dangerous goods. It is a multimodal transport (road-sea-road) from Vantaa (FI) to Tallinn (EE). The consignor is a manufacturing company and the consignee its subsidiary. The table below shows the IMDG classes, UN numbers and packing groups of the cargo.

The sales office of the manufacturing company, i.e. the consignor, receives an order from its subsidiary through the information system. The consignor in Finland and the consignee in Estonia both use the same information system and therefore, the order (called a transfer order) can be viewed directly through the system. After the order has been confirmed by the sales office, the goods are collected, packed and labelled by the warehouse staff. All the necessary documents are issued and sent to the logistics provider, i.e. the carrier (FI). A total of 5 or 6 persons are involved in the case on behalf of the consignor.

The carrier contacts the shipping company and books the appropriate (ordinary/thermo transport) shipping space. A subsidiary of the carrier in Tallinn also receives this information through the same information system. The subsidiary then arranges the follow-on transportation from Tallinn. Three persons are involved in this process, both on behalf of the carrier and of the carrier's subsidiary. The carrier then sends a lorry to collect the goods from the manufacturing site in Vantaa. The consignor loads the trailer while the driver supervises the work. After receiving the cargo and the documents, the lorry drives approximately 30 km from Vantaa to the Port of Helsinki. The driver leaves the documents and the trailer with the shipping company for loading on board ship. The trailer is then transported from Helsinki to Tallinn. The carrier in Tallinn has arranged for a driver to wait for the trailer and the documents after maritime transportation. Because the ship arrives at night, the driver waits until the morning before transporting the goods to the consignee, about 5 km from the port.

The consignor always attempts to ship a full lorry load (FTL), i.e. 33 Euro pallets. If the load is less than full (LTL), there is a possibility of receiving an additional load from another business unit or from the carrier's terminal.

In this case, the approximate annual net volumes of dangerous goods are as follows: UN No. 1263, 3 III - 1.970 tonnes, UN No. 1263, 3 II - 270 tonnes and No. 3082, 9 III - 58 tonnes. These three classes make up about 99.9% of the total DG volume. There are DG shipments to this particular consignee several times a week.

The consignor does not apply a documented process to control the service from the loading point to the delivery, and the IT system does not allow it either. Nor does the case company apply a documented process for the evaluation and performance-monitoring of all its supply chain partners. The consignor does evaluate the partners while they are bidding, but no systematic evaluation is done during the contract period. Meetings are arranged with the partners to review objectives and performance, but top management is not involved in these meetings.

The carrier is in the same situation concerning the evaluation and monitoring of its partners. Deviations, for example complaints about drivers, are monitored. Because of the flat organisation, even top management may attend the review meetings. There exists a considerable amount of competition in the business, which is very cost-sensitive too. Therefore, the carrier co-operates closely with its customers.

The consignor did not identify any particular problems or bottlenecks in the supply chain, nor did the carrier. The cases are not very complex and the supply chain functions effectively.

(A) Communication process: The consignee in Tallinn places the order with the consignor through the information system. The sales office confirms the order and informs the warehouse. The shipping coordinator of the consignor contacts the carrier by phone to inform it about the transportation needed. The carrier books the shipping space from a shipping company – which can be one of several alternatives – and the Estonian subsidiary of the carrier informs a Baltic lorry driver to take over the following leg from the Port of Tallinn to the consignee.

(B) Authority involvement: There exists no key authority involvement in transportation cases to the Baltic countries. Occasional inspections by the police may occur. The drivers may be asked to produce their passport and the registration certificate of the vehicle. If the driver cannot produce the

technical portion of the registration certificate, the journey is discontinued. The driver may transfer the load onto another lorry, but a new registration certificate is then required.

(C) Document process: The following documents are issued by the consignor: international consignment note, multimodal dangerous goods form and emergency instruction card for road transport – in Finnish and in Estonian. The first two documents are faxed to the carrier, but the last one accompanies the cargo. At least 24 hours before the goods are brought into the port area, an advance notice of dangerous goods has to be provided to the Port of Helsinki by the carrier company. It can be either faxed or provided electronically. The carrier issues a CMR waybill for its own purposes. The packages and pallets are DG-labelled by the consignor, the trailer by the carrier.

(D) Liability process: The delivery terms are DDU Tallinn, which means that the consignor is liable for the cargo throughout the transport chain from the departure to the destination – loading included. The consignee is responsible for the unloading at the destination. The driver receives a sealed trailer and is liable for it according to the transportation agreement after loading, until unloading at the destination. The driver signs the international consignment note (CMR waybill) when receiving the cargo. No other signatures are required during the transportation.

(E) Time: The average total transit time in this type of case is about 51–73 hours. 36 hours are required before transportation, and the actual transportation requires 15–37 hours. Pre-defined transport routes have to be used in the Helsinki area when transporting dangerous goods. Therefore, it may require up to 2 hours to drive just 30–35 km. The ship arrives in Tallinn at night, and the driver cannot distribute the goods before morning. That is why he may have to wait 3–11 hours (depending on the vessel used) before transporting the cargo to the consignee. There is no difference between the transportation times of DG- and non-DG cargos.

3.10 Case 10, Mixed cargo by multimodal transport from Finland to Latvia

This case concerns a mixed cargo of 10 tonnes, of which 6 tonnes are dangerous goods and the rest are non-dangerous goods. It is a multimodal transport (road-sea-road) from Vantaa (FI) to Riga (LV). The consignor is a manufacturing company and the consignee is its subsidiary. The table below shows the IMDG classes, UN numbers and packing groups of the cargo.

The sales office of the consignor receives an order from the consignee in Riga (LV) by e-mail. The order is confirmed by the sales office, after which the goods are collected, packed and labelled by the warehouse staff. The necessary documents are issued and then sent to the logistics provider, i.e. the carrier. A total of 5 or 6 persons are involved on behalf of the consignor.

The carrier contacts the shipping company and books the appropriate (ordinary/thermo transport) shipping space. The subsidiaries of the carrier in Tallinn and in Riga, both utilising the same information system, receive the information through the system. The Tallinn subsidiary then arranges the follow-on transportation from the Port of Tallinn to Riga. Three persons are involved in this process, on behalf of the carrier and of its subsidiary in Tallinn. After that, the carrier sends a lorry to collect the goods from the manufacturing site in Vantaa. The consignor loads the trailer while the driver supervises the work. After receiving the cargo and the documents, the lorry drives approximately 30 km from Vantaa to the Port of Helsinki. The driver leaves the documents and the trailer with the shipping company for loading on board ship.

The trailer is transported from Helsinki to Tallinn. The carrier in Tallinn has arranged for a driver to wait for the trailer and the documents after the maritime transportation. The same driver takes over the whole transportation process from Tallinn to Riga (approximately 350 km) because the carrier always attempts to move the actual DG cargo as little as possible. The Baltic customers are also very precise and do not accept any unnecessary delays.

The consignor always attempts to ship a full lorry load (FTL), i.e. 33 Euro pallets. In case of a less than full lorry load (LTL), there is a possibility of receiving an additional load from another business unit or from the carrier's terminal.

In this case, the approximate annual net volumes of the dangerous goods are as follows: UN No. 1263, 3 III - 558 tonnes, UN No. 1263, 3 II - 70 tonnes and No. 3082, 9 III - 21 tonnes. These three classes comprise about 99.8%

of the total DG volume. There are DG shipments to this particular consignee several times a week.

The consignor does not apply a documented process to control the service from the loading point to the delivery; neither does the IT system allow it to do so. The case-company does not apply a documented process for evaluation and performance-monitoring of all its supply chain partners. The consignor does evaluate the partners while they are bidding, but no systematic evaluation is done during the contract period. Meetings are arranged with the partners to review objectives and performance, but top management is not involved in these meetings.

The carrier is in the same situation, concerning the evaluation and monitoring of its partners. Deviations, for example complaints about drivers, are monitored. Because of the flat organisation, even top management may attend the review meetings. There exists a considerable amount of competition in the business, which is very cost-sensitive too. Therefore, the carrier co-operates closely with its customers.

The consignor did not identify any particular problems or bottlenecks in the supply chain, neither did the carrier. The cases are not very complex and the supply chain functions effectively.

(A) Communication process: The consignee in Riga places the order with the consignor by e-mail. The sales office confirms the order and informs the warehouse. The shipping coordinator of the consignor contacts the carrier by phone in order to inform it about the transportation needed. The carrier books the shipping space from a shipping company – which can be one of several alternatives – and the Estonian subsidiary of the carrier informs a Baltic lorry driver to take over the following leg from the Port of Tallinn to the consignee in Riga.

(B) Authority involvement: There exists no key authority involvement in these transportation cases to the Baltic countries. Occasional inspections by the police may occur. Drivers may be asked to produce their passport and the registration certificate of the vehicle. If the driver cannot produce the technical portion of the registration certificate, the journey is discontinued. He may, however, transfer the load onto another lorry, but a new registration certificate is then required.

(C) Document process: The following documents are issued by the consignor: international consignment note, multimodal dangerous goods form

and emergency instruction card for road transport – in Finnish, Estonian and Latvian. The first two documents are faxed to the carrier but the last one accompanies the cargo. At least 24 hours before the goods are brought into the port area, an advance notice of dangerous goods has to be provided to the Port of Helsinki by the carrier company. It can be either faxed or provided electronically. The carrier issues a CMR waybill for its own purposes. The packages and pallets are DG-labelled by the consignor, the trailer by the carrier.

(D) Liability process: The delivery terms are DDU Riga, which means that the consignor is liable for the cargo throughout the transport chain from the departure to the destination – loading included. The consignee is responsible for the unloading at the destination. The driver receives a sealed trailer and is liable for it according to the transportation agreement after loading, until unloading at the destination. The driver signs the international consignment note (CMR waybill) when receiving the cargo. No other signatures are required during transportation.

(E) Time: The average total transit time in this type of case is about 52–74 hours. 36 hours are required before transportation, and the actual transportation requires 16–38 hours. The ship arrives in Tallinn at night, and the driver cannot distribute the goods before the morning. That is why he has to wait 0–7 hours (depending on the vessel utilised) until transporting the cargo to the consignee. There is no difference between the transportation times of DG- and non-DG cargos.

3.11 Case 11, Mixed cargo by multimodal transport from Finland to Lithuania

This case refers to a mixed cargo of 10 tonnes, of which 6.3 tonnes are dangerous goods while the rest of the cargo comprises non-dangerous goods. It is a multimodal transport (road-sea-road) from Vantaa (FI) to Kaunas (LT). The consignor is a manufacturing company and the consignee its subsidiary. The table below shows the IMDG classes, UN numbers and packing groups of the cargo.

The sales office of the consignor receives an order from the consignee in Kaunas (LT) by e-mail. The order is confirmed by the sales office, after which the goods are collected, packed and labelled by the warehouse staff. The

necessary documents are issued and then sent to the logistics provider, i.e. the carrier. A total of 5 or 6 persons are involved on behalf of the consignor.

The carrier contacts the shipping and books the appropriate (ordinary/thermo transport) shipping space. The subsidiaries of the carrier in Tallinn, Riga and Kaunas, all utilising the same information system, receive the information through the system. The Tallinn subsidiary then arranges the follow-on transportation from the Port of Tallinn to Kaunas. Three persons are involved in this process, on behalf of the carrier and of its subsidiary in Tallinn. After that, the carrier sends a lorry to collect the goods from the manufacturing site in Vantaa. The consignor loads the trailer while the driver supervises the work. After receiving the cargo and the documents, the lorry drives approximately 30 km from Vantaa to the Port of Helsinki. The driver leaves the documents and the trailer with the shipping company for loading on board ship.

The trailer is transported from Helsinki to Tallinn. The carrier in Tallinn has arranged for a driver to wait for the trailer and the documents after maritime transportation. The same driver takes over the whole transportation from Tallinn to Kaunas (approximately 700 km) because the carrier always attempts to move the actual DG cargo as little as possible. The Baltic customers are also very precise and do not accept any unnecessary delays.

The consignor always attempts to ship a full lorry load (FTL), i.e. 33 Euro pallets. In case of a less than full lorry load (LTL), there is a possibility of receiving an additional load from another business unit or from the carrier's terminal.

In this case, the approximate annual net volumes of the dangerous goods classes are as follows: UN No. 1263, 3 III - 298 tonnes, UN No. 1263, 3 II - 72 tonnes, UN No. 3082, 9 III - 5 tonnes, and .UN No. 2289, 8 III 0,5 tonnes. These three classes make up 100% of the total DG volume. There are DG shipments to this particular consignee once a week.

The consignor does not apply a documented process to control the service from the loading point to delivery, neither does the IT system allow it. The case company does not apply a documented process for the evaluation and performance-monitoring of all its supply chain partners. The consignor does evaluate the partners while they are bidding, but no systematic evaluation is done during the contract period. Meetings are arranged with the partners to review objectives and performance, but top management is not involved in these meetings.

The carrier is in the same situation as for the evaluation and monitoring of its partners. Deviations, for example complaints about drivers, are monitored.

Because of the flat organisation, even top management may attend the review meetings. There exists a considerable amount of competition in the business, which is very cost-sensitive too. Therefore, the carrier co-operates closely with its customers.

The consignor did not identify any particular problems or bottlenecks in the supply chain, nor did the carrier. The cases are not very complex and the supply chain functions effectively.

