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Secure and Efficient Intermodal Dangerous Goods Transport

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Abstract

Rules and regulations concerning dangerous goods exist for individual transport modes but not for intermodal transports. What does this mean for intermodal transports of dangerous goods, and what problems exist at the intermodal transport interfaces? The purpose is to answer the above mentioned questions and to improve the efficiency and security of intermodal dangerous goods transports. The outcome will be to present a desired intermodal transport flow of dangerous goods. A theoretical study based on regulations and business process improvement methodologies together with a number of interviews have made important information available for an analysis and conclusion. Suggestions for improving some of the problems that exist today are provided and an analysis of the current situation and a desired situation is presented and evaluated. The thesis task is required by Volvo Technology Corporate and it will contribute to the Secure Transport Scenario which will be presented as a part of a Demo Theatre project at the ITS World Congress in Stockholm 2009.

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List of Abbreviations

ADR – The European Agreement Concerning the International Carriage of Dangerous Goods by Road

BPI – Business Process Improvement

BPR – Business Process Reengineering

DG – Dangerous Goods

CTU – Cargo Transport Unit

ECMT – European Conference of Ministers of Transport

EMS Guide – Emergency Schedule

ERP – Enterprise Resource Planning

GT – Gross Tonnage

IMDG – The International Maritime Dangerous Goods Code

INF Code – The International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships

ISPS – The International Ship and Port Facility Security Code

ITS – Intelligent Transport Systems and Services

LQ – Limited Quantity

MFAG – Medical First Aid Guide

MSB – The Swedish Civil Contingency Agency

PPH – Pre- and Post Haulage

RID – Regulations Concerning the International Transport of Dangerous Goods by Rail

Ro-Ro – Roll on Roll off

VTEC – Volvo Technology Corporate

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1. Introduction

The introduction chapter consists of background information about the problem area, a brief description of this thesis role in a bigger project, the research question, the purpose and delimitations.

1.1. Background

In the recent decades the use of intermodal transportation has grown dramatically and this trend will continue with even more speed in the 21st century. The policy makers all over the world in response to economic globalization consider the use of intermodal transportation and development of relative infrastructures to achieve more influence in the international business playground. The shippers, forwarders and carriers seek to remain competitive by means of consolidating their cargos more efficiently, reducing the cost of handling and more efficient use of documentation and information technology which are some of many benefits of intermodality in transportation. Agile corporations with international supply chains depend on intermodal transportation services to meet customers' demands for rapid production and delivery¹.

Dangerous goods transports also follow this increasing trend. A transport containing dangerous goods can have severe effects on the environment if an accident occurs and they often incur a higher cost for the society than non dangerous goods accidents². This is one reason why it is very important to focus on improving the efficiency and security for dangerous goods transports and avoid potential accidents. Statistics from the Swedish police shows that around one fourth of the controlled dangerous goods transports on Swedish roads have a violation of the law³.

Efficient and secure transports are also demanded by the industry. Due to the fact that companies are producing and sending smaller quantities of goods more frequently the transports needs to be more efficient and there exists no room for accidents which means that the safety and security must be held at an acceptable level.

A combination of intermodal transports and secure and efficient dangerous goods transports is the topic for this thesis which was conducted at Volvo Technology. The thesis will combine intermodal transports and dangerous goods and complement previous work in this area. It will also be a part of a Secure Transport Scenario which will be presented as a part of a Demo Theatre project at the ITS World Congress in Stockholm 2009. The thesis will contribute with input by process map case flows of intermodal dangerous goods transports, and also by performing an intensive literature study of existing rules and regulations, concerning single mode transports and intermodal transports of dangerous goods. An illustration of the thesis role in the ITS World congress can be seen in Figure 1.

1 Rondinelli & Berry, 2000

2 Ellis, 2002

3 SR Radio interview with the police, 2008

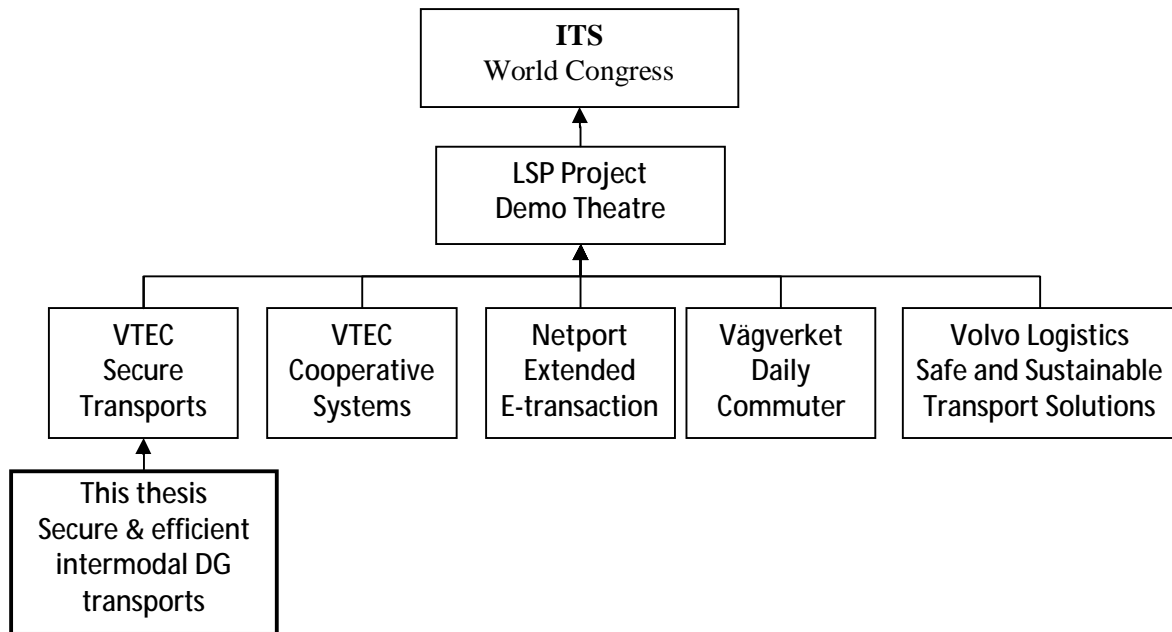


Figure 1 Simplified Picture of This Thesis's Contribution to ITS World Congress¹

1.2. Research question

Studies on the interface of intermodal dangerous goods transportation can be an interesting and meaningful research area from many perspectives. Due to the inherent attributes of the dangerous goods themselves, there are hazards in addition to those normally associated with general transport activities. Meanwhile, the high incidents rates at the transport nodes together with the increasingly popularity of intermodal transport today, exposed transport nodes as one of the main focus areas to further enhance security and efficiency. Databases with information on dangerous goods transportation, such as the US Department of Transportation's Hazardous Materials Information System⁴, show that more than half of the total number of incidents occur during activities at the transport nodes. In particular, as there are different regulations governing the transport of dangerous goods by road, rail and sea, and in practice, it is not always solely one regulation that regulates the whole intermodal transport of dangerous goods. Even though regulations for different transport modes are harmonized in great extent, there may still be some areas and problems that need to be improved. Based on such, the authors have come up with the following research question:

What problems exist in the interfaces of intermodal dangerous goods transports and the application of rules and regulations, and how can these problems be reduced?

Definition of interface: An interface is a point where two transport actors connect, both concerning the physical flow and the information flow. The physical interface refers to a terminal, a port or a loading/unloading area at a company. The information interface refers to communication and documentation between different actors in the transport flow.

The problems areas in this research paper refers to those that concerns the application of rules and regulations, and those that might originate from the activities of any actor or process concerned at the transport interfaces.

⁴ Ellis, 2002

Improved implementation and better harmonization of rules and regulations together with reducing the problem areas in the transport interfaces will not only enhance the security of dangerous goods transport but also improve the transport efficiency due to the decreased number of accidents that improved security would lead to. In order to answer the identified research question above, the authors have divided the problem into several sub-problems as follows:

- What are the existing rules and regulations concerning dangerous goods transports on road, rail and sea?
- What are the application and control situation of DG regulations in Sweden?
- What are the problems concerning application and control of rules and regulations in Sweden?
- What does a general intermodal dangerous goods transport flow look like?
- What are the current problems among involved actors, activities at the transport interfaces?
- How to solve the problems concerning the application and control of rules and regulations and problems at the transport interfaces?
- What does the desired flow with improved legal environment and reduced problems look like?
- What are the deployment barriers to reach the desired flow?

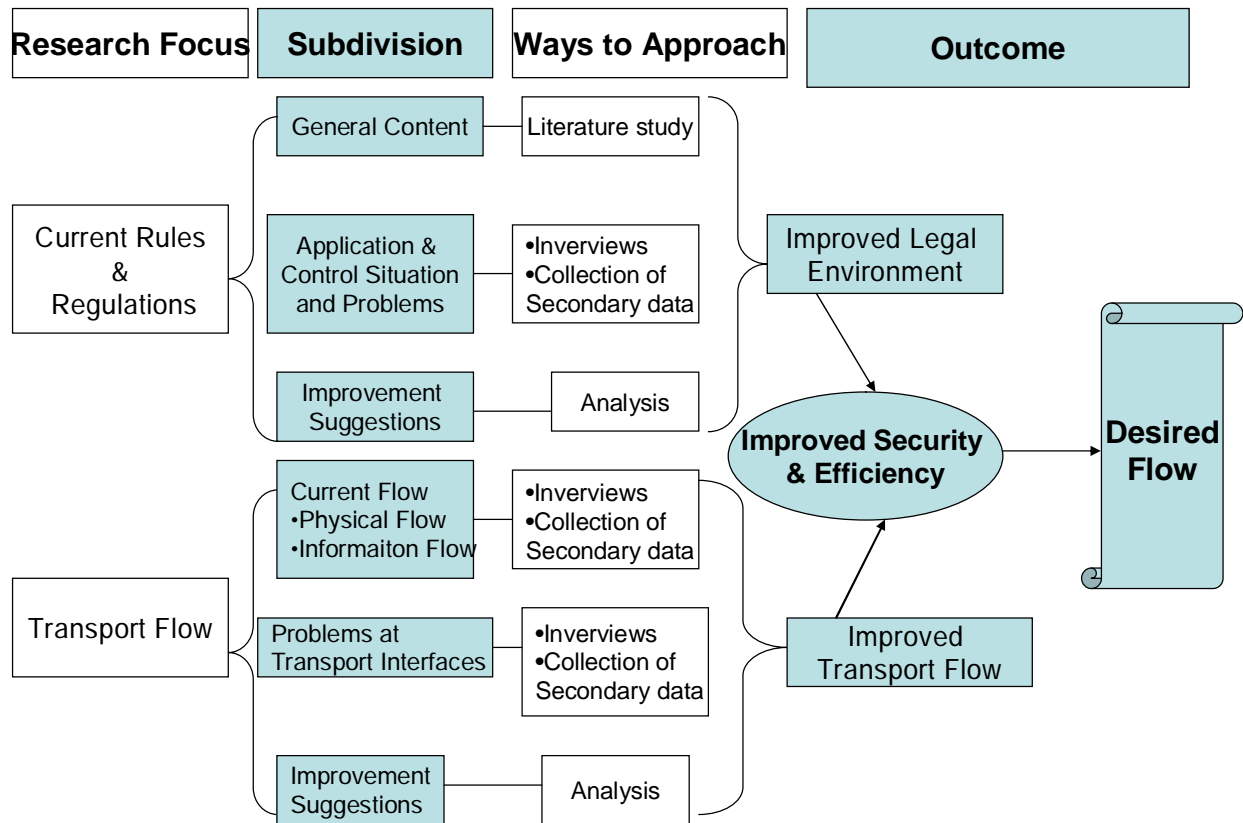
1.3. Purpose

The purpose of this research paper is to improve the efficiency and security of intermodal dangerous goods transports by identifying and reducing problems concerning the application and controls of rules and regulations and problems on the transport interfaces. The output of the paper will depict a desired flow with improved legal environment and improved efficiency and security of the transport chain taking into consideration of the deployment barriers.

This research report which directly touches the critical problem areas concerning the interface of intermodal transports of dangerous goods and the problems related to rules and regulations will contribute to improved security and efficiency of dangerous goods transports.