(A) Communication process: The consignee in Kaunas places the order with the consignor by e-mail. The sales office confirms the order and informs the warehouse. The shipping coordinator of the consignor contacts the carrier by phone in order to inform it about the transportation needed. The carrier books the shipping space from a shipping agent – which can be one of several alternatives – and the Estonian subsidiary of the carrier informs a Baltic lorry driver to take over the following leg from the Port of Tallinn to the consignee in Kaunas.

(B) Authority involvement: There exists no key authority involvement in the transportation cases to the Baltic countries. Occasional inspections by the police may occur. Drivers may be asked to produce their passport and the registration certificate of the vehicle. If the driver cannot produce the technical portion of the registration certificate, the journey is discontinued. He may, however, transfer the load onto another lorry, but a new registration certificate is then required.

(C) Document process: The following documents are issued by the consignor: international consignment note, multimodal dangerous goods form and emergency instruction card for road transport – in Finnish, Estonian, Latvian and Lithuanian. The first two documents are faxed to the carrier but the last one accompanies the cargo. At least 24 hours before the goods are brought into the port area, an advance notice of dangerous goods has to be provided to the Port of Helsinki by the carrier company. It can be either faxed or provided electronically. The carrier issues a CMR waybill for its own purposes. The packages and pallets are DG-labelled by the consignor, the trailer by the carrier.

(D) Liability process: The delivery terms are DDU Kaunas, which means that the consignor is liable for the cargo throughout the transport chain from the departure to the destination – loading included. The consignee is

responsible for the unloading at the destination. The driver receives a sealed trailer and is responsible for it according to the transportation agreement after loading, until unloading at the destination. The driver signs the international consignment note (CMR waybill) when receiving the cargo. No other signatures are required during the transportation.

(E) Time: The average total transit time in this type of case is about 58–73 hours. 36 hours are required before transportation, and the actual transportation requires 22–37 hours. The vessel arrives in Tallinn at night, and the driver cannot distribute the goods before the morning. That is why he may have to wait approximately one hour (depending on the vessel utilised) before distributing the cargo to the consignee. There is no difference between the transportation times of DG- and non-DG cargos.

3.12 Case 12, Anhydrous ammonia by rail and sea transport from Russia to Finland

This transport case gives a chain description of anhydrous ammonia transported by rail and sea transport modes from a chemical plant in north-west Russia to the case company's production facilities in south-west Finland. The case company is a supplier of agricultural fertiliser products, and is operating in several European countries. The table below shows the IMDG class, UN number and packing group of the cargo.

The substance is first packed onto railway wagons at a chemical plant in Russia, and transported about 750 km to a port in western Latvia. There the cargo is unloaded into a storage tank. When the required amount of the substance is ready to be shipped, the tanker arrives in port. The tanker for liquefied gas is loaded in the Latvian port, and sails about 270 nautical miles (500 km) to its port of destination in south-western Finland. There the cargo is discharged into a storage tank, where it stays until it goes to production. The total amount of anhydrous ammonia transported yearly through this transport chain is about 24,000 m^3.

(A) Communication process: In this case, the case company is a consignor and makes a contract with the consignee, who gives a loading time for the company. The case company then contacts the time-chartered ship and gives them information on the cargo.

In case of emergency, the information goes directly to the rescue services. If they need some information concerning the substance involved, they will ask the case company's specialists.

(B) Authority involvement: There is normal authority involvement in this case. Customs and Border Guard check that everything is in order when the consignment crosses the border. Customs also collects information on the dangerous goods in advance, well before the ship arrives at its port of destination. In Finland, this information is collected via the PortNet system, a database used by the ports and several authorities. The Finnish Maritime Administration is also involved in the transport chain, collecting shipping route fees. Ports also collect port charges.

(C) Document process: The Russian supplier takes care of the necessary waybill, multimodal dangerous goods form (MDGF) and the material safety data sheet (MSDS). These documents accompany the cargo. Rail wagons are fitted with DG labels. At least 24 hours before the goods are brought into the port area, an advance notice of dangerous goods must be provided to the port of destination by the carrier company.

(D) Liability process: The transaction is done according to International Commercial Terms (INCOTERMS), Free On Board (FOB), which means that the seller is required to deliver goods on board a vessel designated by the buyer. The seller fulfils its obligations to deliver once the goods have passed over the ship's rail.

The production site is responsible for filling operations. After deplugging the filling pipe, the consigner is responsible up to docking at the port in Latvia. The same organisation is also responsible for the documents.

The Russian and Latvian railway companies are liable according to the rail transportation laws in the two countries. Hazards are studied on a case-by-case basis. Not every movement is documented and signed for separately.

(E) Time: The total throughput time in this transport chain is normally about 8 days. The train from Northwest Russia to the port in Latvia takes about 4 days. Loading the cargo from train to tanker takes 1 day as does the unloading of the cargo from the tanker. The sea voyage itself takes about 2 days. For non-dangerous goods, the total throughput time is the same.

3.13 Case 13, Fluorosilicic acid by rail and sea transport from Finland to Sweden

This transport case gives a chain description of fluorosilicic acid transported by rail and sea transport modes from the case company's chemical plant in eastern Finland to production facilities in south-west Sweden, which belong to the same concern as the case company. The case company is a supplier of agricultural fertiliser products. It is operating in several European countries. The table below shows the IMDG class, UN number and packing group of the cargo.

The substance is first loaded onto railway wagons at a plant in Finland, where the consignment continues to a port in south-west Finland. There the substance is loaded onto a chemical tanker, which sails to the south-western port of Sweden. The substance is used at these production facilities. The distances en route are: from the production facilities in eastern Finland to the port in south-western Finland approximately 600 km, and from the port in Finland to the port in Sweden 560 nautical miles (1040 km).

(A) Communication process: In this transport chain, both the consignor and the consignee are part of the same group of companies, so the communication between them works efficiently. The logistics companies used in the chain are also familiar and trustworthy, so neither are there problems in that respect. During the transport chain, the case company is in contact with the rail transport company at both ends of the journey. The case company charters the chemical tanker through a Swedish company/agent, which handles the communication with the vessel. If there are some problems in the chain, for example delays, communication happens as follows: the rail company directly contacts the case company, and the vessel contacts the agent, which contacts the case company or the consignee company. In case of an accident, the rescue services normally contact the case company for information.

(B) Authority involvement: There is normal authority involvement in this case. Customs and Border Guard check that everything is in order when the consignment crosses the border. Customs also collects the information on dangerous goods in advance, well before the ship arrives at its port of destination. The Finnish Maritime Administration is also involved in the transport chain, collecting shipping route fees. Ports also collect port charges.

(C) Document process: The consignor arranges all the necessary documents to accompany the shipment and provides appropriate DG labelling for the product. The required documents include the consignment note, MDGF and MSDS. Each logistics provider receives all these documents with the shipment.

(D) Liability process: The two logistics companies are responsible for the transportation parts of the chain, but the group of companies/concern including the case company is responsible for the other parts of the chain including loading and unloading of the cargo.

The delivery terms are FOB Finnish port, which means that the consignor is responsible for delivering the goods on board a vessel designated by the consignee. The consignor fulfils its obligations to deliver when the goods have passed over the ship's rail. The consignee is responsible for the sea transport and unloading at the port of destination.

(E) Time: The total transit time, from the beginning of the transportation to the consignee, is about 132 hours (5 1/2 days). In the case of non-DG substances, the overall throughput and transit time is the same. The total transit time can, however, vary greatly, because the frequency of the sea transport is only once every three weeks. This means that the railway wagons carry the substance to the storage tank at the Finnish port more often than the ship sails between Finland and Sweden.

3.14 Case 14, Ammonium nitrate fertiliser by rail, sea and road transport from Finland to Estonia

This transport case gives a chain description of ammonium nitrate fertiliser transported by rail, sea and road transport modes from the case company’s chemical plant in eastern Finland to a distribution storage in eastern Estonia. The ammonium nitrate-based fertiliser transported in this case contains less than 70% ammonium nitrate and less than 0.4% total combustible/organic material calculated as carbon or with less than 45% ammonium nitrate and unrestricted combustible material. This fertiliser is dangerous according to IMDG Code, but classified as harmless by ADR and RID.

The case company is a supplier of agricultural fertiliser products. It operates in several European countries. The transported substance in this

case is a class 9 ammonium nitrate fertiliser transported in big bags. The table below shows the IMDG classes, UN numbers and packing groups of the cargo.

The transport route begins from the case company's production facilities in eastern Finland and ends at the consignee in Estonia. The cargo is first transported to the case company's own south-western port in Finland by rail. The cargo is then unloaded at a warehouse, where it waits for the ship to arrive. After that, it is put on a dry bulk ship sailing from Finland to a port in north Estonia, where it is transported by lorry to a distribution storage in eastern Estonia. The customer picks up the cargo from there itself.

The distances en route are: from the production facilities in eastern Finland to the port in south-western Finland approximately 600 km, from the port in Finland to the port in Estonia 280 nautical miles (550 km), and from port to the warehouse in eastern Estonia approximately 200 km. The estimation of dangerous goods annually transported on the route is 4,000 tonnes.

The problem in this transport chain is differences in regulation. The transported substance is dangerous according to the IMDG Code, but not according to ADR and RID. This presents a problem in the labelling of the big bag. Normally the labels are firmly printed on the bag, but then a problem may occur with the traffic police, who may think that the cargo is dangerous, because of the DG labels on it.

(A) Communication process: In this transport chain, the case company is the consignor. It tells the consignee when it can call for the goods from the Estonian warehouse. The consignor charters a dry bulk ship from the spot market, which will deliver the cargo to Estonia. The consignor also hires a logistics company to transport the cargo from the Estonian port to the distribution warehouse in eastern Estonia. These logistics providers are in contact with the consignor which handles communication between them.

Some problems may occur with the lorry drivers, who might want extra salary for transporting a dangerous cargo. When they see the DG labelling, they may not believe that the cargo is not dangerous according to ADR.

In case of emergency, information goes directly to the rescue services. If they need some information concerning the substance involved, they will ask the case company's specialists. No specific audits or evaluations of other supply chain operators are conducted by the case company, i.e. the consignee. More extensive communication and feedback takes place only when there have been some problems in the supply chain. Other

communication concerning the supply chain takes place when negotiating contracts, etc.

(B) Authority involvement: There is normal authority involvement in this case. Customs and Border Guard check that everything is in order when the consignment crosses the border. Customs also collects information on dangerous goods in advance, well before the ship arrives at its port of destination. In Finland, this information is collected via the PortNet system, which is a database used by the ports and several authorities. The Finnish Maritime Administration is also involved in the transport chain, collecting shipping route fees.

In theory, there might be some problems with the Estonian Traffic police, as mentioned earlier, when transporting this type of ammonium nitrate-based fertiliser. The substance is not subject to ADR, but is subject to the IMDG Code, which means that it has to be labelled according to IMDG during sea transport. This fertiliser is normally transported in big bags, which means that the labelling is printed on the bags. Traffic police might not believe that this fertiliser is not a dangerous good (at least according to ADR), as it has DG labelling all over it.

(C) Document process: The consignor arranges all the necessary documents to accompany the shipment and provides appropriate IMDG labelling for the product. The required documents include the consignment note and MDGF and MSDS. Each logistics provider receives all these documents with the shipment.

(D) Liability process: The consignor hires all the necessary operators throughout the supply chain and is also liable for the cargo throughout the chain. Incoterm DDU is used throughout.

(E) Time: The total transit time, from the beginning of the transportation in production facilities to the distribution warehouse, is about 132 hours (5 1/2 days). In the case of non-DG substances, the overall transit time is the same. The total throughput time can, however, vary greatly, because the cargo stays in different warehouses along the chain. The cargo can even stay as long as 5 months in a warehouse in Estonia, waiting for winter to end. The absolute minimum throughput time, however, is 1½ weeks.

4 KEY FINDINGS OF SINGLE CASE ANALYSIS

4.1 Key findings from cases 1, 2 & 3

4.1.1 Communication process

A lack of language skills creates a problem to a certain extent, because the Russian drivers communicate only in Russian. In one of the cases (case 3), the only English-speaking person in the Russian organisation is in Moscow. If something complex, such as a change of loading point, needs to be explained, it may cause problems if the personnel at the Finnish loading site do not speak Russian.

4.1.2 Authority involvement

In case 1, supply chain design, it should be taken into consideration that municipal decision-makers have a role in granting special permits. This may have an influence on the supply chain routing and the locations of supply sites.

The City of Helsinki allows 10,000 gross tonnes of hydrogen in the Helsinki area. Port authorities have a right to grant exceptional permits after hearing from the municipal environmental- and rescue committees. TUKES – the safety technology authority – is also involved in the process. The Environmental Committee of City of Helsinki would like to forbid entry of all DG goods into the Helsinki area. It was not in favour of the case, not even with the return transportation of loose 2-5 bar containers. Because of this, the port authorities denied the issuing of an exceptional permit. This begs the question: what will be the attitude of the Environmental Committee of the City of Helsinki to DG transportations when the new port of Helsinki is opened in 2008?

The denial of an exceptional permit had a great impact on the supply chain. Instead of having one trailer with one driver circulating through the Port of Helsinki, the case company had to use two trailers with two drivers – one in Finland through the Port of Hanko to the Port of Paldiski, where the other one was waiting with an empty container. The exchange of the containers was necessary because the transporting ship stayed in port for

only two hours. There was no time to deliver the trailer straight to the client. The Finnish trailer then returned to Hanko on the same ship.

In case 2, passengers have more demand for sea travel during summer periods than winter periods. This causes capacity differences in DG supply. One of the findings was that there were a total of three ships from Finland transporting methane during the winter, two of which two took more passengers during the summer. The remaining one was out of service for several days.

4.1.3 Document process

The ADR permission process seems to be different between Russia and Finland. According to the Finnish Ministry of Traffic and Communications, there in no need separately to apply for ADR traffic authorisation for every trip to Russia. However, it has emerged that the trailers cannot pass the border without doing so. In addition, there is a charge made for every application. This difference in processes may have an impact on the fact that today companies are use an excessive quantity of Russian trailers.

4.1.4 Liability process

The supply chain of hydrogen from Finland to Russia is well designed. Russian drivers are trained by the Finnish case company to load the air gases and stamp the documents on behalf of the Russian and Finnish organisations. The export documents are arranged by the freight forwarder and posted to the case company‘s driving planning centre.

4.1.5 Time

It might be expected that DG consignments across the border would require more time than normal consignments. However, this is not the case at the Vaalimaa border station. All DG trailers have a right to pass the queuing line and then wait in the customs area.

4.2 Key findings from case 4

The described supply chain seems to be functioning very well. There were no actual bottlenecks or problems perceived in any of the five processes described. The case company defined only the actual ordering process as slightly laborious. The smooth functionality is a result of a systematical and long-lasting development of the supply chain by all parties. The transparency of supply chain information is apparent because of the single lead logistics partner responsible for all logistics operations.

Another finding was that the goods were being transported first to the Port of Helsinki and from there to the Port of Kotka by road, instead of transporting them straight to Kotka by ship. This is done because the Port of Kotka does not use handling equipment suitable for unloading loads of less than one container. All substances imported by the case company – in full container loads – are delivered directly to the Port of Kotka by ship.

4.3 Key findings from cases 5, 6, 7 & 8

4.3.1 Communication process

In case 6, the major problem was the late decision on whether the ro-ro ship should be labelled as a cargo- or passenger vessel. If the ship is eventually labelled as a passenger ship, there may be delays in the supply chain and the goods might even have to spend the night at the seaport. A poor flow of information on the new DG maritime packing regulations has also caused major problems lately. On some occasions, the information on how to pack the dangerous goods cargo did not reach the consignor, which then caused difficulties and repacking in the Port of Helsinki. Therefore, delays occurred in the whole supply chain process.

In case 7**,** if a Russian logistics provider is utilised on the route, problems may occur problems in trying to contact them. A few members of staff of the case company can communicate in Russian, but apparently it is difficult to contact the drivers, or/and the transport company itself, in order to receive the required information.

Finally in case 8, some problems may occur with Russian logistics providers. On some occasions, these providers notified their customers only at the last minute of a delay in the arrival time of their lorry of a few days up

to a week. In these cases, the goods required unscheduled space in the warehouse of the case company.

4.3.2 Authority involvement

It appears from case 5, that in France, less weight is allowed on a lorry than is allowed in other Member States. In Poland, no dangerous goods may be transported by road on Sundays, which was revealed in case 8.

In case 7, the major problem seems to be the disorganised activity of the border customs, which sometimes seems indiscriminate. It is not unusual for drivers to be asked to change the tariff headings on their customs clearance. The Russian customs change the list of tariffs quite often. The creation of a standard list of tariffs could decrease some problems at the border.

4.3.3 Document process

In case 8, the transportation sometimes got stuck at the border between Poland and Ukraine due to partially missing customs codes, which were supposed to have been delivered to the border customs by the customs operating in Kiev.

4.3.4 Liability process

No perceived problems occurred.

4.3.5 Time

The major problem in case 5 was the availability of suitable heated tank containers needed for transporting dangerous goods. Apparently, it is not known exactly how many heated tank containers are available at any one time in the warehouse of the logistics provider, in France or the Netherlands. Delays of many days may occur due to poor tank container situations. This can make it difficult for the case company to manage its stock levels.

In case 8, when considering the total time the cargo is in transit, there is usually a small time benefit of a couple of hours for DG-goods in comparison

to non-DG cargo. This is because the passage of dangerous goods is prioritised at the Poland – Ukraine border.

4.4 Key findings from cases 9, 10 & 11

4.4.1 Communication process

Neither the consignor nor the carrier reported any problems in the communication process. Both of them are content with the situation and consider that the supply chain functions effectively. There is a long-term partnership between the parties involved, therefore everyone knows their role in the supply chains of the cases presented.

4.4.2 Authority involvement

According to the interviewees, there is no key authority involvement in addition to the advance notice of dangerous goods provided to the Port of Helsinki. Random problems have emerged because of a missing or damaged technical portion from the registration certificate of the trailer. This has to accompany the trailer at all times, otherwise the lorry is not allowed to continue the transportation with that particular trailer. However, the cargo can be loaded onto another trailer. There sometimes appears to be difficulties with the exchangeable trailers: the documents are left in the trailer, where they may get wet or be stolen. In such cases, the driver informs the contact person in his own country and also the carrier in Finland. The Finnish Vehicle Administration (AKE) is then asked for a new registration certificate. In urgent cases during the summertime, the document has occasionally been sent by fast catamaran ferry from Finland to the driver.

4.4.3 Document process

The parties do not identify any problems with documents either. Both of them point out that everything is clear and functional on these routes in Estonia, Latvia and Lithuania. However, the consignor may face problems elsewhere. The practice between shipping companies varies: not all companies accept electronic signatures and insist on a signature in written by hand. Sometimes

the consignor also has to correct automated documents manually with correction fluid, to meet the requirements.

The consignor recently sent a consignment to Hungary. In Poland, the lorry was not allowed to proceed, because the police stopped it and asked to see the DG markings and descriptions on the packing list. The consignor emphasised that all the required documents conformed to regulations, and had always been accepted in Poland before. In this case, the lorry had to stay in Poland for two days until the consignor paid the set penalty.

4.4.4 Liability process

No problems occur with liability issues. The consignor hands over the consignment to the carrier, who is then responsible for the case. The consignor is not aware of any accidents that have occurred, nor of any special incidents or near-misses. The carrier knows its liabilities and cannot pinpoint any problems.

4.4.5 Time

According to the carrier, Baltic customers are precise and therefore do not accept any unnecessary delays in transportation. All roles and responsibilities have to be clarified in the supply chain to ensure functionality. All parties normally succeed in this and no difficulties arise. In addition, it can be noted that the involvement of DG material has no effect on the transportation time in these selected cases.

4.5 Key findings from cases 12, 13 & 14

4.5.1 Communication process

There are no major problems in the communication process. Both the consignee and the consignor are content with the situation and consider that the supply chain functions effectively. In all of the cases, there is a long-term partnership between the parties involved, and therefore everyone knows their roles in the chain.

In case 14, some problems exist with the lorry drivers, because they want to extra salary, because they think they are transporting a dangerous cargo. When they see the DG labelling, they may not believe that the cargo is not dangerous according to ADR.

4.5.2 Authority involvement

According to the interviewees, there is no key authority involvement in addition to the advance notice of dangerous goods provided to the ports involved. Random problems have emerged in case 14, because of differences in dangerous goods regulations, especially between ADR and IMDG.

In case 14, some problems may occur with the Estonian Traffic police, when transporting this type of ammonium nitrate-based fertiliser. The substance is not subject to ADR, but is subject to IMDG, which means that it has to be labelled according to IMDG for the sea transport. It is normally transported in big bags, which means that the labelling is printed on the bags. Traffic police may not believe that the fertiliser is not a dangerous good according to ADR, as it has DG labels on it.

4.5.3 Document process

Neither do the parties identify any problems with documents. Everything is clear and functional on these routes between Finland, Estonia, Latvia, Sweden and Russia. However, the consignor in case 14 has some problems with labelling.

4.5.4 Liability process

No problems occur in questions of liability. In each case, the consignor hands over the consignment to the carrier, who is responsible after that. Then at the very end of the chain, the consignee is normally responsible for discharging the cargo. Liabilities are mentioned in INCOTERMS, and are followed accordingly. The case company is not aware of any accidents that have occurred, nor of any special incidents or near-misses. The carrier is also aware of its liabilities.

4.5.5 Time

According to the case company, no unnecessary delays in the transportation are accepted. The throughput time of the transportation chain might, however, vary greatly between the cases, because warehousing exists in the transport chains.

All roles and responsibilities have to be clarified in the supply chain to ensure functionality. All parties normally succeed in this and no difficulties arise. In addition, it can be noted that the involvement of DG material has no effect on the transportation time in these above-mentioned cases.

5 CROSS-CASE ANALYSIS

In this chapter, a cross-case analysis, based upon the cases presented above, will be carried out. All the empirical case data was collected from seven participating commercial actors between September and November 2006. Altogether, 14 cases were presented in this study, involving dangerous goods classes 2, 3, 8 and 9. All the cases included dangerous goods cargo either imported or exported to/from Finland.

The empirical case data was collected by interviewing employees from the participating companies. The opinions of consignors, consignees and logistics providers are all represented in this study. All the interviewees were managerial-level employees involved in DG transport within their organisations. The purpose of this cross-case analysis is to draw together conclusions from the single cases' key findings. The analysis of each DG supply chain is divided into five different processes, which are *communication process*, *authority involvement*, *document process*, *liability process* and *time*.

5.1 Communication process

Regarding communication, the lack of a common language has caused some problems with drivers from the Eastern countries, for example Russia. This can cause deficiencies in communication between the consignor and the foreign logistics provider. For example, information on problems or proper instructions may not reach the partners effectively. In Finland, these negative effects have not been so severe, because it is relatively easy to find people who can speak and/or understand Russian. However, that may not be the case in other European countries.

It has also proved to be difficult to contact Russian drivers on the road. In the case of a delay, this is a significant problem, because Russian logistics providers do not seem promptly to inform their supply chain partners of delays. Furthermore, the revised arrival time for a Russian lorry may be as much as one week later. These types of problems could be related to differences between business cultures.

In cases where Finnish companies utilised Finnish logistics providers, there appeared to be no major problems. There usually exists a long-term relationship between the parties involved, therefore communication is fluent, and there is mutual trust between the supply chain partners.

However, the following issue has been regarded as a problem: at least when transporting from Helsinki to Estonia, the decision on whether a ro-ro ferry should be specified as a cargo- or passenger vessel, as it also carries people, is made very late. If it is specified as a passenger vessel just before departure, there can be delays in delivery, which causes problems in the effective planning of the supply chain.

Poor information flow on the new maritime regulations concerning the packing of dangerous goods has also caused problems. On some occasions, information on the proper packing of dangerous goods cargo did not reach the inland consignor, so repacking was required, which caused delays in the whole supply chain.

5.2 Authority involvement

When transporting dangerous goods, the involvement of the authority is normally more active than in the transport of other types of goods. The reason for this is the greater risk to transport system users, the public and the environment.

The carriage of dangerous goods is a heavily regulated field, and the legal provisions are subject to regular changes and amendments. There are international conventions and agreements in this field. Some of them apply to international carriage, some also to domestic carriage. The carriage of dangerous goods has been the subject of comprehensive EU legislation as well.

However, during actual transportation in the presented cases, the level of authority involvement appeared to be similar to that in the transport of normal goods. The only difference was that Customs collected the information on dangerous goods in advance, well before the ship arrived at its port of destination. In Finland, this information is collected via the PortNet system, a database used by the ports and other related authorities.

It emerged in interviews that some problems might occur with traffic police, because of differences in dangerous goods regulations for different transport modes. For example, when transporting a certain type of fertiliser, which is not subject to ADR, these kinds of problem might appear. The problem is that this fertiliser is subject to IMDG, which means that it has to be labelled accordingly for the sea transport. It is normally transported in big bags, which means that the labelling is printed on the bag. At roadside checks, traffic

police might not believe that the fertiliser is not dangerous, as it has DG labelling all over it. So a problem exists in differences between regulations.

In some cases, especially when transporting high-consequence dangerous goods, the occupational health authorities might supervise the situation. The supplier must also guarantee that the containers, in which the DG cargo is transported, are inspected and accepted by the national security authorities. It should also be taken into consideration that municipal decision-makers have a role in granting special permits. This may have an influence on the supply chain routings and the locations of supply sites. However, when considering the cases presented above, no evident problems relating to authority involvement emerged in any of the cases.

5.3 Document process

The document process mainly runs smoothly in all the cases. Document practice seems to be well-established and stable, and no major difficulties arise. The companies studied send regular shipments, for example on a weekly basis, on the same routes. They usually rely on the same logistics providers who know the routes, rules and regulations. In a long-term relationship, the practices have been developed to be fluent, and the parties involved know their roles. All this contributes to the functionality, and issuing documents is considered to be a routine operation.

One of the companies interviewed said that it has to apply for an ADR traffic licence separately for each consignment to Russia. This causes extra costs for the company, but has to be done to enable the consignment to cross the border. According to the Ministry of Transport and Communications of Finland, this type of practice is not necessary. The difference between the two practices may contribute to the growing use of Russian trailers in these consignments, ordered by Finnish companies.

Otherwise the problems reported seem to be sporadic and may not relate to these particular supply chains. One shipping company did not accept an electronic signature, although others did. A Polish policeman deviated from normal practice and demanded DG descriptions on the packing list of the shipment. The lorry was held up for two days until the required penalty had been paid. Traffic occasionally got stuck at the border between Ukraine and Poland, because customs in Kiev had not sent the customs codes for the cargo. Nonetheless, no clear pattern emerges as concerning such problems.