1.4. Thesis Structure

The flowchart illustrates how the research task is conducted in the report, by focusing on the two main parts, the current rules and regulations and the problems areas on transport interfaces, this paper aims to contribute to improved legal environment for transporting actors and improved transport flow. Both areas will together lead to improved security and efficiency of dangerous goods transport. In order to approach the research targets, the authors mainly focus on data collection and analysis parts based on the theoretical support. The data collection covers literature study on rules and regulations, interviews, and other secondary data etc.

Figure 2 Thesis Structure⁵

1.5. Delimitations

Geographical boundary

This thesis covers intermodal transports of dangerous goods between Sweden and other European Countries. The main focus is on road and sea transports but some parts of rail transports are also covered. Air transports are excluded from this thesis. The reasons for focusing on these two modes are that road and sea are the most common way to transport dangerous goods and takes up the main share of dangerous goods transport among all the modes. The regulations for the two modes are authorized by two authorities, one based on European level and the other on international level. And they are less harmonized compared with road and rail regulations, which motivated the authors' further interest to investigate the problems concerning the rules and regulations.

Interviewed actors are mainly from the Gothenburg area taking the advantage of the convenience to collect data nearby, however this does not imply that the authors have chosen narrower and less representative interview groups. Because Gothenburg has the largest port in Sweden they cover nearly all the international shipping business.

⁵ Svensson & Wang, 2009

Transport units

The only transport units this thesis cover are trailers that are transported international on road and Ro-Ro ships. As stated earlier, some information concerning rail transport of trailers will also be presented.

For international transport of dangerous goods, trailer and container are two main transport units and compared with container, trailer is more flexible to short distance transport such as within Europe and easier to handling. The geographical boundary of the research paper to study dangerous goods transport between Sweden and other European countries also delimits our focus on the transport units.

2. Methodology

In the methodology the authors will describe how the data has been collected and handled. The purpose with this chapter is to present why specific methods are used in this thesis.

2.1 Previous Perceptions

The result of this thesis depends on previous perceptions by the authors. The methods used are based on the authors' experience from previously written reports and bachelor thesis. The authors' backgrounds are quite different, which makes their combined previous knowledge area even broader. One of the authors is from Sweden with a bachelor degree in Industrial management and a major in Logistics. The other author is from China and has a bachelor degree in Economics with a major in International Economy and Trade and a master degree in International Marketing. Today both authors are studying a masters program for Logistics and Transport Management at the Graduate School, School of Business, Economics and Law at Gothenburg University. The authors' goal is to use their combined knowledge to come up with good and useful information about the topic that is researched.

2.2 Research Approach

There are two main types of research methods, inductive and deductive. A deductive approach is a process where different theories are tested. This thesis, which was originally planned by Volvo Technology, was conducted with a deductive research approach. A deductive research approach means that the work process goes from a general idea to a more specific idea. It is often referred to as a top down approach and used to test hypotheses.

An inductive research begins with observing a scenario and then analyzing what actually happens. Based on this information models and ideas are constructed, which helps to analyze the scenario. An inductive approach can result in a new theory. Induction is usually described as moving from the specific to the general, while deduction begins with the general and ends with the specific. Arguments based on laws, rules and accepted principles are generally used for Deductive Reasoning. Observations tend to be used for Inductive Arguments⁶.

2.3 Quantitative and Qualitative Research

Two different ways of gathering data are quantitative and qualitative research. Quantitative data collection is a mathematical way to look on a problem. It uses statistical aids and focuses a lot on identifying variations so they don't ruin the results of the measurements. Qualitative data collection uses social factors and develops ways to find and plot processes. In this thesis, the goal is to map an existing flow of dangerous goods and the problems that exists in the flow. The primary data needed is collected through interviews. Complementary information and confirmation of previously qualitative collected data is done with quantitative data with the help of questionnaires⁷.

The analysis flowchart above illustrates how the research task is conducted in the report, by focusing on the two main parts, the current rules and regulations and the problems areas on transport interfaces, this paper aims to contribute to improved legal environment for transporting actors and improved transport flow, both together will lead to improved security and efficiency of dangerous goods transport. In order to approach the research targets, the

⁶ Bryman & Bell, 2003

⁷ Bryman & Bell, 2003

authors mainly focus on data collection and analysis parts based on the theoretical support. The data collection covers literature study on rules and regulations, interviews, and other secondary data etc.

2.4 Case Study

A case study is a very common method concerning scientific researches. It is mainly used as an alternative method together with other research methods⁸. When conducting a case study only a number of objects are thoroughly investigated. Objects can for example be companies or persons⁹. The purpose with a case study is to study a small part of a big chain of events to be able to describe what happens. An advantage with a case study is that no detailed description needs to be done. Another advantage with the method is that it can handle a lot of different empirical data, e.g. interviews and documents. One difficulty with the method is that when only looking on a limited number of objects it could be hard to get a justified picture of the studied case. This means that the authors should be careful not to make any hasty conclusions without confirming them with other objects¹⁰.

To be able to answer the research question and provide an illustration of a general flow of an intermodal dangerous goods transport, not one but several case studies have been conducted. By getting input from more than one actor at each part in the flow more problems was depicted. This also led to increased validity and more improvement suggestions for the desired flow.

2.5 Data Collection

Data can be divided into primary and secondary data. Primary data is information gathered by the researcher through methods such as questionnaires and interviews. Secondary data is data that is already collected from another source¹¹. The data used in this thesis is mostly from primary data sources but also includes some secondary data sources.

2.5.1. Primary Data

Primary data comes mainly from interviews with key personnel that are involved in the transport flow of dangerous goods. Only a few interviews were conducted through telephone due to the time constraint and the far distance to the interviewee. Almost all interviews were conducted face to face. The reason why face to face interviews were preferred was because more information is revealed when interviewing someone in person. Facial expressions, body language and the work environment are some factors that can contribute with input to the interview and these factors are not possible to get if conducting a telephone interview¹².

2.5.1.1. Structured & Unstructured Interviews

An interview can either be structured or unstructured. A structured interview means that the interviewer asks a number of pre-written questions. The purpose of this is to maintain the same context for all interviews. This makes it possible to summarize all interviews in order to compare the results¹³. An unstructured interview is often used in order to help the person

8 Ejvegård, 2003

9 Hartman, 1998

10 Ejvegård, 2003

11 Bryman & Bell, 2003

12 Bryman & Bell, 2003

13 Bryman & Bell, 2003

being interviewed to open up and subsequently allows for a more open conversation. An unstructured interview means that the interviewer only uses an interview guide with some basic general questions¹⁴. The interviews conducted in this thesis have been structured or semi-structured because there has been a need to compare the information from the different interviews. Almost all interviewees have had a DG safety advisor certificate, meaning that the interviewees are well educated concerning DG rules and regulations. The interviewees have worked either internal at the interviewed company or external as safety advisors.

2.5.1.2. Purpose with Interviews

The General purposes with the interviews are to depict a true picture of an intermodal dangerous goods transport flow to and from Sweden but within Europe, and to identify problems at the transport interfaces. Another purpose is to investigate how well DG rules and regulations works in practice and to find problems related to the application situation today. In order to achieve this, 16 interviews were conducted including actors from the entire transport chain. Table 1 show the type of the interviewee and the interview purpose.

Interviewees	Main purpose of Interviews
DG Producing Company	<ul style="list-style-type: none"> • DG preparation and sending process , starting point of the flow • Common problems at the sender’s place where driver and sender meets
Forwarder	<ul style="list-style-type: none"> • Transport flow • Problems at the transport interfaces • Rules and regulations application situation and problems
Hauler	
Rail Company	
Shipping Company	
Port of Gothenburg	<ul style="list-style-type: none"> • Problems at the ports • Transport flow esp. the flow before/at/after the port • Rules and regulations application situation and problems
External Safety Advisors	<ul style="list-style-type: none"> • Rules and regulations application situation and problems
MSB (The Swedish Civil Contingency Agency)	
The Swedish Transport Agency	<ul style="list-style-type: none"> • Dangerous goods Control situation and problems with control • The common problems found by controlling authorities
The Coast guard	
Production leader at the port of Gothenburg	<ul style="list-style-type: none"> • Common problems at the transport interfaces

Table 1 Conducted Interviews

2.5.1.3. Questionnaire

To further strengthen the validity of this thesis result a questionnaire was sent to all the interviewees. The purpose with the questionnaire was to confirm questions that previously have been discussed during the interviews and also to get feedback on different improvement suggestions that the authors had come up with based on the results from the interviews.

14 Bryman & Bell, 2003

2.5.2. Secondary Data

To be able to ask the right questions at the interviews the secondary data was collected and studied before the interviews were conducted. And secondary data in this thesis mainly include the rules and regulations, DG transport documents, statistics and control situations etc. Apart from the content of rules and regulations, secondary data is a minor part of the empirical findings. The sources for secondary data was collected from literature, rules and regulations, articles, statistics offered by relevant authorities, older thesis and official website of the competency agencies(e.g. UN pages, MSB website, the Swedish Transport Agency, Port of Gothenburg etc).

2.6. Validity

Sometimes there is a difference between what is studied and what is thought to be studied. How well these two areas correspond is usually called validity and the more abstract the research objects are the harder it is to verify the validity of the research. If the purpose is to say something about a population one must prioritize the sample being representative¹⁵.

The research question of this research paper is defined and decided by the actual needs of the company to fill in the blank of the big project that Volvo Technology contributes, therefore, the final confirmation of the research question is made by both the company and the authors, and there is no point to doubt the research question.

In order to answer the predefined research questions and increase the validity, suitable theories and methods are applied to achieve the goals. Supply chain flow theories which contains physical flow and information will definitely help to map the intermodal transport flow of dangerous goods and business process improvement theory which target on the current situation and desired situation is also within the research scope according to the research questions.

Since this research paper mainly deal with the actual problems in the transport flow and the application and control of rules and regulations, therefore primary data takes major part of the empirical findings to increase the validity.

2.7. Reliability

The reliability tells how well the study and the instruments used for collection of data resists influences by chance. A high reliability is achieved if a number of independent measurements of the same phenomena give identical or almost identical results¹⁶. The fact that the data is based on personal opinions and views makes it harder to control the reliability. The human factor is a big concern, and the way interviewees answer questions may be different from time to time since circumstances and attitudes can change. One threat to the reliability is that questions can be misunderstood by some respondents or interpreted incorrectly. The risk of low reliability not only lies with the respondents but also affects the later analysis step.

In the case of this research, the authors use cross checking to reduce the influences by chances. Similar interview questions are used to interview different actors of the transport chain by giving different priorities and focus depending on the position and role of the interviewees until we get nearly the same answers. The fact that the interviewed actors'

15 Bryman & Bell, 2003

16 Bryman & Bell, 2003

knowledge areas often overlap have also improved the reliability, because it gives the authors the possibility to control collected information from previous interviews that has been conducted. Meanwhile, the authors also updated each set of coming interview questions based on the feedback from the previous interviews, and contradicting answers concerning the same questions will be especially picked out from previous interview questions to the new ones. Besides, both authors were present during all interviews and all the interviews are recorded in order to reduce the misunderstood of the information. There were no sensitive questions asked during the interviews and the interviewees could be anonymous if they preferred. The authors have interviewed several actors that have different roles in the transport flow, and within each role e.g. a transporting company, several interviews has been conducted to improve the reliability. The high number of interviews, the absence of complicated calculations and the authors' background have contributed to a good reliability.

3. Theoretical Framework

This chapter presents the results of a literature study covering intermodal dangerous goods transports, supply chain management concerning process mapping and different business process improvement methodologies.

3.1. Intermodal Transport

One way to define “intermodal transportation” according to the ECMT (European Conference of Ministers of Transport) is that; intermodal transportation is the term used to describe the movement of freight in one and the same loading unit or vehicle which uses successive, various modes of transport (road, rail, water) without any handling of the goods themselves during transfers between modes¹⁷.

The intermodal shipment is usually comprised of two main operations, the first of which is called drayage, pre- and post haulage (PPH) or pick-up and delivery operation, in most cases done by road transport. The second operation is called long haul which can be operated by rail, sea or air transportation or a combination of these. Though the pickup and delivery is usually operated for short distances, it comprises almost half of the transportation operation costs¹⁸.