5.4 Liability process

When considering the cases presented above, no evident liability problems emerged in any of these cases. Each of the supply chain partners appeared to be well aware of the issues involved. This conclusion is to some extent expected, considering the fact that liability issues directly affect company image. The utilisation of Incoterms in DG supply chains also seems to clarify substantially all liability issues.

In problematic situations, the party responsible for the problem is identified and the proper reclamations are made. It appears that the utilisation of logistics providers has delegated a major part of responsibilities from consignors and consignees to these logistics providers. The responsibilities of a consignor largely involve packaging, attachment of required documents and proper labelling of the DG cargo. In some cases, a consignor is also responsible for the training of the personnel involved in loading and unloading the DG cargo. Correspondingly, a consignee rarely has any responsibilities in DG supply chains, according to these selected cases.

The transparency of liability information is being optimised in cases where a single logistics partner, responsible for all the logistics in the DG supply chain, is used. Therefore, this type of supply chain model is recommended.

5.5 Time

These selected cases give reason to conclude, that the overall transportation time for dangerous goods is less than the overall transportation time for non-dangerous goods, when transporting to areas outside the EU. This appears to be a result of DG prioritisation at the borders. However, the question of supply chain time is not as clear within the EU area. The following question may be asked here: what role do land border formalities and road transportation regulations play in this conclusion? In addition, maritime DG transportations from Finland to the south and west are strongly dependent upon maritime traffic schedules.

A factor that might affect the difference in transportation times between transportation of dangerous goods and non-dangerous goods is the availability of heated tank containers. Lack of such a container can sometimes cause a delay of up to one week.

Variations in DG supply chain throughput times cause deficiencies in customer service. A growing problem for commercial operators and

authorities is how to balance the DG flow, especially with increasing volumes. These DG supply chain throughput time variations become essential when dealing with specialised transportation equipment. A supplier does not necessarily know when these types of specialised equipment are available. In cases with the longest throughput time, investments in the improvement of supply chain information transparency are required, otherwise lead times will grow longer.

5.6 Other findings

People are especially interested in the transport of dangerous goods, because of the risks that they present to the environment and public. At the same time, DG companies are afraid that, if accidents occur, their reputation will suffer. That is also why producers and companies involved in DG transportation tend to keep their knowledge to themselves. They think that giving information to the public might increase their awareness of these issues, and so lead to a tightening of the regulations in the future. That is also why they think that giving as little information as possible is the best solution in most of the cases.

Probably the most obvious difference between the transport of dangerous and non-dangerous goods is the need for special equipment. Tanks need to be temperature-regulated and specially built in most cases. The availability of these special transport units is much more limited than the availability of normal ones. This lack of proper transport units may set some limitations to the transport frequency. If suitable equipment is not available, the only solution might be to postpone the shipment.

6 CONCLUSIONS

The objective of this multiple case study was to provide an insight into how DG supply chains work, with an overview of the problems with which the actors are faced. The main emphasis was placed on operations rather than costs. It was essential to find out how effective, efficient and professional the operations are in the various phases of the supply chain.

Based on this study, we can draw some conclusions. This chapter contains some suggestions for remedial actions and also presents some implications.

6.1 Regulatory implications

It was not the main purpose of this study to provide legislators with recommendations. However, it is important to disseminate information on what stakeholders think about dangerous goods regulations, as it seems to be problematic in some of the cases.

Dangerous goods transportation is a highly regulated field, and all the different transport modes have their own regulations. Nowadays, the transport chains include many different transport modes, so keeping track of things might sometimes be difficult.

It emerged in interviews that one of the major problems in dangerous goods transportation seems to be the differences between the regulations of different transport modes. Some goods may be classified as dangerous according to one regulation and harmless according to another. This makes the supply chain much more complex.

Each of the states around the Baltic Sea has its own transport law, but the international legal framework described earlier in the report determines the principal contents of this legislation. The huge volume of legislation is a result of legislators´ concern regarding public safety in the transportation of dangerous goods. This also causes some overlapping in some cases.

Regulation that limits the amount of dangerous goods transported on a passenger ship has quite a large impact on DG transport in the BSR, because such a large amount of DG is transported on passenger ferries. In the summertime the ro-ro and ro-pax ferries carry so many passengers that the amount of DG cargo has to be decreased compared to during the winter. This limits transport chain planning to an increasing degree, as the current trend is to replace most old ro-ro vessels with ro-pax vessels. The amount of

the dangerous goods on passenger-carrying vessels seems to be constantly decreasing, because of such limitations.

There are also some local regulations or special permits made by municipal decision-makers, which may affect the routing of dangerous goods transport. For instance, some transport routes may be prohibited for DG transport, or at least the amount of cargo may be limited.

Here are a few suggestions for remedial actions, based on this study:

- Decision-makers should be actively supplied with accurate information on dangerous goods transport.
- Coordination between different authorities is needed in the field of safety.
- Regulations must be adapted to the Baltic Sea Region conditions whenever possible.

6.2 Managerial implications

In addition to the regulatory implications described, this study has also provided some insights into practical business management. The most important area of business management to which this study has contributed is supply chain logistics.

It emerged in the interviews that the general public is especially interested in the transport of dangerous goods, because of the risks that it presents to the environment and to themselves. However, the companies involved in DG transportation tend to think that giving information to the public might increase their awareness of DG issues too much, resulting in a future tightening of regulations. That is why companies seem to think that giving as little information as possible is the best solution in most cases.

The companies also emphasised that, when transporting dangerous goods, requirements stretch far beyond those of a normal shipment. That is why it is imperative to have system-controlled operations, up-to-date equipment, well-trained personnel and an approved quality system. In most cases, dangerous goods cargo must be transported in temperature-regulated and purpose-built cargo units. The availability of these special transport units is much more limited than the availability of normal cargo units. This lack of proper transport units may limit transport frequency. Special equipment also raises the price of transportation. However, the most important factor in DG transportation is the human factor. Attitudes must be right and training sufficient.

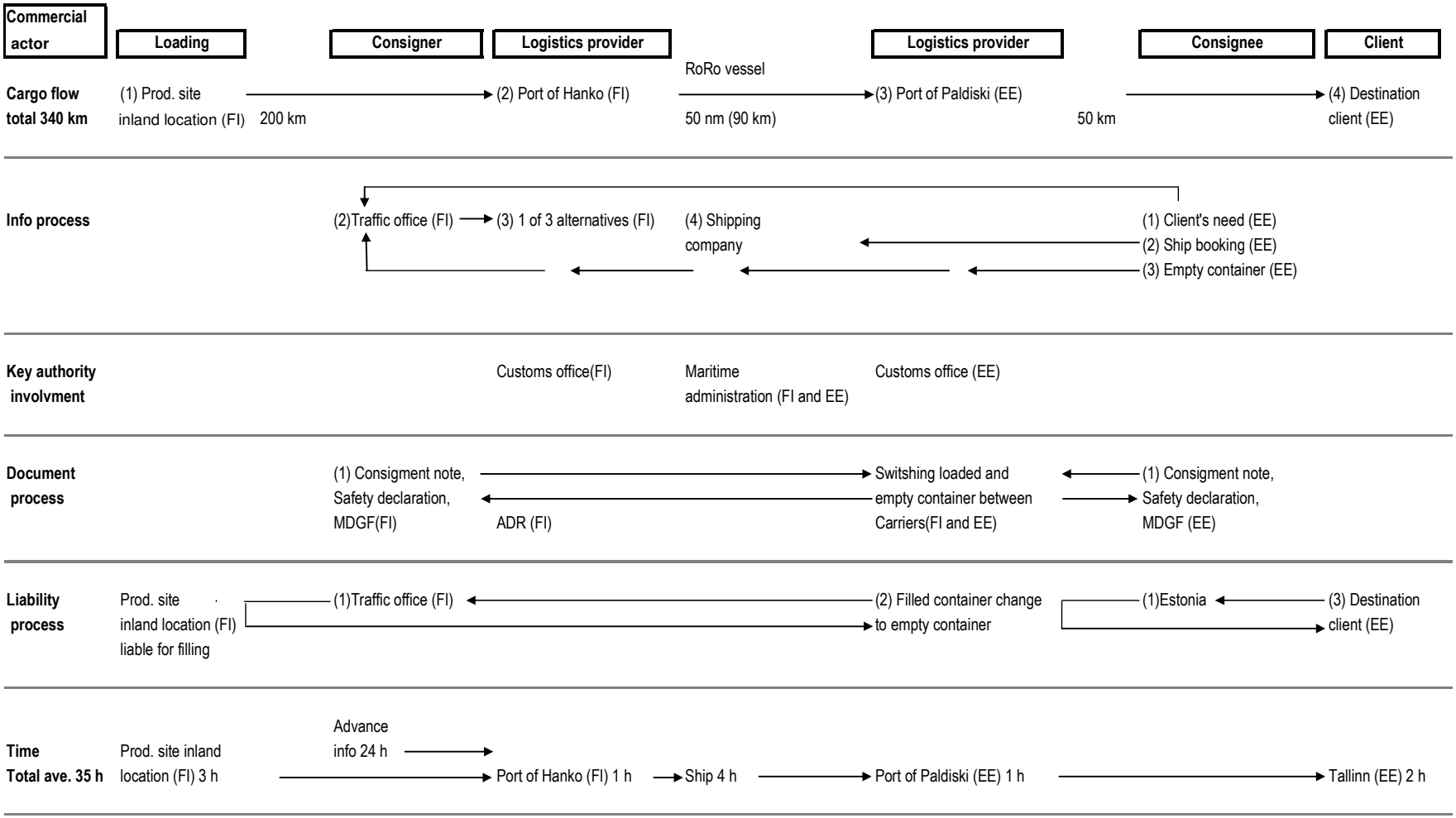
There are no major problems in the DG supply chains presented in this study. The companies use familiar logistics providers and the trading partners are already well-known. These factors have decreased the number of problems, and, if something unexpected happens, it can easily be clarified. Dangerous goods transportation is such a specialised business that there are only a limited amount of actors involved. The same familiar logistics providers are used in many cases, which makes the transport chain more efficient.

Based on the above, we can suggest a few remedial actions for the future:

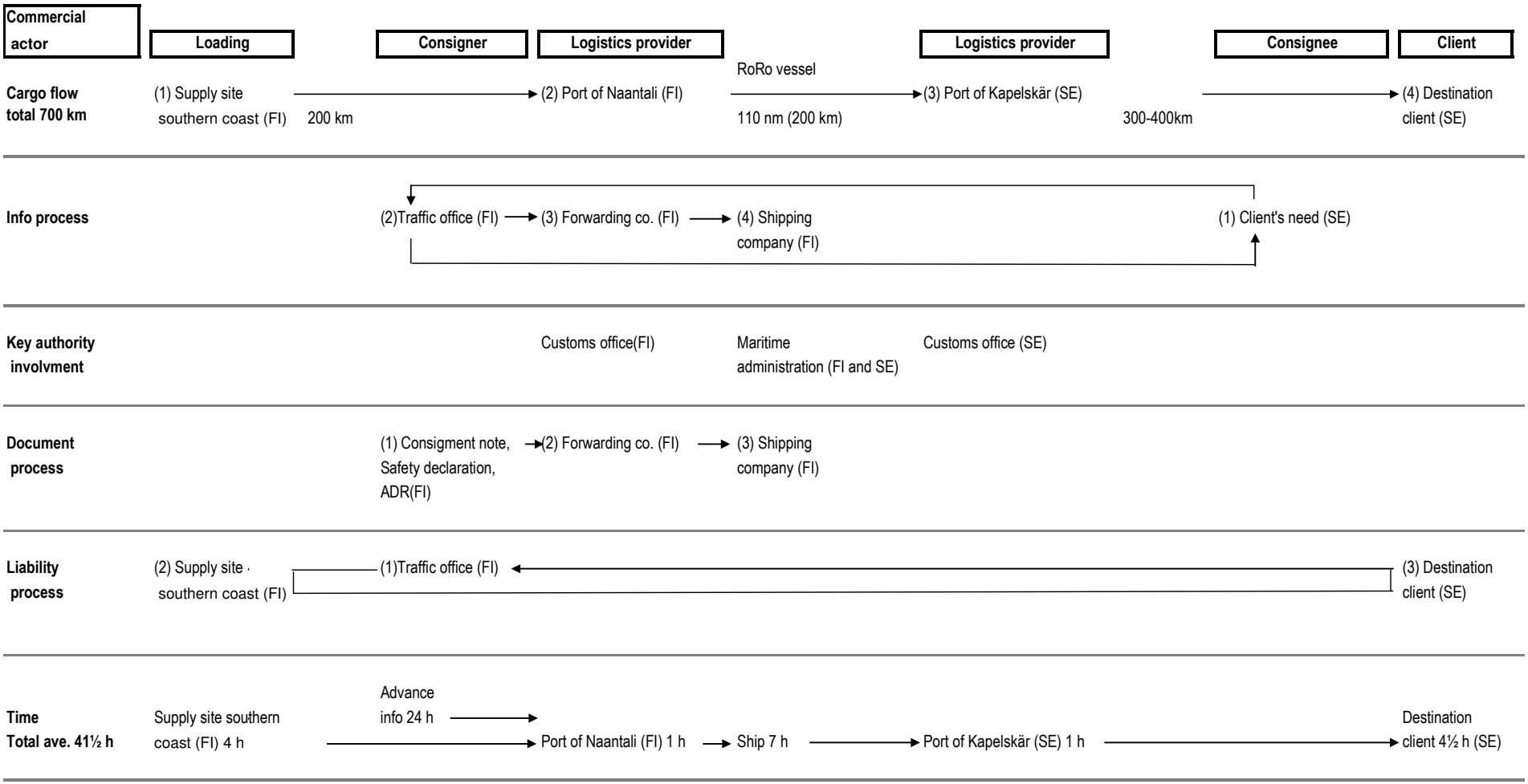
- The human factor can be affected only by high-quality education and training, practice, up-to-date knowledge and the use of modern equipment.
- Work to improve the safety of dangerous goods transportation must be actively continued. Emphasis should be placed on transport safety measures that prevent accidents from happening.
- The public needs to be better informed about the research conducted in the field.

APPENDIX 1 PROCESS CHARTS OF THE CASES

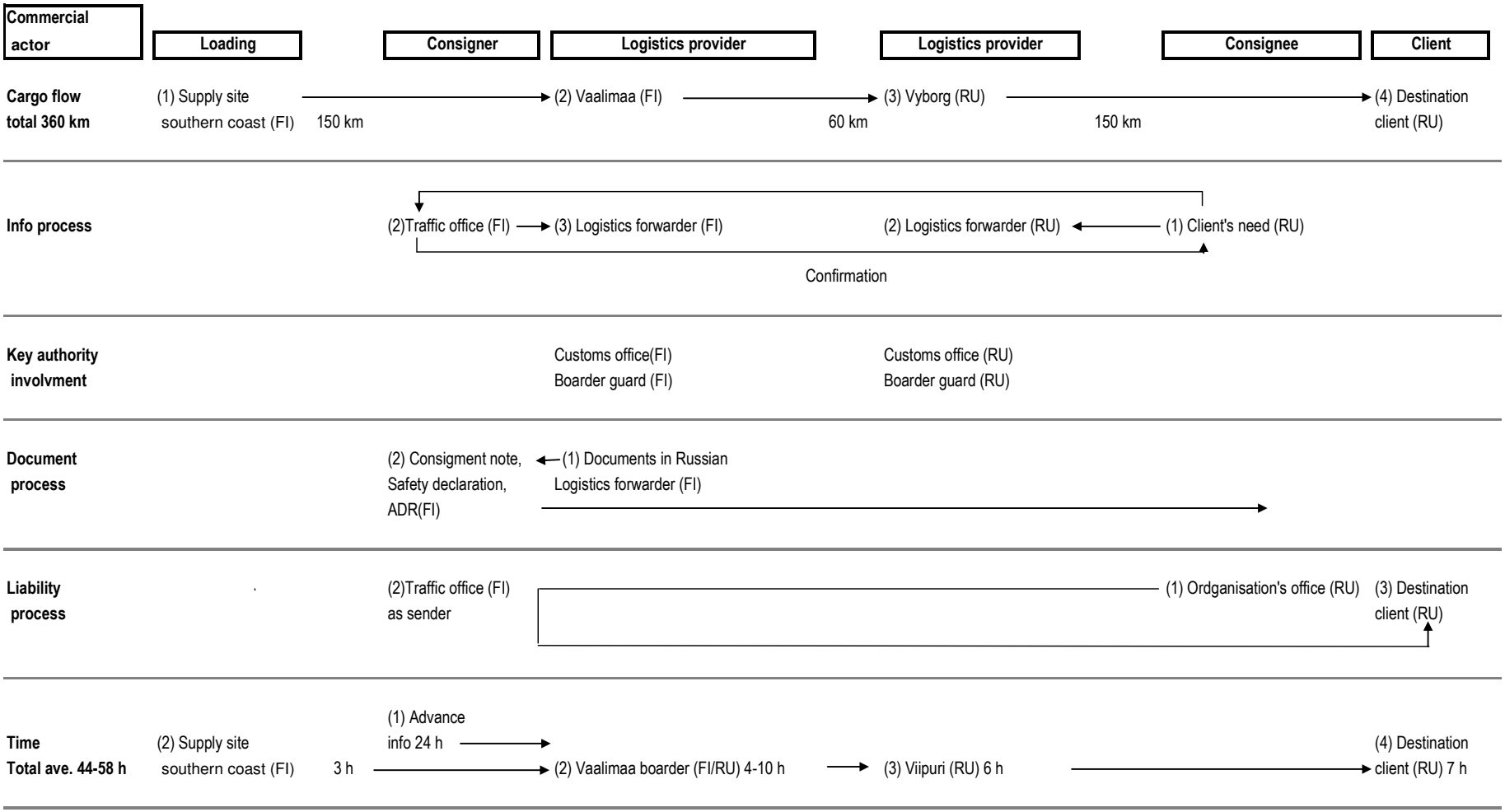
Case 1


Commercial actor
Loading
Consigner
Logistics provider
Logistics provider
Consignee
Client
RoRo vessel
Cargo flow
total 340 km
(1) Prod. site inland location (FI)
200 km
(2) Port of Hanko (FI)
50 nm (90 km)
(3) Port of Paldiski (EE)
50 km
(4) Destination client (EE)
Info process
(2)Traffic office (FI)
(3) 1 of 3 alternatives (FI)
(4) Shipping company
(1) Client's need (EE)
(2) Ship booking (EE)
(3) Empty container (EE)
Key authority involvment
Customs office(FI)
Maritime administration (FI and EE)
Customs office (EE)
Document process
(1) Consigment note, Safety declaration, MDGF(FI)
ADR (FI)
Switshing loaded and empty container between Carriers(FI and EE)
(1) Consigment note, Safety declaration, MDGF (EE)
Liability process
Prod. site inland location (FI) liable for filling
(1)Traffic office (FI)
(2) Filled container change to empty container
(1)Estonia
(3) Destination client (EE)
Time
Total ave. 35 h
Prod. site inland location (FI) 3 h
Advance info 24 h
Port of Hanko (FI) 1 h
Ship 4 h
Port of Paldiski (EE) 1 h
Tallinn (EE) 2 h

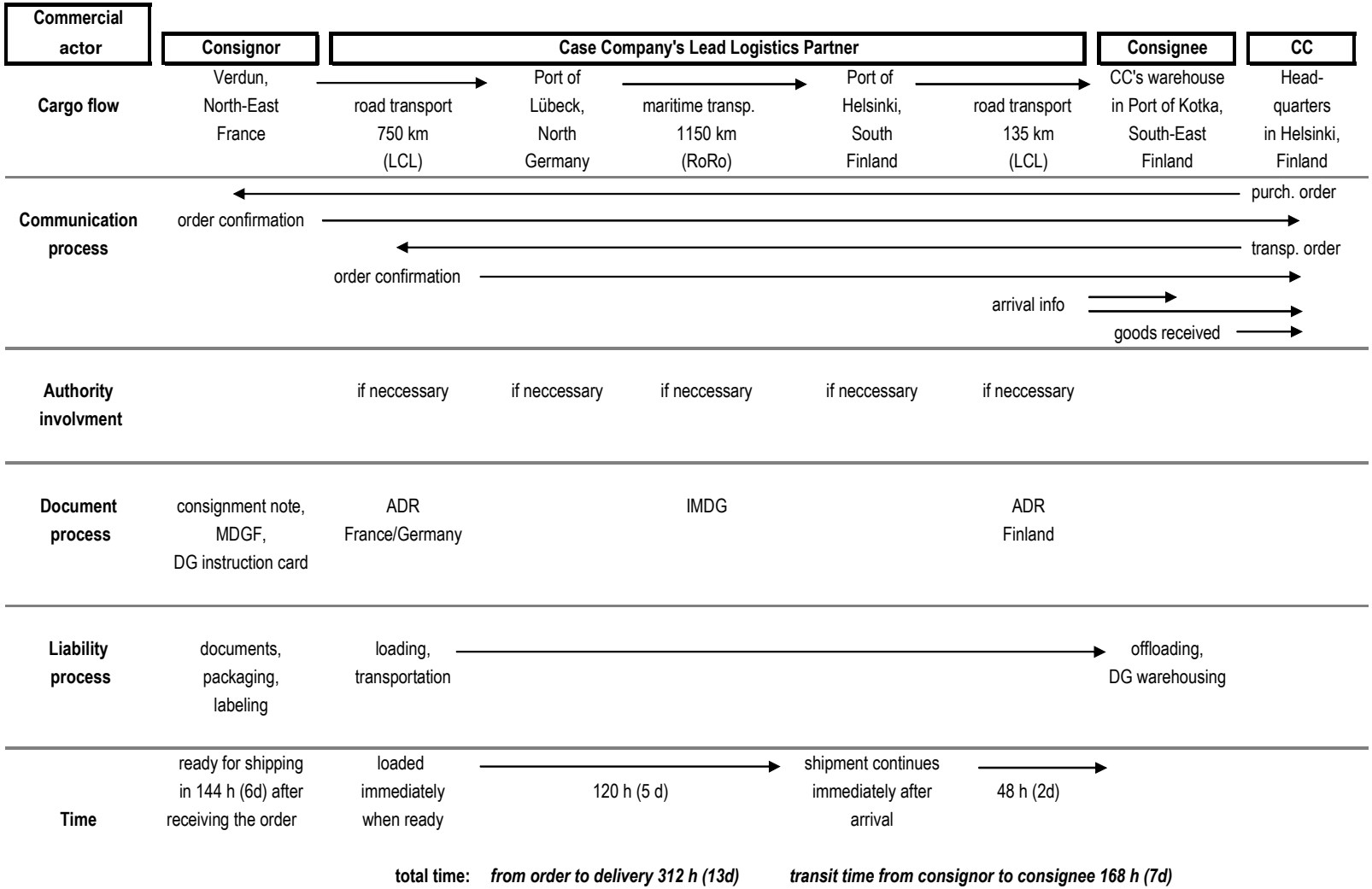
Case 2


Commercial actor
Loading
Consigner
Logistics provider
Logistics provider
Consignee
Client
Cargo flow total 700 km
(1) Supply site southern coast (FI)
200 km
(2) Port of Naantali (FI)
RoRo vessel
110 nm (200 km)
(3) Port of Kapelskär (SE)
300-400km
(4) Destination client (SE)
Info process
(2)Traffic office (FI)
(3) Forwarding co. (FI)
(4) Shipping company (FI)
(1) Client's need (SE)
Key authority involvment
Customs office(FI)
Maritime administration (FI and SE)
Customs office (SE)
Document process
(1) Consigment note, Safety declaration, ADR(FI)
(2) Forwarding co. (FI)
(3) Shipping company (FI)
Liability process
(2) Supply site southern coast (FI)
(1)Traffic office (FI)
(3) Destination client (SE)
Time
Total ave. 41½ h
Supply site southern coast (FI) 4 h
Advance info 24 h
Port of Naantali (FI) 1 h
Ship 7 h
Port of Kapelskär (SE) 1 h
Destination client 4½ h (SE)