As the international supply and demand chains develop, the need for a seamless logistics system and accordingly transportation system becomes more evident in order to provide more quick procurement, production and distribution to the customers. Some of the most important factors in the development of intermodal transportation as such approaches towards a better logistics service are as follows: Economic Globalization is internationalizing the market for all goods and services and also the sourcing of material and production. Development of agile manufacturing and business practices, and the demand for more efficient international supply chains require an efficient transportation approach. Faster delivery requirements from customers and shippers and increasing door-to-door service demand from carriers also call for more efficiency in the use of transportation means. The sustainability and environmental aspect of the intermodal transportation has been an important incentive that has been development by governmental and international policymakers. For this reason, the White Paper of the European Commission, entitled European Transport Policy for 2010 (European Commission, 2001), strongly supports the further encouragement of intermodal transport¹⁹.

According to Andy Brice²⁰ heavy investments are needed in the future to be able to switch from road to any of the other modes of transportation. Since road is the mode of transportation where door to door deliveries are easiest to carry out it is also the mode which is best developed today when it comes to availability and capacity at hubs and terminals. Just a small change of ten percent of the volume being transported from road to either rail or short-sea would require an increase of over fifty percent for rail capacity and even more for short-sea transportation. Another problem concerning the future is mentioned by Ebeling²¹. It is the

17 European Conference of Ministers of Transport, 2001

18 McHarris et al. 2007

19 Rondinelli & Berry, 2000

20 ICIS Chemical Business, 2007

21 ICIS Chemical Business, 2007

different time frames for demand and supply of infrastructure. Demand rises over night while a project that concerns problems with infrastructure takes several years to plan and develop²².

3.1.1. Transportation Networks

The transportation network defined by Lumsden²³ is composed of nodes and links, it represents the physical flow of resources and goods during the transport process. A node is a place where the flow is stopped or can be stopped, e.g. terminals, ports or warehouses. Links stand for the transport of the goods²⁴. The link time represents the time for transport which is decided by a number of factors such as the mode of transport, the characteristics of the transport goods etc. Node time includes the active and passive node time. The active node time refers to those for the internal handling of the goods while the passive node time is the time the goods are not moved such as stored without any handling activities²⁵.

3.1.2. Intermodal Transport Interfaces

Terminals are the main infrastructure which has to be developed for intermodal purposes in each mode and their interface. This development has been more fundamental for airports and road carriers in recent years, because the terminals had not been compatible for intermodal use by default. While railroads and ports usually have the capability and equipment needed²⁶.

In general there are multiple functions of terminals. Lumsden identified eight functions which are consolidation, transshipment, coordination, sorting sequencing, kitting, commercializing and warehousing, the focused activities for most terminals are consolidation, transshipment, coordination and sorting²⁷.

The interface in a transport chain have shown to be critical from a damage perspective, and according to the database Hazardous Materials Information System (the US department of transportation 2000) more than half of the total number of incidents, concerning transportation, occurs during activities such as loading, unloading, and temporary storage i.e. activities that occur at transport interfaces. What causes accidents at transports interfaces probably differs significantly from what causes accidents that occur when en-route. Often a release of dangerous goods at a transport interface is caused by incidents such as errors in loading and unloading bulk cargoes, or dropping and damaging packages²⁸.

The pressure that has been put on intermodal transports to help reduce congestion affects the environment, and improve mobility implies that there is a need for more efficient transport interfaces. An increased understanding for what to do and how to handle dangerous goods are important to be able to reduce the number of accidents and improve the security at the interfaces, i.e. a better understanding of existing rules and regulations concerning intermodal transports of dangerous goods will help to improve security and efficiency²⁹.

22 ICIS Chemical Business, 2007

23 Lumsden, 1998

24 Lumsden, 1998

25 Lumsden, 1998

26 McHarris et al. 2007

27 Lumsden, 1998

28 Ellis, 2002

29 Ellis, 2002

3.2. Supply Chain Management

Advances in communication and transportation techniques are some of the motivating factors that have been contributing to the continuous evolution of the supply chain, and the techniques to manage it effectively. A typical supply chain consist of several actors e.g. suppliers, manufacturers, retailers, and customers. How well a supply chain performs depends on how well the actors in the chain perform, and also on how well the different actors collaborate. Due to the fierce competition today companies must understand that the time when single companies competed against each other has passed and we have entered a new time where entire supply chains compete against each other³⁰.

Simchi-Levi et al. (2008) defines supply chain management as:

Supply chain management is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right location, and at the right time, in order to minimize system wide costs while satisfying service level requirements.

3.2.1. Flows

Movements within the supply chain can be described as flows. The most common way of defining the flows are to divide them into the following three; physical, information and monetary.

Physical flow

The physical flow involves activities all the way from procurement of raw material until products are manufactured and delivered to end consumers. The physical flow has traditionally been seen as the primary flow of the logistics flows. For a manufacturing company, raw material and components are delivered to the company while finished products are being sent to the customers. It is easy to make the mistake thinking that the physical flow only goes one way and forget about the important reverse flow that is almost impossible for some companies to avoid due to e.g. reclamation and recycling³¹.

Information Flow

To be able to have an efficient physical flow it is important to get fast and correct information about customers demand, available resources, and inventory levels, both in your own company and your supplying companies. One tool to assist the information flow is the ERP-system. ERP-systems help to gather and structure information and assist managers with the planning process³².

Monetary Flow

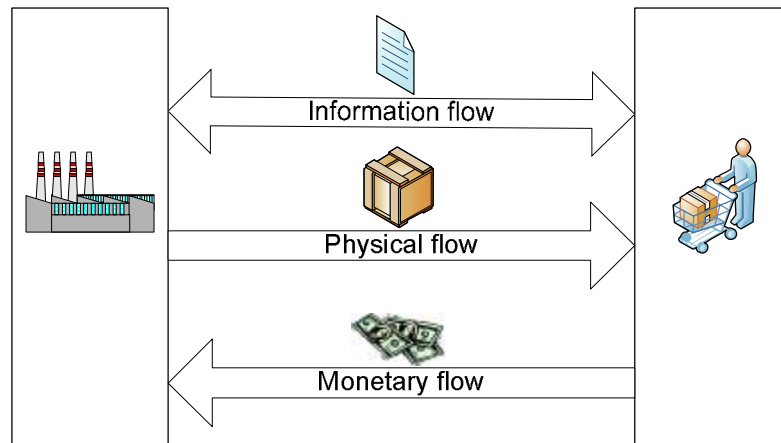
As an effect due to a physical flow when a company sells a product to a customer, follows a monetary flow in the opposite direction. The monetary flow is often initiated when the selling company sends a bill to the customer. When customer reclamation occurs the monetary flow goes the other direction i.e. from the company to the customer³³.

30 Simchi-Levi et al. 2008

31 Mattson & Jonsson, 2005

32 Mattson & Jonsson, 2005

33 Mattson & Jonsson, 2005

Figure 3 Logistic Flows³⁴

3.2.2. Process Mapping

To be able to improve a process it is important to have a clear picture of it before the improvement is applied. If there is a lack in information about the current process, a change in the process cannot be measured, because two values are needed. One other reason why the current state should be mapped is because the concerned personnel often have a limited view of what the process looks like. In a functional organization, individual persons can be expected to possess knowledge about their own department. However, since logistic processes almost always flows between different departments and companies there is a lack of knowledge covering the holistic view³⁵.

Process mapping consists of constructing a model that shows the relationships between the activities, people, data and objects involved in the production of a specific output. One reason why process mapping is popular is because it has been widely recognized that process mapping models can offer useful, and relatively inexpensive, descriptions which can help both improving and re-designing business processes³⁶.

³⁴ Mattson & Jonsson, 2005

³⁵ Mattson & Jonsson, 2005

³⁶ Business Process Management Journal, 2002

3.3. Business Process Improvement

According to Cheung and Bal (1998), a methodology for business improvement is only as good as the tools and techniques that support it. In the Business Process Management Journal (2002) three of the most common methodologies for both the radical redesign and the incremental improvement of business processes are presented, discussed, and analyzed. A common name for these kinds of methodologies is BPI, which is short for Business Process Improvement. The mentioned methodologies are; “COBRA” (Constraints and Opportunities in Business Restructuring – an analysis), “BPR” (Business Process Reengineering) and the “best practice BPI methodology”. These three methodologies were chosen to be analyzed in the journal because they are developed and put in to practice by leading organizations and consultancy firms³⁷. The authors have chosen to include the same methodologies due to the same reason. The methodologies are presented in Table 2, Table 3 and Table 4. Almost all BPI methodologies include a construction of a map process and from the three presented methodologies it is clear that this is a crucial point.

3.3.1. The Cobra Six Stage Methodology

	The COBRA six stage methodology (Coulson-Thomas, 1995)
Stage 1 Outputs:	<i>Establishing the approach and goal setting</i> Business vision, values and goals defined BPR/change objectives and strategy agreed Senior management commitment gained Risks understood and priorities agreed
Stage 2 Outputs:	<i>Opportunity seeking</i> Re-engineering opportunities identified Core team selected Change priorities agreed
Stage 3 Outputs:	<i>Process analysis</i> Existing processes analyzed and process models developed Effective and customer focused processes identified Change capacity assessed
Stage 4 Outputs:	<i>Process redesign</i> Definition of redesigned processes Model of the transformed organization Know-how development and implementation strategy defined IT levers defined
Stage 5 Outputs:	<i>Implementation of change</i> New ways of working and learning Changes attitudes Implemented know-how development strategy Flexible IT infrastructure and developed business systems
Stage 6 Outputs:	<i>Performance monitoring</i> Cultural attitudinal and behavioral change benchmark Business performance and capability benchmark Technology effectiveness benchmark

Table 2 Process Mapping Techniques COBRA³⁸

³⁷ Business Process Management Journal, 2002

³⁸ Coulson-Thomas, 1995

3.3.2. The BPR Project-Stage-Activity Framework

The BPR project-stage-activity framework (Kettinger et al. 1997)	
Stage 1 Activities:	<i>Envision</i> Establish management commitment and vision, Identify IT levers, Select process
Stage 2 Activities:	<i>Initiative</i> Inform stakeholders, Organize reengineering teams, Conduct project planning Determine external process customer requirements, Set performance goals
Stage 3 Activities:	<i>Diagnose</i> Document existing process, Analyze existing process
Stage 4 Activities:	<i>Redesign</i> Define and analyze new process concepts Prototype and detailed design of a new process, Design human resource structure Analyze and design IS
Stage 5 Activities:	<i>Reconstruct</i> Reorganize, Implement IS, Train users, Process cut-over
Stage 6 Activities:	<i>Evaluator</i> Evaluate process performance, Link to continuous improvement programs

Table 3 Process Mapping Techniques BPR³⁹

3.3.3. BPI Best Practice Methodology

BPI best practice methodology (Povey, 1998)	
Step 1	Get the CEO to personally drive the business process improvements efforts
Step 2	Analyze the organization's top level processes and select the priorities for action
Step 3	Train staff in process management and organization's approach to process improvement teams; establish a project plan for the next phase
Step 4	Develop a root definition of the process to be redesigned
Step 5	Map and analyze the "as is" process
Step 6	Develop the "to be" model of the improved process
Step 7	Compare the "as is" and "to be" processes and identify all the changes that need to be made
Step 8	Test that each required change is both culturally feasible and systemically desirable. Conduct walk-throughs with affected staff and run simulation and pilot tests
Step 9	Develop Action plans
Step 10	Train staff in the new process
Step 11	Roll out the new process, ensure that it meets all its requirements and is stable
Step 12	Implement continuous improvement based processed management to the new process
Step 13	Regularly assess each process
Step 14	Redesign the process again when it is no longer able to meet requirements (start again at step 1)

Table 4 Process Mapping Techniques BPI Best Practice⁴⁰

³⁹ Kettinger et al., 1997

⁴⁰ Povey, 1998

After closely analyzing all three methods the authors have chosen to use the BPI “best practice methodology” in this thesis. This methodology was chosen because it included the steps and processes this thesis needed to be able to answer the research question.

The BPI best practice methodology consists of 14 steps that should be carried out to achieve continuous improvement. To be able to do all 14 steps one must be located on a high strategic level in the company that the improvement process should be conducted. Another reason why all steps couldn't be made was because this case study doesn't refer to a single company, it refers to a general flow of dangerous goods including several companies. Since the authors are two students who were assigned a research problem by Volvo Technology, some of the steps in the methodology were not possible to do. The steps that will be carried out in this thesis are step 4-9. **Step 4** started with that Volvo Technology assigned the authors to solve a problem. The authors then read literature, such as rules and regulations and older thesis treating the subject. Some of the first interviews also contributed with input that aided the “definition of the process that needed to be redesigned”. **Step 5**, a number of conducted interviews together with secondary data from interviewees and other literature made this step achievable. **Step 6** develop the “to be” model of the improved process, has been done through all the improvement suggestions that the authors got from the interviewees. When the present flow and the desired flow was formed, the authors analyzed what changes needed to be done to go from the “as is” scenario to the “to be” scenario i.e. **step 7**. To validate that the improvement suggestions are feasible and applicable in the real world, (**step 8**) questionnaires was sent to all interviewees. The purpose with the questionnaires was to make sure that the authors hadn't misinterpreted any information and also to get feedback on the suggested improvements. **Step 9** is presented in the conclusion of this thesis, it covers what changes needs to be done, who should be responsible and what deployment barriers exists to be able to get to the “to be” scenario. See Figure 4 for an illustration of an adapted version of the BPI best practice methodology that was used in this thesis. Under each step it says how the step was conducted.

BPI "General Flow Improvement"						
	(Step 4) Define the problem	(Step 5) Map & Analyze	(Step 6) Develop the "to be" scenario	(Step 7) Identify changes	(Step 8) Validate result	(Step 9) Present conclusion
	The Authors were assigned the problem from Volvo Technology	Interviews and literature study	Improvement suggestions from interviewees	Analyse empirical data	Questionnaires were sent to all interviewees	A conclusion was formed based on the analysis

Figure 4 BPI "General Flow Improvement"⁴¹

41 Svensson & Wang, 2009

4. Rules and Regulations

DG rules and regulations is one of the two focuses of this thesis. In this chapter, three parts are covered. Chapter 4.1 the background information describes the general information concerning DG, the content of different modes of regulations in terms of road, rail and sea, harmonization and compliance etc. it leads to answer to the sub question “What are the existing rules and regulations concerning dangerous goods transports on road, rail and sea?” Chapter 4.2 presents the current application situation of different rules and the present control situation by the relevant authorities and it answers the sub question of “What are the application and control situation of DG rules and regulations in Sweden?”, continuously, chapter 4.3 and chapter 4.4 together describe the problems identified concerning the application of rules and regulations and the control situation and difficulties. Which apparently answers the sub question of “What are the problems concerning application and control of rules and regulations in Sweden?”

4.1. Background

Dangerous goods are defined as substances and articles that have dangerous potentials to cause injury to people, and damage to the environment, property and other goods.⁴² These dangerous potentials result from the properties of dangerous goods such as explosiveness, corrosiveness, toxicity, flammability and radioactivity.⁴³ The United Nations system is used to classify dangerous goods to ensure that all modes of transport (road, rail, air and sea) classify dangerous goods in the same way based on the types of dangers the goods represent.⁴⁴ And according to the UN Recommendations on the Transport of Dangerous Goods Model Regulations (Fifteenth revised edition (2007)), nine classes of dangerous goods are identified and described which can be seen in Table 5.

Class	Danger	Examples
Class 1	Explosives	- All types of military ammunitions, bombs, etc. - Industrial explosives (dynamite etc.) - Fireworks
-Division 1.1	Substances and articles which have a mass explosion hazard	
- Division 1.2	Substances and articles which have a projection hazard but not a mass explosion hazard	
- 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	
- Division 1.4	Substances and articles which present no significant hazard	

42 Räddningsverket Dangerous Goods

43 Ellis, 2002

44 Räddningsverket Dangerous Goods

- Division 1.5	Very insensitive substances which have a mass explosion hazard	
- Division 1.6	Extremely insensitive articles which do not have a mass explosion hazard	
Class 2	Gases compressed, liquefied, or refrigerated	
- Division 2.1	Flammable gases - Propane, LPG	- Cigarette lighters
- Division 2.2	Non-flammable, non-toxic gases	- Air, oxygen, nitrogen, helium
- Division 2.3	Toxic gases	- Ammonia, chlorine
Class 3	Flammable liquids	- Petroleum products - Paints - Alcoholic beverages
Class 4	Flammable solids; substances liable to spontaneous combustion; substances which, on contact with water, emit flammable gases	
- Division 4.1	Flammable solids self-reactive substances and solid desensitized explosives	- Sulphur - Matches
- Division 4.2	Substances liable to spontaneous combustion	- Phosphorus - Fish meal, seed cake
- Division 4.3	Substances, which in contact with water, emit flammable gases	- Metal powders - Sodium
Class 5	Oxidizing substances and organic peroxides	
- Division 5.1	Oxidizing substances -Ammonium nitrate fertilizers	- Hydrogen peroxide - Bleaching agents
- Division 5.2	Organic peroxides - Dibenzoyl peroxide	- Catalysts for polyester resin
Class 6	Toxic and infectious substances	
- Division 6.1	Toxic substances	- Sodium cyanide - Pesticides
- Division 6.2	Infectious substances	- Medical diagnostic specimens - Medical wastes
Class 7	Radioactive material	- Nuclear fuel - Uranium hexafluoride - Medical radioisotopes
Class 8	Corrosive substances	- Sulphuric acid, caustic soda - Car batteries
Class 9:	Miscellaneous dangerous substances and articles	- Environmentally hazardous substances - Mobile phone/computer batteries

Table 5 Hazard Classes/Divisions⁴⁵

45 UNECE secretariat

Many international organizations, multi-jurisdictional entities, and national bodies base their regulations for dangerous goods transport on the UNCOE (United Nations Committee of Experts) Recommendations on the Transport of Dangerous Goods, Model Regulations. The UN regulations were first published in 1956 and are revised regularly in order to reflect new technology and information, and to respond to the changing need of users⁴⁶. The latest version so far is Fifteenth revised edition (2007). Regulations which are based on the UN Recommendation on the Transport of Dangerous Goods, Model Regulations are the IMDG code for the maritime transport, the international Civil Aviation Organization's Technical Instructions for the Safe Transport of Dangerous Goods by Air, and the European regulations of ADR for road transport and RID for rail transport. The different rules and regulations drawn up for different modes of transport are to regulate both the domestic and international dangerous goods transportation. The regulations also apply to temporary storage in warehouses, at terminals or similar.⁴⁷

The general principle of the DG rules and regulation is to prevent harm to people, property, and the environment. In addition, international regulations also aim to reduce barriers to the transport of goods by having consistent regulations across borders. Facilitating trade and the safe, efficient transport of hazardous goods are the underlying goals of the UN recommendations on the transport of dangerous goods⁴⁸.

The UN recommendations on the transport of Dangerous Goods strive to attain safety through addressing recommendations in areas as follows:

- List of dangerous goods most commonly carried and their identification and classification
- Consignment procedures: labeling marking, and transport documents.
- Standards for packaging, test procedures, and certification
- Standard for multi-modal tank-containers, test procedures and certification.

Additional requirements necessary for specific transport modes and countries can be added to these base recommendations as required.⁴⁹

Countries using the international or regional regulations use appropriate acts or legal instruments to apply the regulations within their own country. In the case of Sweden, the Swedish Civil Contingencies Agency (MSB) administers ADR and RID and publishes the documents in Swedish with an Annex S containing special requirements which apply nationally⁵⁰. MSB is also responsible to educate safety advisors and making the exams for the safety advisors⁵¹. The Swedish authority for the IMDG Code is the Swedish Transport Agency⁵².

Regulations are updated every two years to incorporate revisions made to the UN recommendations. All the member countries of the organization that develop the regulations

46 Ellis, 2002

47 Räddningsverket Dangerous Goods

48 Ellis, 2002

49 UNECE 2009

50 Telephone Interview with MSB

51 Telephone Interview with the Swedish Transport Agency

52 Telephone Interview with MSB

have input and have the rights to participate in setting the regulations. Meeting agendas and proposed changes must be submitted to members well in advance, which allows time for consultation with relevant agencies and industries as required by some members within their countries⁵³.

4.1.1. ADR

ADR is the European Agreement concerning the International Carriage of Dangerous Goods by Road. ADR started to apply in 1968 but it was concluded as early as 1957 by the UNECE Inland Transport Committee. ADR is an Agreement between States, and no overall enforcing authority exists. ADR itself does not prescribe any penalties. The main goal with ADR is to increase the safety of international transport by road. Another goal for ADR is to work as an important trade facilitation instrument. Today there are 43 Contracting Parties to ADR⁵⁴. Except for dangerous goods which are totally prohibited for carriage, and except when carriage is regulated or prohibited for reasons other than safety, the international carriage of dangerous goods by road is authorized by ADR on the territory of Contracting Parties provided that the conditions laid down in annexes A and B are complied with⁵⁵.

The content of ADR mainly concerns the listing and classification of dangerous goods, their marking and labeling and packaging standards, also some much more detailed provisions such as the types of packaging that may be used, the consignment procedures, transport equipment (vehicle to be used, vehicle construction and equipment), transport operation (training of drivers, supervision, emergency procedures, loading and unloading, placards of vehicles)⁵⁶. Annexes A and B of ADR have been annexed to the European Union Council Directive 94/55/EC on the approximation of the laws of the Member States with regard to the transport of dangerous goods, as a result, these requirements have become applicable not only to international transport of dangerous goods but also to domestic traffic in all countries of the European Union as from 1 January 1997⁵⁷.

Dangerous goods in ADR have the same classes as in the UN Recommendation. The labels on the outer packaging of the dangerous goods indicate the hazards of the dangerous goods present which acts as the warnings to all those involved in the transport chain. (see Appendix B). If a substance has several hazards features, the primary one decides the classification. However, the package unit must be labelled with both the primary classification and the secondary ones, in a decreasing order⁵⁸.

Each substance also has its own specific UN-number, a four-digit number which is preceded by the letters UN. The UN number is marked on the packaging⁵⁹. The advantages of using the UN Number in transportation instead of the name of dangerous goods are that language barriers can be overcome, and it can avoid confusing similar names⁶⁰. An over pack, should

53 Ellis, 2002

54 UNECE secretariat

55 ADR applicable as from 1 January 2009

56 ADR applicable as from 1 January 2009

57 ADR applicable as from 1 January 2009

58 ADR 2.1.3.5.3

59 ADR 5.2.1.1

60 IMDG Code reference: 2.0.2

be marked with “Over pack” together with all the labels and UN numbers that the over pack contains visibly if needed⁶¹.

There are three packaging groups I, II and III for different dangerous goods with different extent of hazards. Packaging Group I is the most dangerous, II less dangerous and III least dangerous. The packaging group decides the kinds of storage units that the dangerous goods may be transported in and also the rules for Limited Quantity (LQ). However, it only applies to classes 3, 4.1, 4.2, 4.3, 5.1, 6.1, 8 and 9⁶². The packaging unit also has to be approved to contain dangerous goods. The Approved units have one letter designated for the packaging groups as follows⁶³:

X – Approved for packaging group I, II and III

Y – Approved for packaging group II and III

Z – Approved for packaging group III

The hazard identification number which includes two or three numbers represents the degree of the dangers that are associated with the dangerous goods. The first digit indicates the primary danger and the classification. The second digit indicates the extent of intensification of the hazard. Usually the second digit is either a zero or a repeating digit of the first one. If the second digit is a zero the hazard is adequately represented by the first digit, if it is a repeated number of the first, then it implies an intensification of the danger⁶⁴. For example, 33 for petroleum refers to extremely inflammable while kerosene with 30 is just inflammable. The hazard identification number is displayed on the top row of an orange sign that has to be on the truck or container containing dangerous goods. The second row of the orange sign contains the UN number. In total the sign has to be at least 30 * 40 cm where all lines are 15 mm wide. In case of mixed cargo transport, the sign is blank. See figure 1 below for examples⁶⁵.

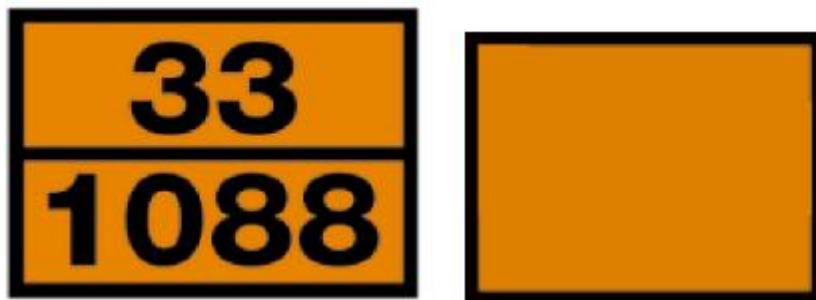


Figure 5 The Orange Sign with Hazard Identification Number and UN number (left) and the Sign for Mixed Cargo (right)⁶⁶

4.1.2. RID

RID are the Regulations concerning the International Transport of Dangerous Goods by Rail. RID is annexed to the Convention for international transport by rail (COTIF), and therefore it is applied by all Contracting Parties to the COTIF, The RID Regulations are aligned closely

⁶¹ ADR 5.1.2.1

⁶² ADR 2.1.1.3

⁶³ ADR 2.1

⁶⁴ ADR 5.3.2.3

⁶⁵ ADR 5.3.2.2.2

⁶⁶ ADR 5.3.2.2.3

with ADR thanks to the work of a Joint Meeting of the UNECE Working Party on the Transport of Dangerous Goods and of the RID Safety Committee, also known as the RID/ADR/ADN Joint Meeting⁶⁷.