Case 3

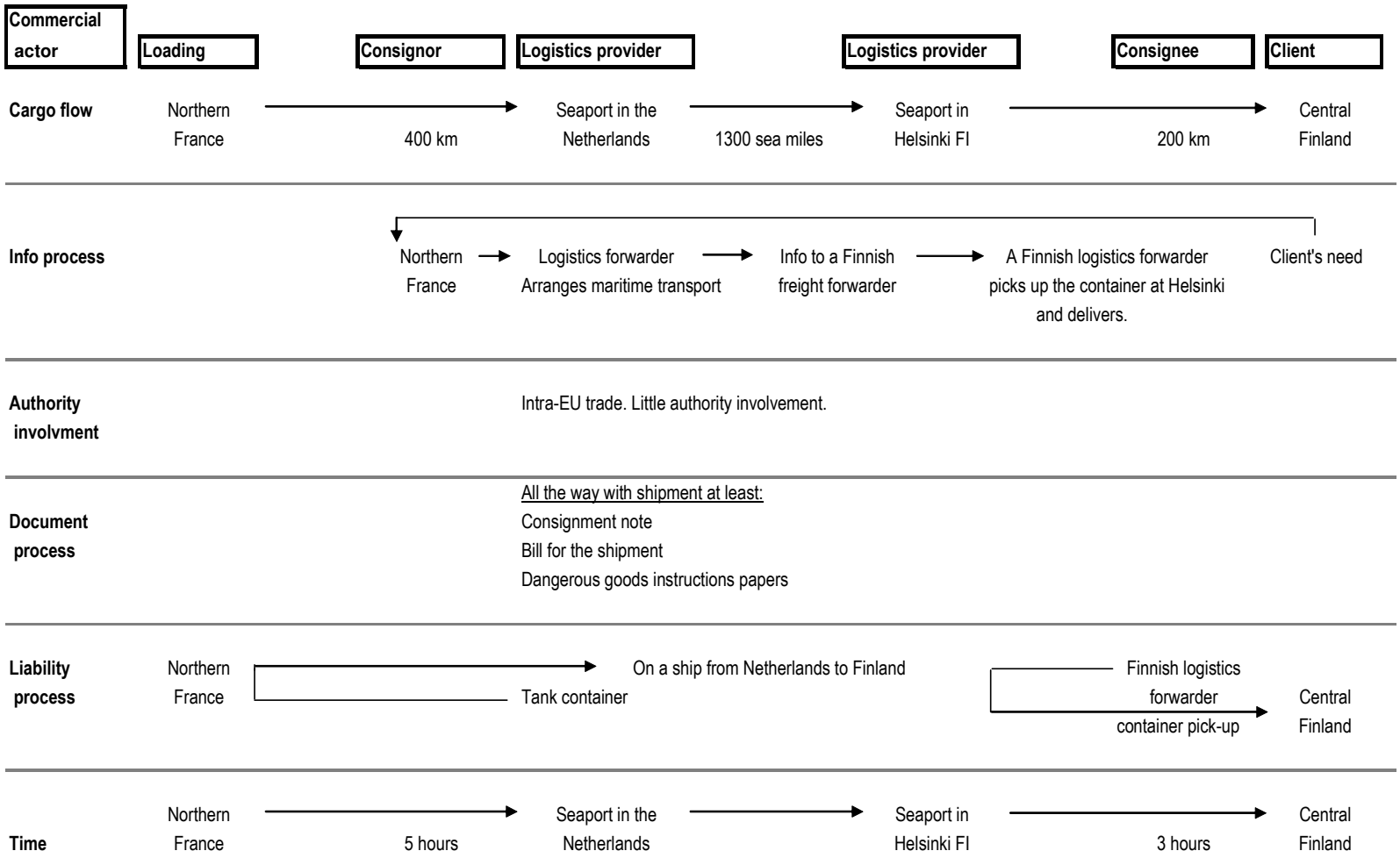

Commercial actor
Loading
Consigner
Logistics provider
Logistics provider
Consignee
Client
Cargo flow
total 360 km
(1) Supply site
southern coast (FI)
150 km
(2) Vaalimaa (FI)
60 km
(3) Vyborg (RU)
150 km
(4) Destination
client (RU)
Info process
(2)Traffic office (FI)
(3) Logistics forwarder (FI)
(2) Logistics forwarder (RU)
(1) Client's need (RU)
Confirmation
Key authority involvment
Customs office(FI)
Boarder guard (FI)
Customs office (RU)
Boarder guard (RU)
Document process
(2) Consigment note,
Safety declaration,
ADR(FI)
(1) Documents in Russian
Logistics forwarder (FI)
Liability process
(2)Traffic office (FI)
as sender
(1) Ordganisation's office (RU)
(3) Destination
client (RU)
Time
Total ave. 44-58 h
(2) Supply site
southern coast (FI)
3 h
(1) Advance
info 24 h
(2) Vaalimaa boarder (FI/RU) 4-10 h
(3) Viipuri (RU) 6 h
(4) Destination
client (RU) 7 h

Case 4 ***CC = Case Company** **annual amount of DG in the supply chain = 35 000 kg**



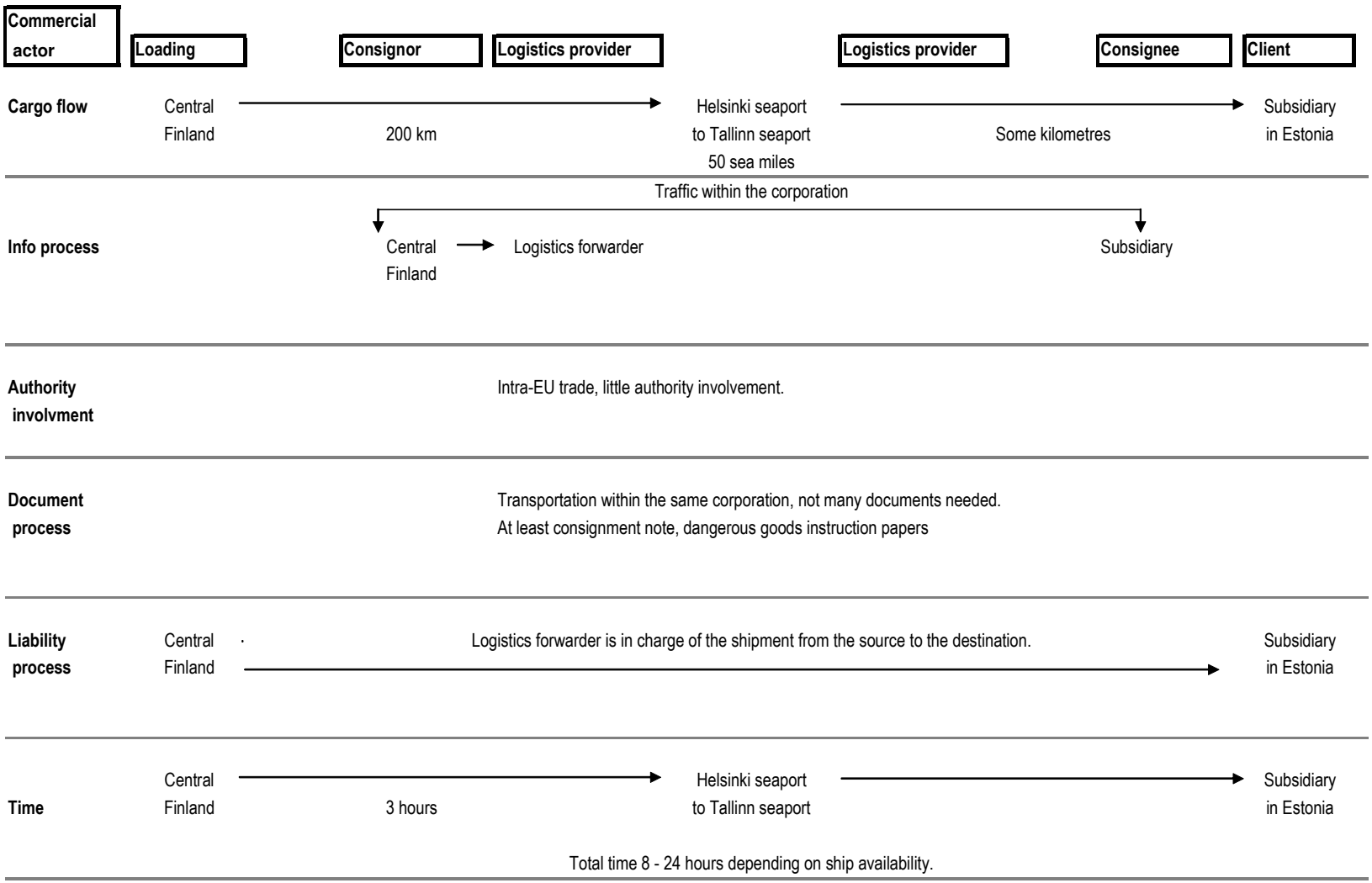
total time: ***from order to delivery 312 h (13d)*** ***transit time from consignor to consignee 168 h (7d)***

Case 5

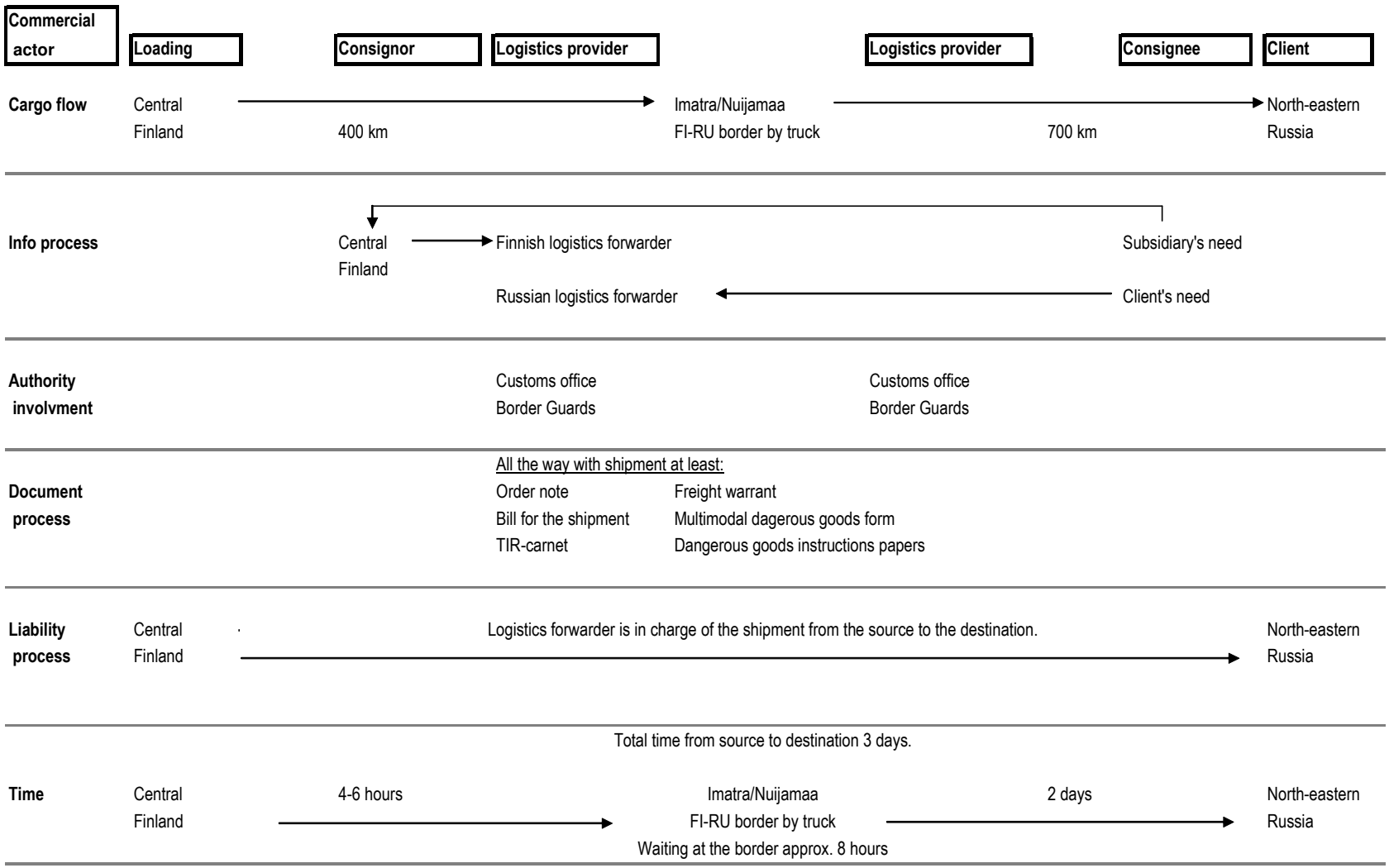


Total time from order placement to delivery at destination approximately 1,5 weeks. Includes waiting at the seaports.

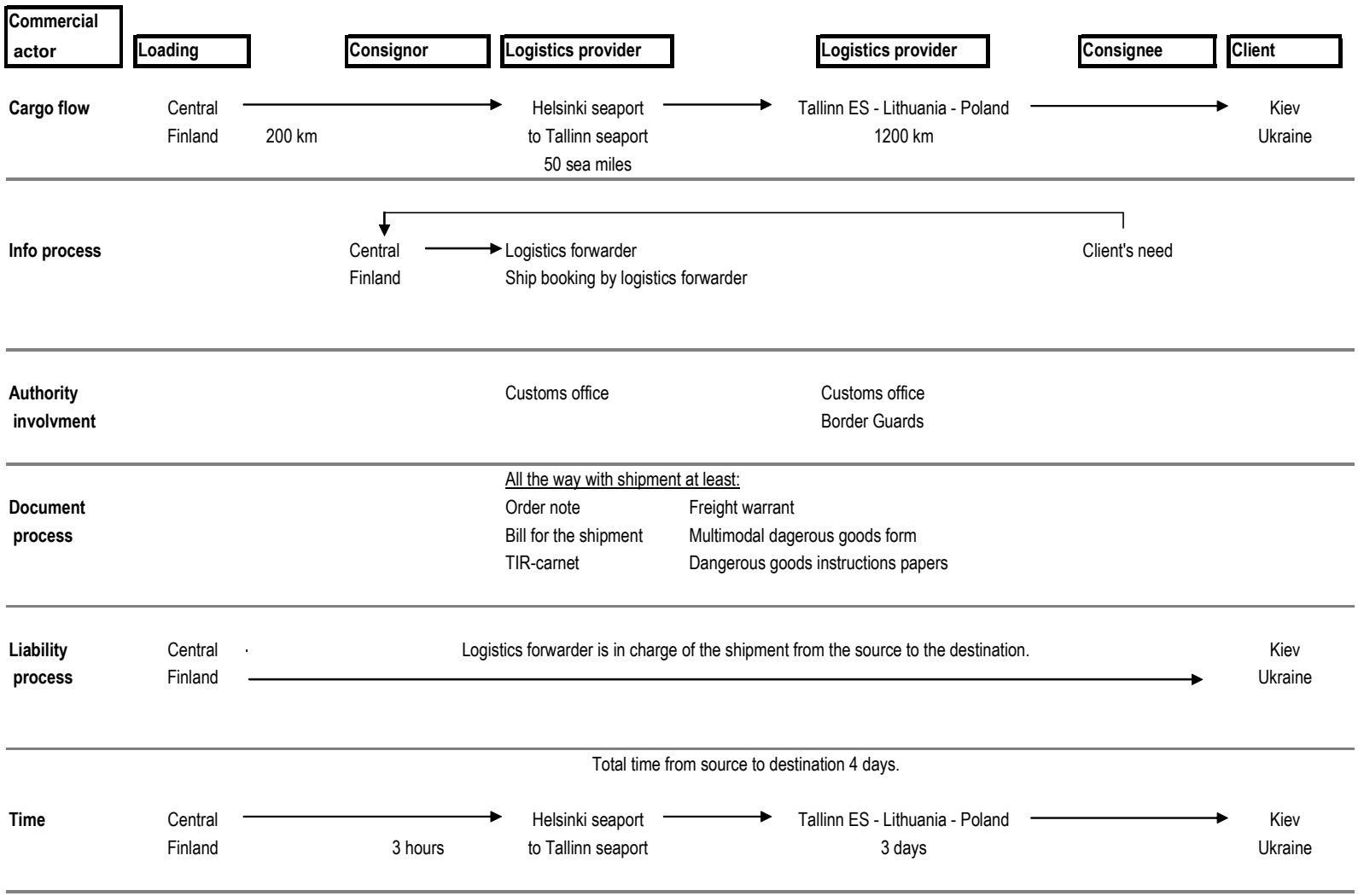
Case 6


Commercial actor
Loading
Consignor
Logistics provider
Logistics provider
Consignee
Client
Cargo flow
Central Finland
200 km
Helsinki seaport to Tallinn seaport 50 sea miles
Some kilometres
Subsidiary in Estonia
Traffic within the corporation
Info process
Central Finland
Logistics forwarder
Subsidiary
Authority involvment
Intra-EU trade, little authority involvement.
Document process
Transportation within the same corporation, not many documents needed.
At least consignment note, dangerous goods instruction papers
Liability process
Central Finland
Logistics forwarder is in charge of the shipment from the source to the destination.
Subsidiary in Estonia
Time
Central Finland
3 hours
Helsinki seaport to Tallinn seaport
Subsidiary in Estonia
Total time 8 - 24 hours depending on ship availability.