4.1.3. IMDG

The International Maritime Organization (IMO) which is a United Nations specialized agency has developed international legislation dealing with two key issues for the maritime industry: namely, the safety of life at sea, and prevention of pollution from ships. Based on that, The IMO has developed two international conventions: The SOLAS Convention (covering safety of life at sea) and the MARPOL Convention (covering pollution prevention)⁶⁸. In order to supplement the principles laid down in the SOLAS and MARPOL Conventions, the IMO developed the International Maritime Dangerous Goods (IMDG) Code⁶⁹.

The International Maritime Dangerous Goods (IMDG) Code was developed as a uniform international code for sea transport of dangerous goods which covers conditions such as packing, container traffic and stowage, with particular reference to the segregation of incompatible substances⁷⁰. The IMDG Code has become mandatory for adoption by SOLAS signatory states since 1st January 2004⁷¹.

The objective of IMDG Code is to⁷²:

- Enhance the safe transport of dangerous goods
- Protect the marine environment
- Facilitate the free unrestricted movement of dangerous goods

Updating the IMDG Code

The IMDG Code is updated every two years taking into consideration of such aspects as new dangerous goods that must be included, new technology and methods of working with or handling dangerous goods, safety concerns which arise from experience, each version of the Code is given an Amendment number to signify how many times it has been updated. This number and the year of the amendment can be found at the bottom of each page⁷³.

67 UNECE secretariat

68 IMDG Code reference: 1.1.2

69 IMDG Code reference: 1.1.1

70 International Maritime Dangerous Goods (IMDG) Code

71 IMDG Code reference: 1.1.1

72 An Introduction to the IMDG code

73 An Introduction to the IMDG code

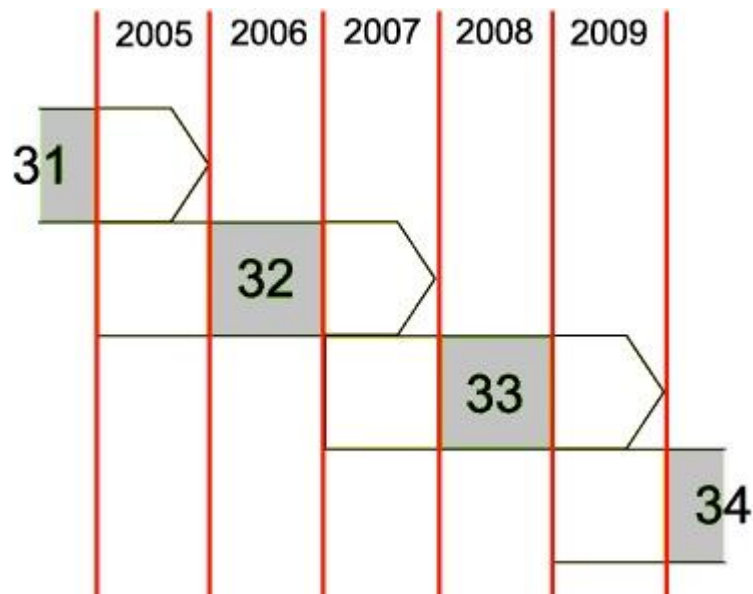


Figure 6 The Amendment Cycle of the IMDG Code by Exis Technologies⁷⁴

There are alternating years for implementation of IMDG. In January of the yellow years, the new Amendment is published and can be applied immediately, depending on the timing of National Competent Authority adoption. The white years is a transition year, the preceding Amendment can also be used. In the grey years, only present Amendment may be used⁷⁵.

The Code consists of seven parts presented in IMDG Volume 1, IMDG Volume 2 and a Supplement⁷⁶.

Dangerous goods in IMDG Code have the same classes as in the UN Recommendation. By testing the dangerous goods according to UN test procedures, a shipper is able to classify dangerous goods based on the 9 hazard classes⁷⁷. And the labels are internationally accepted. These hazard warning labels can be found in Volume 1 of the IMDG Code⁷⁸.

Dangerous goods in any of the nine classes transported are uniquely identified by two pieces of information: the UN Number, and the corresponding Proper Shipping Name (PSN). The UN Number and the PSN together enable the rapid and precise identification of the designated dangerous goods in the transport process for correct handling, stowage, segregation etc which also assists the correct handling procedure in case of emergency⁷⁹.

The 2002 edition of the IMDG Code introduced training for the first time. Although the training requirements are not mandatory, the IMO Member Governments realized that the safe transport of dangerous goods by sea relies on the detailed understanding and involvement of all persons involved. As a result, properly planned and maintained initial and re-training programs for all persons concerned with the transport of dangerous goods are recommended⁸⁰.

⁷⁴ An Introduction to the IMDG code

⁷⁵ An Introduction to the IMDG code

⁷⁶ An Introduction to the IMDG code

⁷⁷ IMDG Code reference: 2.0

⁷⁸ IMDG Code reference: 5.2.2.2.2

⁷⁹ IMDG Code reference: 2.0.2

⁸⁰ IMDG Code reference: 1.3

These training requirements highlight the need for all shore-based personnel involved in the shipment of dangerous goods to receive training corresponding to their responsibilities. The shore-based personnel according to IMDG refer to those:

- classify dangerous goods and identify PSNs
- pack dangerous goods in packages
- mark, label or placard dangerous goods
- pack/unpack containers
- prepare transport documents
- offer dangerous goods for transport
- accept dangerous goods for transport
- handle dangerous goods in transport
- prepare dangerous goods loading/stowage plans
- load/unload dangerous goods in transport
- carry dangerous goods in transport
- enforce, survey or inspect for compliance with applicable rules and regulations

Although current as recommendation in the IMDG Code, the training section has been made mandatory under national legislation by several competent authorities⁸¹.

4.1.4. ISPS

On July 1st, 2004, amendments to the 1974 convention for the safety of life at sea (SOLAS), including the new International Ship and Port Facility Security Code (ISPS Code) entered into force and became mandatory for all SOLAS Member Countries. The new international maritime security regime imposes a wide range of obligations on governments, shipping companies, and port facilities⁸².

Concerning ports, the ISPS Code applies to port facilities serving ships engaged on international voyages. As a result, any individual port may contain more than one port facility to apply the ISPS Code. Contracting governments are the ones that decide the extent to which the Code may be applied to port facilities within their territory. Port facilities according to the Code are defined as the ship/port interface. The wider issue of port security was dealt with as part of the further joint work between the IMO and the International Labor Organization (ILO) which resulted in the adoption of the IMO/ILO Code of Practice on Security in Ports⁸³.

The main obligations on port facilities according to ISPS Code include, undertaking Port Facility Security Assessments (PFSA), developing Port Facility Security Plans (PFSP), designating Port Facility Security Officer (PFSO) and making sure that training and drills take place regularly. The designated PFSO is responsible for developing, implementing and maintaining the PFSP. Other responsibilities and requirements include regular security inspections of the port facility, adequate training of port facility security personnel, reporting to the relevant authorities and ensuring that security equipments is properly operated, tested and maintained. Clearly implementing these obligations generates costs and may have economic implications⁸⁴.

81 IMDG Code reference: 1.3

82 Bichou, Bell, & Evans, 2007

83 Bichou, Bell, & Evans, 2007

84 Bichou, Bell, & Evans, 2007

4.1.5. Harmonization

There have been ongoing efforts to harmonize regulations for the different transport modes, and these are reflected in the latest editions of the regulations. The latest edition of the IMDG code is a significantly revised version--the primary reason for the revision was to have greater harmonization with the other transport modes. The ADR and RID regulations for road and rail transport of dangerous goods in Europe have also been revised in great extent to achieve greater harmonization. According to many safety advisors, ADR and RID are today nearly the same. The primary goal for harmonization was to make the regulations more user-friendly and understandable, which could lead to improved safety and efficiency⁸⁵.

Since the regulations for different modes are all based on the UN model regulations, they have many similarities. All the regulations have common sections presented in the same order⁸⁶. Part 1 to 7 are common to IMDG, ADR, and RID. Although these sections have the same titles and in general the same topics, there are differences specific to each mode. If regulations have extra sections specific to the transport mode, they are put after the common sections. IMDG has only seven sections while the latest version of ADR has Section 8 and Section 9, which refers to vehicle crews and operations, approval of vehicles and requirements for the construction⁸⁷.

ADR, RID, and IMDG have similar dangerous goods list. The first four columns of the list concerns information on the dangerous goods and classification. The first column is about the UN number, the next in ADR refers to name and description, while proper shipping name in the IMDG. Other differences are the stipulations for limited quantities. In the IMDG code an amount is prescribed in the table otherwise, the word "none", provided those limited quantity exceptions do not apply. For ADR, a code instead of amount is provided in the table, e.g. LQ1, which is an abbreviation for limited quantity and is followed by a code that needs to be looked up in a table to determine the limited quantity amount. The code LQ0 means no exceptions for limited quantities for these particular dangerous goods. The IMDG code has a special column for stowing and segregation information, while the ADR has a column to designate special provisions for loading, unloading and handling⁸⁸.

Each mode of transport has its unique characteristics and aspects which result in some differences in the corresponding rules and regulations. For example, the IMDG code has a special section on segregation and stowage of dangerous goods, with categories of segregation referring to if different classes of dangerous goods need to be segregated by a hold or a deck. There are also limitations for the amount and type of dangerous goods carried on vessels with over a specified number of passengers (see Figure 10 in chapter 5 for more information concerning load categories). Other aspects such as designation of maritime pollutants, preservation of the marine environment, and requirements for shipboard safety are also special to the IMDG code. Specific sections for ADR and RID include for example, sections on vehicle approvals, loading and unloading among other areas etc⁸⁹.

85 Ellis, 2002

86 Ellis, 2002

87 Ellis, 2002

88 Ellis, 2002

89 Ellis, 2002

4.1.6. Compliance

The key factors to ensure compliance with regulations are to have clear, easily understood contents, education to increase awareness of the regulations, and enforcement to ensure that companies and individuals are aware that there is a cost or penalty for not complying. Regulations vary by transport mode and jurisdiction, as does compliance and enforcement of the regulation.⁹⁰

4.1.7. Ongoing Proposal to Improve Current Rules and Regulations

There are always things in the regulations that could be improved. The Swedish Transport Agency makes proposals for the IMO to change the regulation. One proposal last year (2008) was concerning the height of the proper shipping name on packages, it should be the same height as the UN number. This proposal was accepted. Another long proposal was concerning transporting wood pallets in bulk. Some kinds of cargos are eating oxygen, and during some transports several people have died due to the increase of carbon monoxide in the cargo hold. The Swedish Transport Agency had a proposal to warn about this in the BC code and that personnel should have a portable gas meter with them that can measure the carbon dioxide and monoxide. Another proposal was concerning the SOLAS convention. In the SOLAS it says that vessels must have sprinklers under deck. In the IMDG code several substances in class 4.3 reacts with water and evolves hydrogen or other flammables. This lead to a proposal concerning how to change the stowage category or at least put something in the list of DG that you should think about that some classes reacts with water, but this proposal was rejected. Next year Germany is going to make a proposal in this area again.

In the regulations the responsibility for actors that are handling DG are stated and concerning the ADR regulation this information is clear enough but the responsibilities are not stated as clearly in the IMDG regulation. From 2011, different actors' responsibilities and the fact that people which are involved and dealing with information and documentation need education will be stipulated in the IMDG code, i.e. from 2011 it will be mandatory for people that handle DG to have proper education⁹¹.

4.2. Current Application and Control Situation

4.2.1 Current Application Situation

There are clear rules and regulations governing each single mode of transport of dangerous goods. In Europe, it is ADR/ADR-S for road, RID/RID-S for rail, and IMDG for sea. ADR and RID are regulations that apply for all member countries, ADR-S/RID-S only applies to domestic transport, in case of international transport within Europe, the general ADR/RID will be applied⁹². In ADR-S, S is mainly about Road workers, fuel folder, machines etc⁹³. ADR-s mostly consists of exceptions and not additional rules⁹⁴.

As for intermodal transports, there is no common regulation to regulate the entire transport chain. Since the consignor pays for the transport and prepare for the DGD, it is usually the consignor who decides which rules and regulations to apply. In most case, the strongest

90 R ddningsverket Dangerous Goods

91 Forwarder 2

92 External Safety Advisor 1

93 Hauler 1

94 External Safety Advisor 1

regulation in the whole transport chain is chosen for packaging, labels, marking, placards and documents, which can then be applied from the beginning to the end⁹⁵. Air regulation usually is the strongest regulation. IMDG is stronger than RID and RID and ADR are nearly the same but in case of intermodal transport of rail and road, RID is applied as there are some special parts in RID. One example is that according to RID, the number of the danger has to be stated in the declaration for tank or bulk transport which based on ADR is not necessary⁹⁶.

When only one regulation such as IMDG is applied for intermodal transports, on the road transport part, the consignor just needs to note in the multimodal dangerous goods form document from the beginning about the reference of applying IMDG. For example, according to ADR 1.1.4.2.1, for combined sea and road/rail transport, consignments that fully meet the requirements of the IMDG code shall be accepted for carriage under ADR/RID, and a statement shall be included in the transport document as follows: “Carriage in accordance with 1.1.4.2.1”⁹⁷.

For example one dangerous goods export from Jönköping through Gothenburg port which is composed of both road and sea transport. The IMDG code is the strongest regulations and is therefore the regulation applied from the start in Jönköping⁹⁸. The products are packaged, labeled and so on according to the IMDG regulation. The Multimodal dangerous goods form is used through the entire transport. The consignor needs to write a note on the multimodal dangerous goods form stating that this transport will be followed by a sea transport according to ADR 1.1.4.2.1⁹⁹.

However there are some companies that does not use the multimodal dangerous goods form and they applies several regulations based on different parts of the transport. One international painting company the authors interviewed is such an example. Their current IT system does not support the multimodal dangerous goods form, and today it is much easier for them to produce both ADR and IMDG documents for intermodal transport of road and sea. In the future, the regulations will force companies to use the multimodal dangerous goods form as it is easier to use¹⁰⁰.

Apart from the above mentioned principles to apply rules on dangerous goods in intermodal transports, there are always some exceptions. In the transport area of Baltic Sea, there is the Memorandum of Understanding for the Transport of Packaged Dangerous Goods on Ro-Ro Ships in The Baltic Sea, which will be later referred to in this thesis as the Baltic Sea Agreement¹⁰¹ According to the Baltic Sea Agreement, ADR or RID can be applied instead of IMDG in Baltic Sea area. This is due to the reason that the Baltic Sea has softer waves than many others oceans, therefore softer regulations such as ADR or RID can be applied. Naturally the ship’s manager has to choose to apply the agreement and the vessel needs to be allowed to be used for a sea transport according to the Baltic Sea Agreement¹⁰². The Baltic

95 External Safety Advisor 2

96 External Safety Advisor 2

97 ADR 1.1.4.1.1.

98 External Safety Advisor 1

99 External Safety Advisor 2

100 Producing company 1

101 External Safety Advisor 2

102 External Safety Advisor 1

Sea Agreement is not mandatory to apply, it is up to the local shipping company to decide to apply or not¹⁰³.

4.2.2. Current Control Situation

In order to achieve expected efficiency and safety level, rules and regulations must work together with control¹⁰⁴. According to many interviewees, in general, current rules and regulations have reached a level that is good enough according to what the society expects. The focus now should be to control that the regulations are followed¹⁰⁵.

In Sweden, there are two parties responsible for the direct control of dangerous goods transports concerning the two major modes road and sea, the coastguards are responsible for controlling sea transports of dangerous goods and the police for road transport. The two parties also have a joint control around once every second month¹⁰⁶. The controls are conducted randomly and the content includes documentation, labelling marking, vehicles, loading or handling activities such as lashing etc¹⁰⁷. In order to access the transport nodes, pre notify and contact with port and terminals staff is necessary due to security reasons. The police cannot go inside the port but they have special parking places to check trailers outside the ports.

The police and coast guard don't have equal rights, both can require the actors to correct the mistakes and send reports, but the police enjoy the unique rights to open a sealed transport unit and fine actors that have done wrong. When the coast guard find a problem they hold the unit and call the forwarding company to ask if they can fix the problem and meanwhile send them a document to report the problem. Then the forwarding company in turn contact the responsible party which could be the consignor or the hauler company and provide the document to them and the responsible party will be responsible to fix the problem.

Apart from the direct controls of DG by the two parties mentioned above, the Swedish Transport Agency has the overall governance and supervision on all four modes of dangerous goods transports¹⁰⁸, and also additional control about the vessels shipping dangerous goods. They share statistics of incoming and outgoing DG on the control frequency and deficiencies rates with other EU organizations and countries. However, so far there is no risk control for what to do with the statistics. MSB is the responsible authority for supervising safety advisors and truck drivers¹⁰⁹. MSB has a database which lists all registered companies that are handling or transporting DG and they are responsible to control that registered companies use a safety advisor.

A common problem concerning rail are dirty placards and orange signs. For road transports it is that fire extinguishers are not updated in time¹¹⁰, they need to be inspected every year¹¹¹. In addition, the table below shows the statistics concerning the number of cargo transport units (CTUs) inspected and deficiencies rates concerning sea transport within Sweden. According

103 External Safety Advisor 2

104 External Safety Advisor 1

105 Producing Company 1

106 The Swedish Transport Agency

107 Rail Company 1

108 The Swedish Transport Agency Website

109 MSB

110 Rail Company 1

111 Hauler 1

to the interview with the Swedish Transport Agency, one of the big reasons for the different deficiencies rate among different years is caused by the different control focus from year to year¹¹². Table 6 illustrates common deficiencies found by the coast guard, the statistics shows the most common deficiencies found from the controls during the stated years. The sum for each column do not add up to 100%, the reason why is because some minor areas for deficiencies are not presented in the statistics.

Year		2003	2004	2005	2006	2007
CTUs inspected		344	245	481	964	767
CTUs with deficiencies (%)		39 %	46 %	49 %	45 %	23,7 %
Type of deficiency (%)	Securing of cargo inside CTU	15 %	5 %	42 %	18 %	10 %
	Transport document	35 %	21 %	21 %	26 %	19 %
	Marking, labelling of packages	9 %	3 %	3 %	7 %	4 %
	Placarding of CTUs	28 %	27 %	27 %	21 %	4 %
	Stowage	4 %			1 %	
	Segregation	6 %				
	Other				24 %	13 %

Table 6 DG Transport Units Inspection and Deficiencies by Sea in Sweden ¹¹³

4.3. Application Features and Problems

4.3.1. Simplification

One good ongoing process for current rules and regulations is that it is moving towards much more simplified document requirements in the transport process. One example is that earlier there were a number of various proper shipping names with detailed information that needed to be enclosed, this is a typical example of things that are more complicated than necessary. In practice nobody will read such detailed information on the package. Now there are much more simplified shipping names. Another example is the simplified written instruction¹¹⁴. After July 1st 2009, there will be just one Written Instructions for all classes of DG with all UN numbers in one set of paper, before it had to be different instructions for each UN number, which make the preparation of documents rather complicated¹¹⁵, because the written instructions has to be written in all countries languages that the DG are transported through. So it could be eight pieces in eight languages for one UN Number if the transportation will pass eight countries. And if the transport includes six UN numbers in case of mix cargo transport, then it is six times eight, forty eight papers only for Written Instructions. In the IMDG Code, the EMS (Emergency Response Procedures for ships carrying Dangerous Goods) and MFAG (Medical First Aid Guide) systems were very complicated in the past, but now (2009) they are changed into a much easier system which mean fewer documents and clearer instructions¹¹⁶.

112 The Swedish Transport Agency

113 The Swedish Transport Agency

114 Producing company 1

115 Forwarder 2

116 Producing company 1

4.3.2. Updated Regulations

Every second year the rules are updated, and there are adaptation periods for different rules and regulations. ADR/RID have half a year adaption period and IMDG has one year, the necessity of the adaptation period half year according to some interviewees are that it gives some time for actors to adapt to new changes. In the practical life, it takes time for new regulations to spread, it shouldn't take time but it does¹¹⁷.

However, it may be troublesome for some actors as well. For producing companies the half year adaption period is often enough for changing labels, updating packages and update the IT system. One problem for producing companies is concerning products that are already produced and are on the shelf. When companies produce against a stock i.e. produce to fill up an inventory at e.g. warehouse, the inventory can become obsolete due to invalid old labels. According to the rules and regulations, final products that are packaged before January 1st can be on the shelf for a year until it is sold out¹¹⁸.

For haulers, the adaptations can be troublesome especially for international transport and intermodal transport. Although all regulations are made on European or UN levels, it is the single country's laws that apply the regulation in each country. And different countries usually apply the rules at different times which can lead to confusion for transporting companies. During the adaption period, transport companies are allowed to choose which version of the regulations they would like to apply by themselves, as long as the country the transport companies are in have updated and translated the new version of ADR in time. If the country the transport company belongs to haven't updated and translated the new version, the transport companies are not allowed to apply the new version. This becomes a problem when a consignor from one country that haven't updated the regulations, send the goods to a country that have updated the ADR regulation. If there are new requirements in the updated ADR such as labeling etc then the goods labeled based on the old regulation may be a problem. In Sweden ADR-S was updated in February 2009 and in Norway the regulation were not updated before April¹¹⁹. Another problem is concerning the IT-systems. Some IT system only has the ability to apply one version of a regulation at a time. When different customers of such a company apply different versions of the same regulation a problem arise, since the IT-system can't handle two versions¹²⁰.

4.3.3. Harmonization

There is an ongoing harmonization between IMDG, ADR and RID. Many conditions in IMDG can be found in ADR and RID. In general, ADR, RID and IMDG are easy to follow¹²¹.

Although the regulations have many similarities the harmonization is far from optimal. Different regulations still have different conditions and requirement which makes the intermodal transport inefficient. One problem can be found in the DGD, some information is necessary according to IMDG but not according to ADR and RID, e.g. information about the flash point. If the transporter does not apply the IMDG from the start then there will be problems or extra work when changing transport mode¹²². Another problem is concerning

117 Forwarder 3

118 Producing company 1

119 Rail Company 1

120 Shipping Company 2

121 External Safety Advisor 1

122 Rail Company 1

mixed cargo, i.e. a transport with different classes of dangerous goods. Some classes are allowed to be transported together by road but not by sea e.g. peroxides and flammable dangerous goods¹²³.

Concerning the transportation of Limited Quantity, according to ADR there is no need for DG labels and documents for transport Limited Quantity i.e. no need for placards and dangerous goods declaration. The IMDG code states that there must be placards on a trailer for sea transport together with relevant documents when transporting Limited Quantity. By applying the IMDG regulation from the start and label the trailer and write a DGD this problem will be dealt with. When transporting Limited Quantity, haulage drivers often add the placards on the trailer at the port before the goods are further transported on sea.¹²⁴

There are also some special problems for the transporters that only apply the IMDG for intermodal transports. These mainly refer to the very small part of conditions in ADR that are stronger than IMDG. One example is that for road and rail tank transports, placards with numbers of the danger are needed but that doesn't exist in the IMDG code. Taking UN number 1965 with liquid petrol gases as an example, for road transport, the drivers have to have an orange sign where it says 23 on the first line which stands for liquid gases class 2 then second line the UN number 1965. But if it is transported on ship, then only the UN number 1965 is enough. This is not seen as a problem because the extra information is allowed to be on the trailer during the sea transport as well.

Another problem concerning limited quantity transportation is that in both ADR and RID, there are no conditions concerning the amount or maximum weight for LQ. The condition is only focusing on a limit for small packages of DG. Maybe the regulations are affected too much by the industry. The whole idea with LQ is based on industry demands and it is being misused by some actors¹²⁵. Many companies are loading entire trucks with dangerous goods but with small packages, and they don't have any labels that say there are DG transports since it is considered to be limited quantity. When transporting LQ the truck drivers don't need an ADR driver certificate or a DGD. In the IMDG code there is nothing that is called LQ transport, all DG even small volumes need a DGD and proper labels¹²⁶. The latest version of ADR, which will be mandatory to apply from July 1st 2009, has a new stipulation that says that LQ with a weight above 8 tons needs to be labelled and treated as a DG transport.