Case 7


Commercial actor
Loading
Consignor
Logistics provider
Logistics provider
Consignee
Client
Cargo flow
Central Finland
400 km
Imatra/Nuijamaa
FI-RU border by truck
700 km
North-eastern Russia
Info process
Central Finland
Finnish logistics forwarder
Subsidiary's need
Russian logistics forwarder
Client's need
Authority involvment
Customs office
Border Guards
Customs office
Border Guards
Document process
All the way with shipment at least:
Order note
Bill for the shipment
TIR-carnet
Freight warrant
Multimodal dagerous goods form
Dangerous goods instructions papers
Liability process
Central Finland
Logistics forwarder is in charge of the shipment from the source to the destination.
North-eastern Russia
Total time from source to destination 3 days.
Time
Central Finland
4-6 hours
Imatra/Nuijamaa
FI-RU border by truck
Waiting at the border approx. 8 hours
2 days
North-eastern Russia

Case 8


Commercial actor
Loading
Consignor
Logistics provider
Logistics provider
Consignee
Client
Cargo flow
Central Finland
200 km
Helsinki seaport
to Tallinn seaport
50 sea miles
Tallinn ES - Lithuania - Poland
1200 km
Kiev
Ukraine
Info process
Central Finland
Logistics forwarder
Ship booking by logistics forwarder
Client's need
Authority involvment
Customs office
Customs office
Border Guards
Document process
All the way with shipment at least:
Order note
Bill for the shipment
TIR-carnet
Freight warrant
Multimodal dagerous goods form
Dangerous goods instructions papers
Liability process
Central Finland
Logistics forwarder is in charge of the shipment from the source to the destination.
Kiev
Ukraine
Total time from source to destination 4 days.
Time
Central Finland
3 hours
Helsinki seaport
to Tallinn seaport
Tallinn ES - Lithuania - Poland
3 days
Kiev
Ukraine

Case 9 (less than truck load)

Commercial actor	Consignor (FI)	Logistics provider (FI) (Carrier A)	Port of Helsinki (FI) Port operator (FI)	Shipping company (alternatives FI/EE)	Port of Tallinn (EE) Port operator (EE)	Logistics provider (EE) (Carrier B = subisidiary of A)	Consignee (EE)
Cargo flow		(2) Road transport (FI)		(4) Sea transport (FI–EE)		(6) Road transport (EE)	(7) Consignee =
Average total distance 125 km	(1) Consignor's production unit in Vantaa (FI)	Vantaa (FI)–Helsinki (FI) 30 km	(3) Port of Helsinki (FI) Loading the vessel	90 km	(5) Port of Tallinn (EE) Unloading the vessel	Tallinn (EE)–Tallinn (EE) 5 km	Consignor's subsidiary in Tallinn (EE)
Info process	Sales dpt of the consignor (2) Info to the carrier (FI)	(3) booking of the shipping space (4) info to the carrier B (EE)				Carrier B (EE)	(1) Order to the consignor into the system
Key authority involvment							
Document process	(1) ICN + MDGF to the carrier	(2) Advance Notice of DG (24 h before the cargo's arrival at the port) + CMR waybill	Port of Helsinki		Port of Tallinn		Consignee
	EIC to accompany the cargo with the driver	(3) CMR waybill, ICN + EIC from the driver (FI) to the shipping company		(4) CMR waybill + ICN + EIC to the driver (EE)		(5) CMR waybill + ICN + EIC to the consignee (EE)	
Liability process	Delivery terms DDU Tallinn (EE) Consignor's liability: the whole transport chain, excl. unloading (EE)						Consignee's liability: unloading (EE)
Average transit time total 51–73 hours	36 h needed before the transport Loading at the consignor's production unit in Vantaa (FI)	Road transport Vantaa (FI)–Helsinki (FI) 1–2 h	Waiting + loading in the port of Helsinki (FI) 4–16 h	Sea transport Helsinki (FI)–Tallinn (EE) 4 h	Unloading in the port of Tallinn (EE) 1 h	Short haulage and waiting until distribution in the morning 3–11 h	Unloading by the consignee in Tallinn (EE) 1–2 h
Frequency several times/week	1 h						

ICN = International Consignment Note
MDGF = Multimodal Dangerous Goods Form
EIC = Emergency Instruction Card

Case 10 (less than truck load)

Commercial actor	Consignor (FI)	Logistics provider (FI) (Carrier A)	Port of Helsinki (FI) Port operator (FI)	Shipping company (alternatives FI/EE)	Port of Tallinn (EE) Port operator (EE)	Logistics provider (EE + LV) (Carrier B = subsidiary of A)	Consignee (LV)
Cargo flow		(2) Road transport (FI)		(4) Sea transport (FI–EE)		(6) Road transport (EE–LV)	(7) Consignee = Consignor's subsidiary in Riga (LV)
Average total distance 470 km	(1) Consignor's production unit in Vantaa (FI)	Vantaa (FI)–Helsinki (FI) 30 km	(3) Port of Helsinki (FI) Loading the vessel	90 km	(5) Port of Tallinn (EE) Unloading the vessel	Tallinn (EE)–Riga (LV) 350 km	
Info process	Sales dpt of the consignor (2) Info to the carrier A (FI)	(3) booking of the shipping space (4) info to the carrier B (EE + LV)				Carrier B (EE + LV)	(1) Order to the consignor by e-mail
Key authority involvment							
Document process	(1) ICN + MDGF to the carrier A	(2) Advance Notice of DG (24 h before the cargo's arrival at the port) + CMR waybill	Port of Helsinki		Port of Tallinn	Carrier B (EE + LV)	Consignee
	EIC to accompany the cargo with the driver	(3) CMR waybill ICN + EIC from the driver (FI) to the shipping company		(4) CMR waybill + ICN + EIC to the driver (EE)		(5) CMR waybill + ICN + EIC to the consignee (LV)	
Liability process	Delivery terms DDU Riga (LV) Consignor's liability: the whole transport chain, excl. unloading (LV)						Consignee's liability: unloading (LV)
Average transit time total 52–74 hours	36 h needed before the transport Loading at the consignor's production unit in Vantaa (FI)	Road transport Vantaa (FI)–Helsinki (FI) 1–2 h	Waiting + loading in the port of Helsinki(FI) 4–16 h	Sea transport Helsinki (FI)–Tallinn (EE) 4 h	Unloading in the port of Tallinn (EE) 1 h	Road transport Tallinn (EE)–Riga (LV) 4–5 h Waiting until the distribution in the morning 0–7 h	Unloading by the consignee in Riga (LV) 1–2 h
Frequency once/week	1 h						

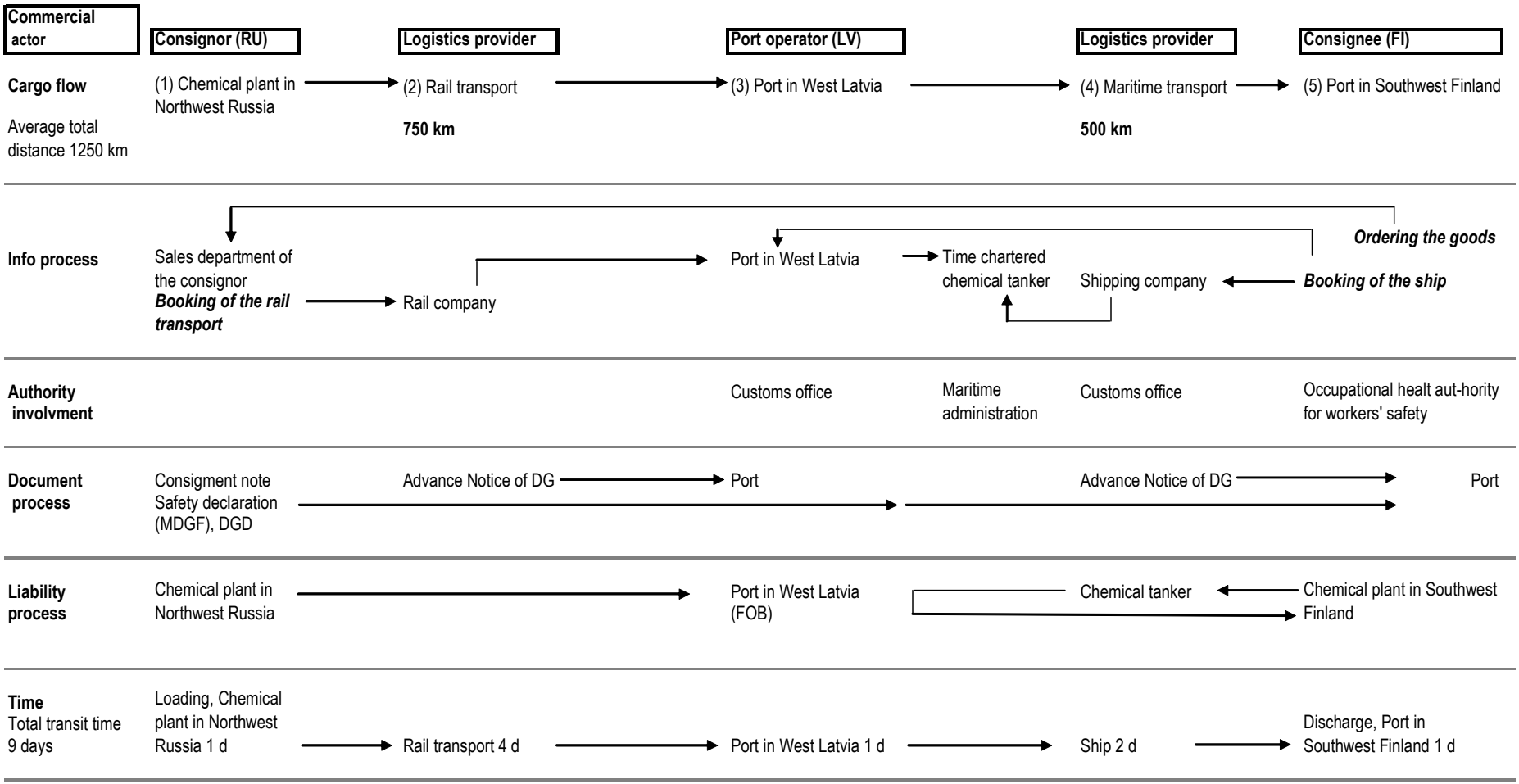
ICN = International Consignment Note
MDGF = Multimodal Dangerous Goods Form
EIC = Emergency Instruction Card

Case 11 (less than truck load)