4.3.4. Other Aspects

One good change in the IMDG code is the stipulation of the education. Earlier it said that those handling DG should be educated in a near future but now it says that they must be educated¹²⁷. The regulations, both ADR and IMDG, do not mention the frequency of education. It only mentions that the education should be done frequently. As a result, the training quality and frequency differs between companies and so does the knowledge level. The rules and regulations don't stipulate how many safety advisors a company needs according to the company's business scale and business frequency¹²⁸.

123 Producing Company 1

124 Rail Company 1

125 Forwarder 3

126 Rail Company 1

127 Forwarder 3

128 Forwarder 3

4.4. Control Difficulties and Problems

According to many interviewees, current control is very effective to reduce problems in the transport chain; however the controls are not frequent enough. The control authorities seem to lack a holistic control plan concerning the forwarders' network. They don't know which companies to control and how frequent they should do it. And it seems that the police only check companies they are familiar with. One forwarding company interviewed got checked by the police nearly every week at their private terminals but another one interviewed have nearly never been checked by the police. The forwarding company that the police do not check have over twenty terminals all over Sweden and have been active many years¹²⁹.

There is no control at the consignors, but it is still the consignors who have the main responsibility for the DG transport. Some control personnel, especially from the police, are lacking knowledge about rules and regulations. The coast guard doesn't have much power, for example, they have no rights to fine and no rights to open sealed transport units¹³⁰.

MSB doesn't know which companies that are transporting DG they only have statistics on the companies that have registered as DG handling companies. This might be a problem because MSB cannot control that companies which are not registered to handle DG have a safety advisor. And if the companies don't have a safety advisor they probably lack proper knowledge about how to handle DG¹³¹. And the control of safety advisors is extremely weak, according to the forwarding companies interviewed; they have only been checked less than five times during the last eight years.

One thing that makes the control difficult is that the news about an upcoming control often reaches out to transporting actors. When a driver finds out that a control will occur, he often calls his friends, other drivers or actors at the transport chain and they call their contacts and so on. Then the drivers might not show up at the port, sometimes road transporters might check in at another harbor just to avoid the control¹³².

It is also quite hard to control foreign consignors, if it is the problems of Swedish consignors, the coastguard often visits the companies; however the control authority can nearly do nothing to foreign consignors.

One thought is that the police are focusing too much on controlling trucks with the orange labels while those without the orange labels are seldom controlled. Some companies are transporting DG without putting the orange labels on the truck. One reason for this could be that it cost more to transport something as DG¹³³. The coast guard has received information that some Russian or Lithuanian drivers have "black deals" with consignors not to declare dangerous goods. E.g. the truck drivers transport the DG as ordinary goods without placing any placards on the truck. Then they earn half the transport cost of the difference between the cost for transporting ordinary goods and DG concerning the sea transport. It cost more to transport DG on sea than transporting ordinary goods. It is difficult to control if a truck

129 Forwarder 3

130 Forwarder 3

131 Port of Gothenburg

132 The Swedish Transport Agency

133 External Safety Advisor 2

contains DG without labeling. The regulations are based on the consignors' conscience. It is up to each consignor's conscience to declare that they transport DG¹³⁴.

In Sweden, the police's control regarding rest time interval is very strict. The drivers should take breaks according to rules and if they drive one minute more than allowed the police can fine them. This could be related to the cultural aspects of following rules and regulations. The Swedish way to interpret rules and regulations is "must follow exactly" while for example, the Italian way's is just to take the rules and regulations as a kind of recommendation¹³⁵.

134 The Swedish Transport Agency

135 Hauler 1

5. Intermodal Transport Flow of Dangerous Goods

Intermodal transport flow of DG is the second focus of the thesis. Starting with some statistics and facts in 5.1, 5.2 describes a combined road and sea intermodal dangerous goods transport covering both the information and physical flow and it answers the sub question “What does a general intermodal dangerous goods transport flow look like?”. In Chapter 5.3, problems on the transport interfaces are identified and it answers the sub question of “What are the current problems among involved actors, activities at the transport interfaces?”

5.1. General Information

The class that is transported most frequently on Swedish roads is class 3, Flammable liquids e.g. petrol & diesel and it is probably the most common class for the rest of Europe as well. Class 3 represents 80% of the DG transported on Swedish roads¹³⁶. The most common transport units concerning international trailer transports of dangerous goods are soft covered trailers and boxed trailers. Some interviewees think it’s easier to properly lash and secure the goods when using boxed trailers, but the soft covered trailers are still very popular since they are less expensive to use. Concerning tank trailers, they are very common for domestic transports but when it comes to international transports they are not as common. There exist several different tank trailers with different specifications. Certificates and rules control what kinds of liquids are allowed to be transported in which tank trailer. A tank trailer can be divided into a number of smaller tanks allowing several types of liquids to be transported in the same tank trailer¹³⁷. Within Europe e.g. in UK, Holland, and Belgium, most of the DG are transported in Trailers. Trailers are very suitable for sending goods short distances, due to the good road infrastructure in Europe¹³⁸.

The most common class transported concerning total export and import, covering all transport units, is class 8 and it has been so for the last three years. Concerning Ro-Ro ships and trailers, class 3 is the most common class transported. See Table 7 for statistics covering total import and export for the port of Gothenburg. Table 10 shows the most common classes per port area, and Table 13 shows the most common UN numbers in the Ro-Ro area.

Important information concerning the statistics in the following tables: Since the port of Gothenburg’s IT system TICS can only store two reported classes per unit, these numbers might not be entirely correct. But the numbers should be quite close to the real values because many classes are not allowed to be mixed together according to the IMDG regulation and therefore most units don’t contain more than two classes. In the tables CT stands for containers and Ro-Ro for trailers, Ro-Ro stands for all kind of trailers even trailers that are loaded with containers. The IT-system TICS can’t show the amount or volume of DG, only the number of units.

136 Hauler 1

137 External Safety Advisor 1

138 External Safety Advisor 1

EMPIRICAL DATA

Class	2005 Nr	2005 %	2006 Nr	2006 %	2007 Nr	2007 %	2008 Nr	2008 %
Class 1 Explosives	1170	3,1	1292	3,2	1278	3,0	788	1,8
Class 2 Gases compressed, liquefied, or refrigerated	3744	9,8	3804	9,4	3636	8,5	4170	9,8
Class 3 Flammable liquids	10145	26,5	10232	25,2	10386	24,2	10594	24,8
Class 4.1 Flammable solids	905	2,4	744	1,8	803	1,9	724	1,8
Class 4.2 substances liable to spontaneous combustion	160	0,4	103	0,3	93	0,2	177	0,4
Class 4.3 substances which, on contact with water, emit flammable gases	166	0,4	143	0,4	104	0,2	106	0,2
Class 5.1 Oxidizing substances	4801	12,6	4874	12,0	4460	10,4	4316	10,2
Class 5.2 Organic peroxides	317	0,8	360	0,9	347	0,8	345	0,8
Class 6.1 Toxic substances	968	2,5	1409	3,4	1198	2,9	1490	3,5
Class 7 Radioactive material	42	0,1	30	0,1	57	0,1	36	0,1
Class 8 Corrosive substances	9986	26,1	10433	25,7	12014	28,0	11652	27,3
Class 9 Miscellaneous dangerous substances and articles	5861	15,3	7178	17,6	8464	19,8	8247	19,3
Total	38265		40602		42840		42645	

Table 7 Number of Reported DG per Class Transported through the Port of Gothenburg¹³⁹

Year	CT	Ro-Ro	Total
2005	12313	19327	31640
2006	13115	20308	33423
2007	14447	21060	35507
2008	14564	20548	35112

Table 8 Number of Reported Units with DG at Port of Gothenburg¹⁴⁰

Year	CT	Ro-Ro	Total
2005	3,6	6,7	5,0
2006	2,6	4,8	3,6
2007	2,7	4,8	3,6
2008	2,6	4,8	3,6

Table 9 Percent DG Units out of Total Number of Units at Port of Gothenburg¹⁴¹

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140 Port of Gothenburg

141 Port of Gothenburg

	CT	%		Ro-Ro	%
Class	8	35%	Class	3	34%
	9	16%		8	22%
	5.1	15%		9	21%
	2	11%		2	9%
	3	5%		5.1	3%

Table 10 Common Classes per Port Area at Port of Gothenburg¹⁴²

Class	UN-nr	Name	% of Total
9	3082	Environmentally hazardous liquids	8%
3	1263	Paint	7%
2	1950	Aerosol	6%
9	3268	Airbag modules	5%
5.1	2014+2015	Hydrogen peroxides	4%

Table 11 Common UN Numbers for the Entire Port of Gothenburg¹⁴³

Class	UN-nr	Name	% of Total
5.1	1942	Ammonium nitrate	10%
8	1604	Ethylene diamine	8%
2	1950	Aerosol	7%
8	2794+2795	Batteries	6%
9	3082	Environmentally hazardous liquids	6%

Table 12 UN Numbers for the CT Area¹⁴⁴

Class	UN-nr	Name	% of Total
3	1263	Paint	9%
9	3082	Environmentally hazardous liquids	9%
2	1950	Aerosol	6%
5.1	2014+2015	Hydrogen peroxides	5%
9	3268	Airbag modules	5%

Table 13 UN Numbers for the Ro-Ro Area¹⁴⁵

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143 Port of Gothenburg

144 Port of Gothenburg

145 Port of Gothenburg

	Sulphur dioxide			Total amount of toxic gases		
	CT	Ro-Ro	Total	CT	Ro-Ro	Total
2004	2	125	126	10	160	170
2005	14	143	157	32	145	177
2006	44	87	131	49	90	139
2007	0	0	0	5	0	5
2008	2	26	28	6	26	32

Table 14 Number of Reported Units with Toxic Gases at Port of Gothenburg¹⁴⁶

Explosive substances and objects are in general not allowed to be stored at the port area but there exist some exceptions. During 2008 the number of units containing explosives has decreased. Fireworks is the most common object in explosives but it has decreased a lot the latest years and there are about 40% of all explosives transported in containers (CT)¹⁴⁷.

	CT		Ro-Ro	
	1.1	Total	1.1	Total
2004	141	935	7	328
2005	69	853	3	317
2006	90	935	7	357
2007	69	909	12	369
2008	52	568	5	220

Table 15 Number of Reported Units with Explosives at Port of Gothenburg¹⁴⁸

Deviation	CT				Ro-Ro				TOTAL			
	2005	2006	2007	2008	2005	2006	2007	2008	2005	2006	2007	2008
Damage when handling	1	4	1	3	1	1	4	1	2	5	5	4
Wrong parked or handled		1								1		
Found leaking/damaged unit	2	1	5	2		2			2	3	5	2
External errors					1				1			
Wrong information in TICS / Not booked or wrong marked	1								1			
Machine faults							1				1	
SUM	4	6	6	5	2	3	5	1	6	9	10	6

Table 16 Number of Reported Accidents or Incidents at Port of Gothenburg¹⁴⁹

The most common transport unit, concerning DG, on rail is tank wagons, it represent 90% of all DG transports for Green Cargo. Tank trailer is not commonly transported. Regarding soft covered trailers and boxed trailers the authors has no information how frequent they are used.

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147 Port of Gothenburg

148 Port of Gothenburg

149 Port of Gothenburg

Information about how to handle all DG classes can be found in the regulations. Class 7, which is radioactive material, is viewed as the DG class that incurs the highest risks¹⁵⁰. And class 1 Explosive is the second dangerous DG class. Special permits and special designed vehicles and transport units are required to be allowed to transport class 1 and class 7.¹⁵¹

5.2. Intermodal Transport flow -a Combination of Road and Sea Transport

In the intermodal transport of dangerous goods export in combination of road and sea, the following actors are usually involved: consignor, forwarder, hauler, shipping company and a port. The police and the coast guard are also involved in random checking and controls. The consignor and the forwarder have a contract, this contract often includes terms that are more restrictive than those in the rules and regulations. Normally, for frequent dangerous goods consignors, the contracts with forwarding companies are yearly based. The forwarder has contracts with haulers and shipping companies. The shipping company has a contract with the port concerning loading, unloading, and rent for parking space¹⁵². The contract relationships define the forwarder as the party that has the holistic responsibility of the dangerous goods transport for the whole transport chain. These responsibilities are in turn transferred to different sub contractors, namely the haulers and shipping companies. As a result, in operational practice, forwarding companies has no specific responsibilities and acts more like coordinators between consignors and the transport actors.