Commercial actor	Consignor (FI)	Logistics provider (FI) (Carrier A)	Port of Helsinki (FI) Port operator (FI)	Shipping company (alternatives FI/EE)	Port of Tallinn (EE) Port operator (EE)	Logistics provider (EE + LT) (Carrier B = subsidiary of A)	Consignee (LT)
Cargo flow		(2) Road transport (FI) →	(3) Port of Helsinki (FI) →	(4) Sea transport (FI–EE) →	(5) Port of Tallinn (EE) →	(6) Road transport (EE–LT) →	(7) Consignee =
Average total distance 820 km	(1) Consignor's production unit in Vantaa (FI)	Vantaa (FI)–Helsinki (FI) 30 km	Loading the vessel	90 km	Unloading the vessel	Tallinn (EE)–Kaunas (LT) 700 km	Consignor's subsidiary in Kaunas (LT)
Info process	Sales dpt of the consignor (2) Info to the carrier A (FI) →	(3) booking of the shipping space → (4) info to the carrier B (EE + LT) →		Shipping company		Carrier B (EE + LT)	← (1) Order to the consignor by e-mail
Key authority involvment							
Document process	(1) ICN + MDGF to the carrier A → EIC to accompany the cargo with the driver →	(2) Advance Notice of DG (24 h before the cargo's arrival at the port) + CMR waybill → (3) CMR waybill ICN + EIC from the driver (FI) to the shipping company →	Port of Helsinki	Shipping company (4) CMR waybill + ICN + EIC to the driver (EE) →	Port of Tallinn	Carrier B (EE + LT) (5) CMR waybill + ICN + EIC to the consignee (LV) →	Consignee
Liability process	Delivery terms DDU Kaunas (LT) Consignor's liability: the whole transport chain, excl. unloading (LT) →						Consignee's liability: unloading (LT)
Average transit time total 58–73 hours	36 h needed before the transport Loading at the consignor's production unit in Vantaa (FI) 1 h	Road transport Vantaa (FI)–Helsinki (FI) 1–2 h	Waiting + loading in the port of Helsinki(FI) 4–16 h	Sea transport Helsinki (FI)–Tallinn (EE) 4 h	Unloading in the port of Tallinn (EE) 1 h	Road transport Tallinn (EE)–Kaunas (LT) 10 h Waiting until the distribution in the morning 0–1 h	Unloading by the consignee in Kaunas (LT) 1–2 h
Frequency once/week							

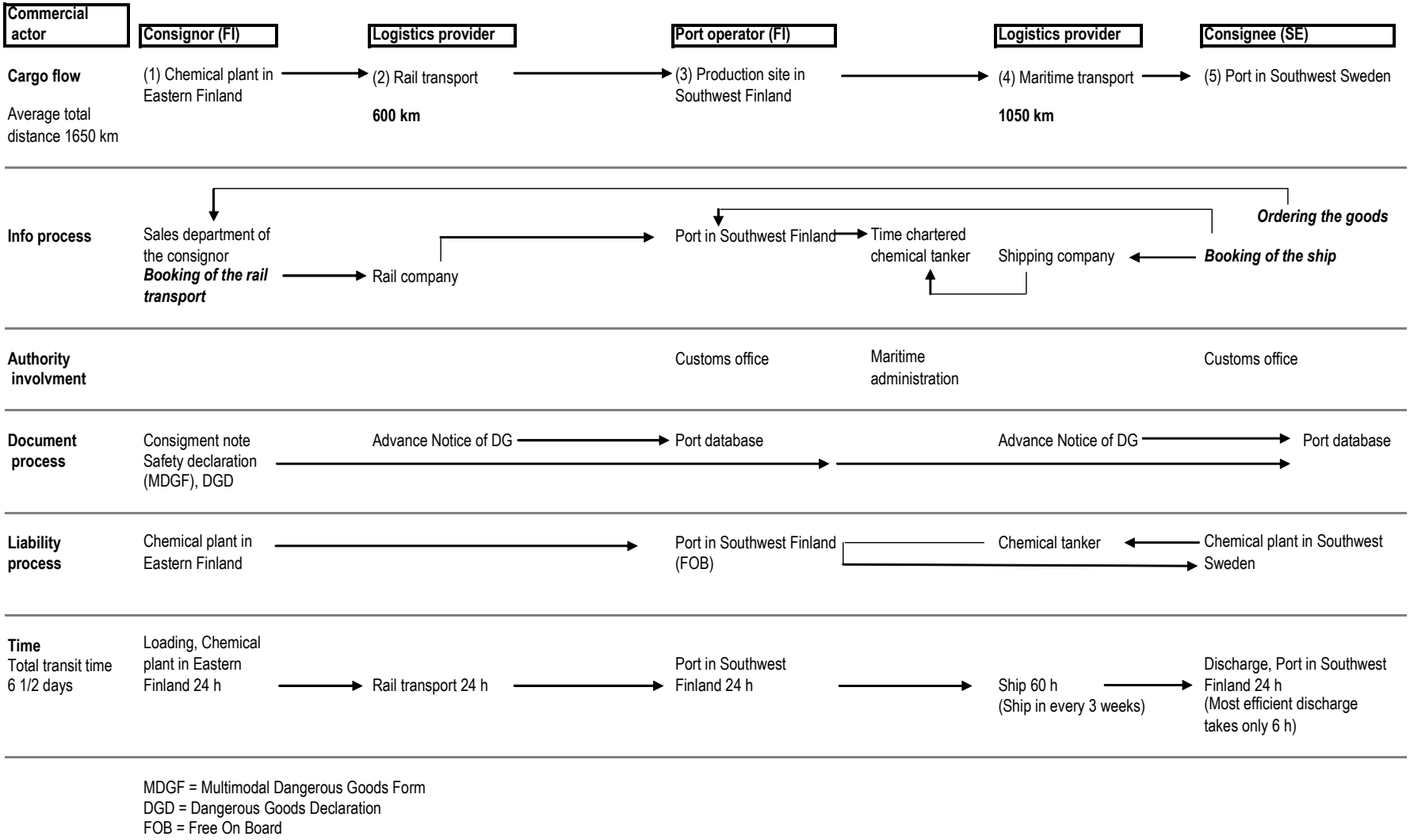
ICN = International Consignment Note
MDGF = Multimodal Dangerous Goods Form
EIC = Emergency Instruction Card

Case 12



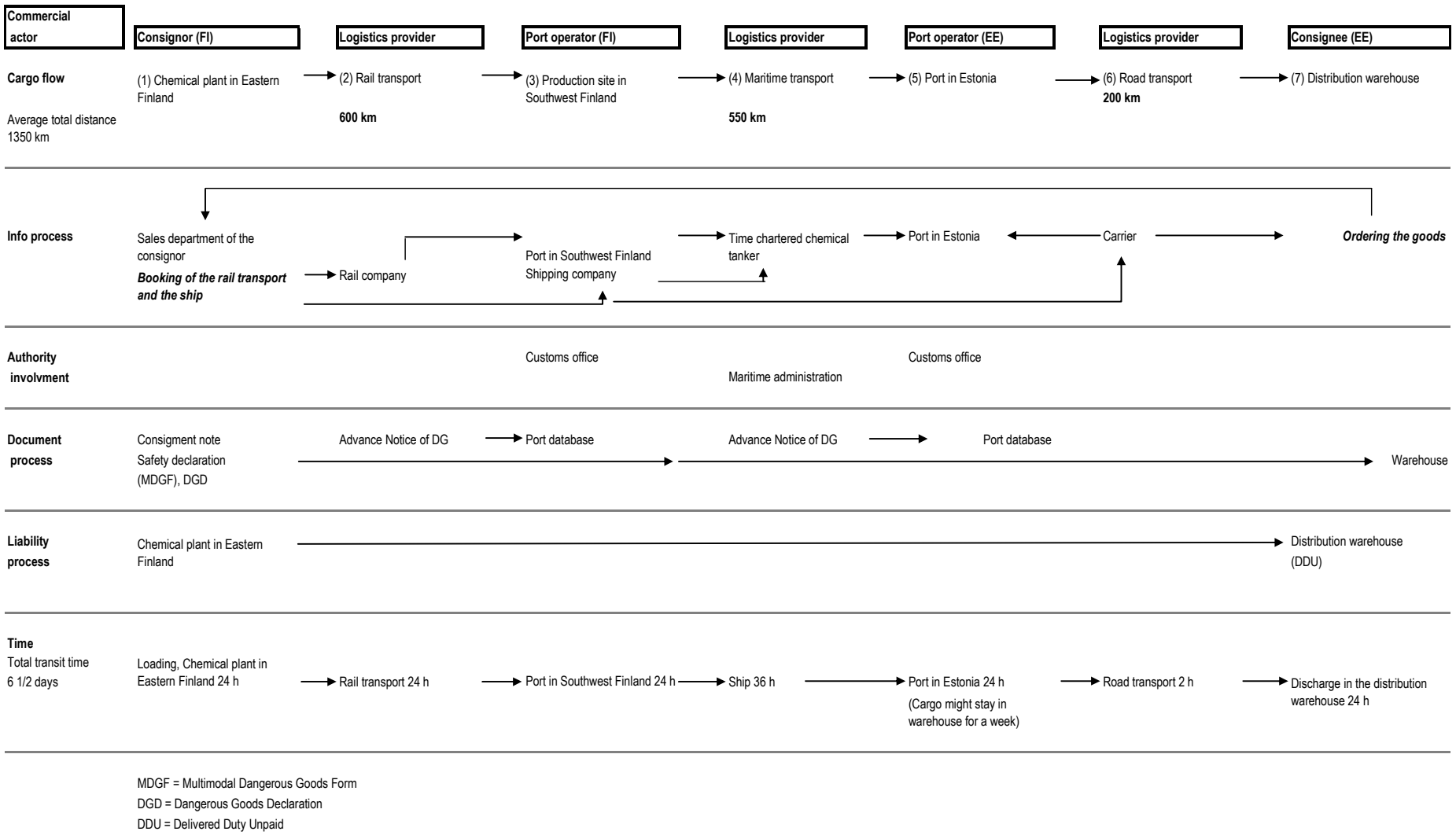
MDGF = Multimodal Dangerous Goods Form
DGD = Dangerous Goods Declaration
FOB = Free On Board

Case 13



MDGF = Multimodal Dangerous Goods Form
DGD = Dangerous Goods Declaration
FOB = Free On Board

Case 14



MDGF = Multimodal Dangerous Goods Form
DGD = Dangerous Goods Declaration
DDU = Delivered Duty Unpaid

APPENDIX 2 CO-OPERATING PARTNERS

DaGoB Partners are listed below (in alphabetical order by countries):

Estonia:
- Port of Tallinn, Tallinn (www.portoftallinn.com)
- Estonian Railway Inspectorate, Tallinn, (www.rinsp.ee)
- Estonian Maritime Administration, (www.vta.ee)

Finland:
- Turku School of Economics (www.tse.fi) Lead Partner, WP 1 Leader
- Port of Turku, Turku (www.port.turku.fi)
- Finnish Maritime Administration, Helsinki (www.fma.fi)
- The Association of Finnish Technical Traders, Helsinki (www.tkl.fi)
- Chemical Industry Federation of Finland, Helsinki (www.chemind.fi)
- Finnish Environment Institute, Helsinki (www.ymparisto.fi)
- The Finnish Port Association, Helsinki (www.finnports.com/first.php)
- Finnish Port Operators' Association, Helsinki (www.satamaoperaattorit.fi)
- Finnish Transport and Logistics SKAL, Helsinki (www.skal.fi)
- Finnish Customs (www.tulli.fi)
- Finnish Traffic Police (www.poliisi.fi)
- West Finland Coast Guard District (www.raja.fi)
- TEDIM Telematics, Education, Development and Information Management, Helsinki, Advisory Partner (www.tedim.com)

Germany:
- TuTech Innovation GmbH, Hamburg (www.tutech.de) WP3 Leader
- Ministry for Urban Development and Environment of the Free and Hanseatic City of Hamburg

Latvia:
- Freeport of Riga Authority, Riga (www.rop.lv)

Lithuania:
- Klaipeda State Seaport Authority, Klaipeda (www.portofklaipeda.lt)

Sweden:
- Lund Institute of Technology, University of Lund, Lund (www.lth.se)
- Swedish Rescue Service Agency, Karlstad (www.srv.se) WP 2 Leader
- University College of Borås (www.hb.se) WP 4 Leader
- Swedish Rail Agency, Borlänge/Stockholm (www.jvs.se)
- Swedish Coast Guard, Karlskrona (www.kustbevakningen.se)
- Baltic Ports Organization (BPO), Stockholm (www.bpoports.com)

Russia:

- Saint-Petersburg Government Committee of Transport-Transit Policy, St. Petersburg (www.petersburg-russia.com)
- North Western Russia Logistics Development and Information Centre, St. Petersburg (www.ilot.wnet.ru)
- Non-profit training and research center for adult education "Protey", St. Petersburg (http://proteus-spb.ru)

More than 300,000,000 tons of dangerous goods are transported in the Baltic Sea Region (BSR) annually. In spite of formal implementation there are still substantial differences in operational practices between stakeholders and authorities involved in the dangerous goods (DG) transport. There is a vast need to improve the exchange of information between DG authorities and commercial actors, and to coordinate DG processes in the whole BSR.

This report is part of the Safe and Reliable Transport Chains of Dangerous Goods in the Baltic Sea Region -project. This project aims at improving the co-operations between public and private stakeholders related to DG transport in the BSR by connecting the stakeholders on different levels, providing up-to-date information on cargo flows, supply chain efficiency and risks related to DG transport.

The objective of this study is to provide an insight on how DG supply chains work with an overview of problems which the actors are faced. The study aims at providing detailed up-to-date information on the supply chains through the selected 14 cases. Supply chain partners, various operations, material flows, information and communication flows and liabilities between parties are all included in the study. The main emphasis is placed on operations rather than costs. It was essential to find out how effective, efficient and professional the operations are in the various phases of the supply chain. The conclusion of each case will reveal individual bottlenecks and development areas. Based on these results recommendations for remedial actions are offered.

Contacts

DaGoB Project Office at Turku School of Economics
Switchboard: +358 (0)2 481 481
Fax: +358 (0)2 481 4640
Website: www.dagob.info
E-mail: firstname.lastname@tse.fi
Mobile phones:
Project Director Lauri Ojala +358 50 502 7031
Project Coordinator Sirpa Nummila +358 40 760 9058
Project Officer Mikko I. Suominen +358 50 502 7071