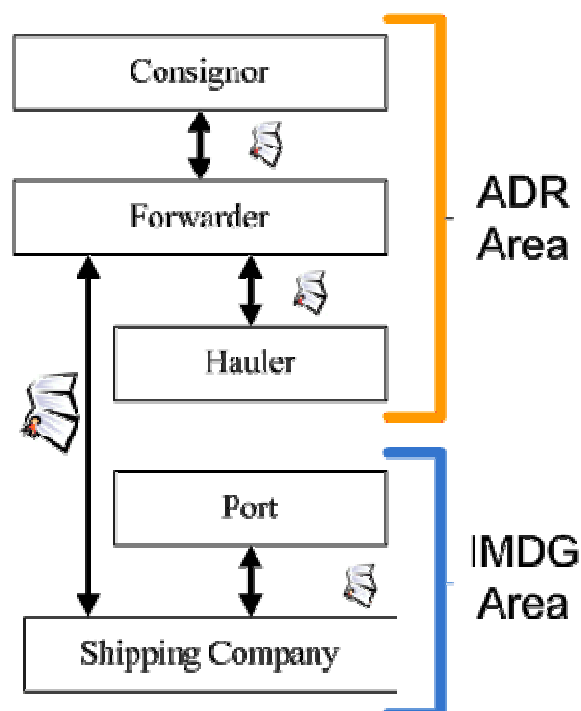


Figure 7 Contracts in a General flow of DG¹⁵³

5.2.1. Activities and Responsibilities

The flow starts at the consignor with an order that is sent either to a forwarder or a transport company. Usually the order is made by email or phone. The forwarder receives the order and control that it has the necessary information i.e. a UN-number, class, packaging group and so

¹⁵⁰ Hauler 1

¹⁵¹ External Safety Advisor 2

¹⁵² Forwarder 1

¹⁵³ Svensson & Wang, 2009

on, and then order a road and sea transport. Orders from forwarding companies are often sent by EDI (for big forwarding companies), email or phone (for smaller forwarding companies). Some forwarders have regular allotments that are booked at shipping companies. In case of an allotment already is booked, the forwarder just notify the shipping company if the allotment will be used or not. The shipping company then reserves a place on the ship and sends a booking number to the forwarder, and notifies the port of an incoming trailer with DG so that the port can reserve a parking place¹⁵⁴.

Before the DG can be transported, the consignor needs to make sure that the DG has approved packaging, marking and labels. The packaging material must be allowed for all transport modes that it will be transported on. It is important to read the packaging certificate to know when it is allowed to be used. For example, if only reading the regulations it could say that a paper box is allowed for transporting a certain class, but it is very important to read the specific paper box certification and see what substances the paper box is allowed for also. The consignor is also responsible to create a DGD and a packing certificate (for tank trailers no packing certificate is needed) as well. The DGD concerns about the goods and the packing certificate concerns about the lashing. The DGD and the packing certificate are two documents but they are often on the same paper¹⁵⁵. Concerning rail transports, according to the RID regulation, the consignor is responsible for the DG during the entire transport¹⁵⁶.

When the hauler arrives to the consignor, the DG is loaded on a small sized truck and transported to a terminal where several consignors' products are loaded on big trailers. At the consignor's place, if the driver is present, he is responsible to make sure that the loading and lashing is done correctly and also to control that the documents from the consignor are correct¹⁵⁷. ADR state that the driver is responsible to deliver the original documents to the next actor in the transport chain to ensure that the end customers get the original documents. The driver is also responsible for informing the next actor in the transport chain on what kind of DG that is included in the transport¹⁵⁸.

The responsibility moves from the consignor to the hauler when the DG is loaded onto the truck and the documents are signed. The consignor is responsible for creating and handing over a DGD document to the truck driver. The DGD document is often included in the waybill which is also created by the consignor. When the hauler's truck arrives and unloads the DG at the forwarder's terminal the responsibility moves to the forwarder until the DG are reloaded and driven out of the terminal. Since some classes are not allowed to be transported together according to the IMDG regulation, the trailers need to be loaded accordingly. There are even segregation rules within classes e.g. some UN numbers within class 8 are not allowed to be transported with other UN numbers within the same class¹⁵⁹.

The truck driver is responsible that the trailer is properly labeled before the transport starts. Normally, if not transporting class 1 or using a tank trailer, the trailer only needs two orange signs for the road transport, one in front of the vehicle and one at the back of the trailer. According to ADR, concerning mixed DG, the orange signs do not have to show which class

154 Hauler 1

155 External Safety Advisor 2

156 RID 1.4.2

157 Forwarder 1

158 Hauler 1

159 Port of Gothenburg

that is transported¹⁶⁰. But for sea transport the trailer needs to be marked with DG placards that show which class that is transported in the trailer. Concerning a general flow of DG, it is hard to say when the placards should be placed on all four sides of the trailer. They might be placed at the beginning of the transport or later at the port. Different actors have given different answers, although it seems that the most common solution is to transport the trailer without placards during the road transport, and placing the placards on the trailer when arriving to the port, the result is inconclusive. Concerning tank trailers, the placards are already placed on the trailers when they arrive to the port. After the DG is properly lashed, the trailer transport can start. When the trailer is loaded, the truck driver collects it and transports it to the port. Once again the responsibility moves to the hauler. The hauler's task is finished when the trailer is parked inside the port area¹⁶¹.

Before the trailers arrive to the port, a copy of the DGD is sent from forwarder in advance to the shipping company, usually a couple of hours before the trailer arrives. And the Port's ID Service usually receives pre-notified information from the shipping companies concerning information of incoming trailers which will be further transported by ship. The shipping companies notify ID service by reporting into the port's IT system. When the information is reported into the system, both the ID service and the port's production leaders have access to the information. The ID Service also specifies the latest time for incoming trailers with DG to arrive¹⁶².

The ID registration can be done either electronically or manually. In case of electronically registration, before the hauler arrives with the trailer, they notify ID service with "direct notification" that an incoming trailer with DG is on its way with a certain booking number. ID service then, if the information is correct, sends information to the transporting company in which parking lane to park the trailer when it arrives. This is the case most of the time. But when the transporting companies don't use the electronic "direct notification" method, the drivers must physically go to the ID service. At ID service, the driver shows a booking number and signs a "drop off" document. After the information is confirmed, ID service informs the driver in which lane to park the trailer and give the driver a card to pass the gate¹⁶³.

When the truck goes through the gate, it is photographed by approximately twenty cameras. Meanwhile, the status of the cargo will be changed in the IT system after the driver has scanned the card. The driver does not need to go out of the truck when entering the gate but he does when leaving because he needs to report on which exact parking space he have parked the trailer¹⁶⁴.

160 Forwarder 2

161 Forwarder 3

162 Shipping Company 1

163 Port of Gothenburg

164 Port of Gothenburg



Figure 8 A Gate at Port of Gothenburg Showing Cameras¹⁶⁵

When the trailer has passed the gate, it is parked at an assigned parking lane that is reserved for a specific class of DG. The port has special areas recognized by special signs to place dangerous goods of different classes. Figure 9 the orange sign, shows where to park DG trailers¹⁶⁶.



Figure 9 DG Parking Sign¹⁶⁷

165 Port of Gothenburg

166 Port of Gothenburg

167 Port of Gothenburg

The responsibility is transferred from the hauler to the port when the trailer passes the gate at the port and the responsibility of the port will not end until the trailer is loaded onto the ship. One difference that is found between the public and private port is that the responsibility moves to the public port when the trailer passes the gate but at the private port the responsibility doesn't move to the port until the trailer is parked at an assigned place. The reason why the private port has chosen to take over the responsibility for the trailer when it is parked is because incidents and accidents can happen when transporting the trailer inside the port area¹⁶⁸. At the port, the truck drivers place the placards on the trailer (if the placards were not already placed on the trailer at the forwarders terminal). The DGDs arrive to the port together with the trailer. After parking the trailer at the port, the drivers have different ways to deliver the DGD to the shipping company, depending on different requirements of different shipping companies. Usually the driver hands the DGD to the port at the gate which later is transferred to the shipping company. Some shipping companies still use something called the "ships bag" to collect the incoming DGDs. When using a "ships bag", truck drivers put the DGD in an envelope and put the envelope inside the "ships bag" which is located at the port's gate. The "ships bag" is later transferred to the ship. The "ships bag" is seen as an old technique but some of the interviewed shipping companies still use it. Some shipping companies don't require that the truck drivers leave the DGD to the ship. It is enough that a copy of the DGD is sent in advance to the shipping company who in turn sends it to the ship. When this is the case, the original DGD following the truck is left in a box on the side of the trailer and it will be located in the box during the entire transport¹⁶⁹. In spite of different ways of handling the DGD document, the original DGD must accompany the DG the entire transport¹⁷⁰.

When the truck driver leaves the port and passes the gate, he goes out from the truck and reports the exact location of the parked trailer i.e. the parking number. Now the port's IT-system have information about where exactly the arrived trailer is located and what DG it contains. As mentioned before, the port of Gothenburg's IT-system can only handle and save two different classes per transport unit meaning that if the trailer has more than two classes some classes will not be shown in the IT-system¹⁷¹.

Arriving ships must notify the port 24 hours before arrival. The shipping company will not start to plan the loading until all DGDs have arrived. The documents can be an electronic copy or a fax copy¹⁷². The Port's production leader works together with the ship's chief officer and the captain when loading the ship. However, it is the captain who has the final decision how to load¹⁷³. Some shipping companies have minor differences concerning the loading process. E.g. shipping company 3 has their own port, and the captain also helps to organize the loading process. When loading they use the hazardous manifest (produced by the shipping company) to plan how to segregate trailers on the ship so different classes are placed in accordance with the IMDG regulation¹⁷⁴. Loading a Ro-Ro ship is considered as fast loading, the ships usually departure a couple of hours after the loading starts. This is seen as

168 Shipping Company 2

169 Shipping Company 3

170 Shipping Company 3

171 Port of Gothenburg

172 Shipping Company 2

173 Shipping Company 2

174 Port of Gothenburg

fast when comparing with the loading of a container ship which can take several days to load¹⁷⁵.

The port uses a kind of vehicles called the tug master to move the trailers within the port area and the tug master drivers are responsible to load the trailers on the ships. The tug master drivers can get information concerning what kind of DG he is driving and how he should handle it from the port's IT system. It is only DG that can be retrieved from the IT-system, no information about normal goods can be retrieved¹⁷⁶. The responsibility moves from the port to the shipping company when the trailers has made physical contact with the ship's loading ramp. After the ship is fully loaded it is ready to departure.

Most of the DG can be shipped with normal cargo. Usually the shipping companies place neither any DG near the living quarter on the ship nor close to the safety boats. DG is often placed on the top deck of the ships¹⁷⁷. Ships can be divided in two classes, class 1 and class 2. Class 1; is cargo or passenger ships that has a maximum of 25 passengers or one passenger per three meter of the ships total length. Class 2 is; other passenger ships that have more than 25 passengers or more than one passenger per three meter of the ships total length. On all ships, both ships in class 1 and class 2, there are five different load categories, category A-E. The load categories, depending on which ship class, place different demands on how to load DG. The load categories state where the DG should be loaded, for example, on deck, below deck or not allowed to be loaded. In the dangerous goods list column 16, each DG substances' category can be found. Load category A is the most "friendly" category, meaning that the DG is allowed to be stored both on and below deck. Figure 10 shows how to load each DG category according to IMDG Code¹⁷⁸.



		
Load Category	Cargo Ship	Passenger Ship
A	On deck or below deck	On deck or below deck
B	On deck or below deck	Only on deck
C	Only on deck	Only on deck
D	Only on deck	Not allowed
E	On deck or below deck	Not allowed

Figure 10 Load Category¹⁷⁹

175 Shipping Company 1

176 Port of Gothenburg

177 Shipping Company 2

178 IMDG, Amendment 34, 7.1.1

179 IMDG, Amendment 34, 7.1.1.2

In Figure 11 a general flow is presented of an intermodal transport of dangerous goods on road and sea. The white boxes illustrate the information flow and the grey boxes the physical flow.

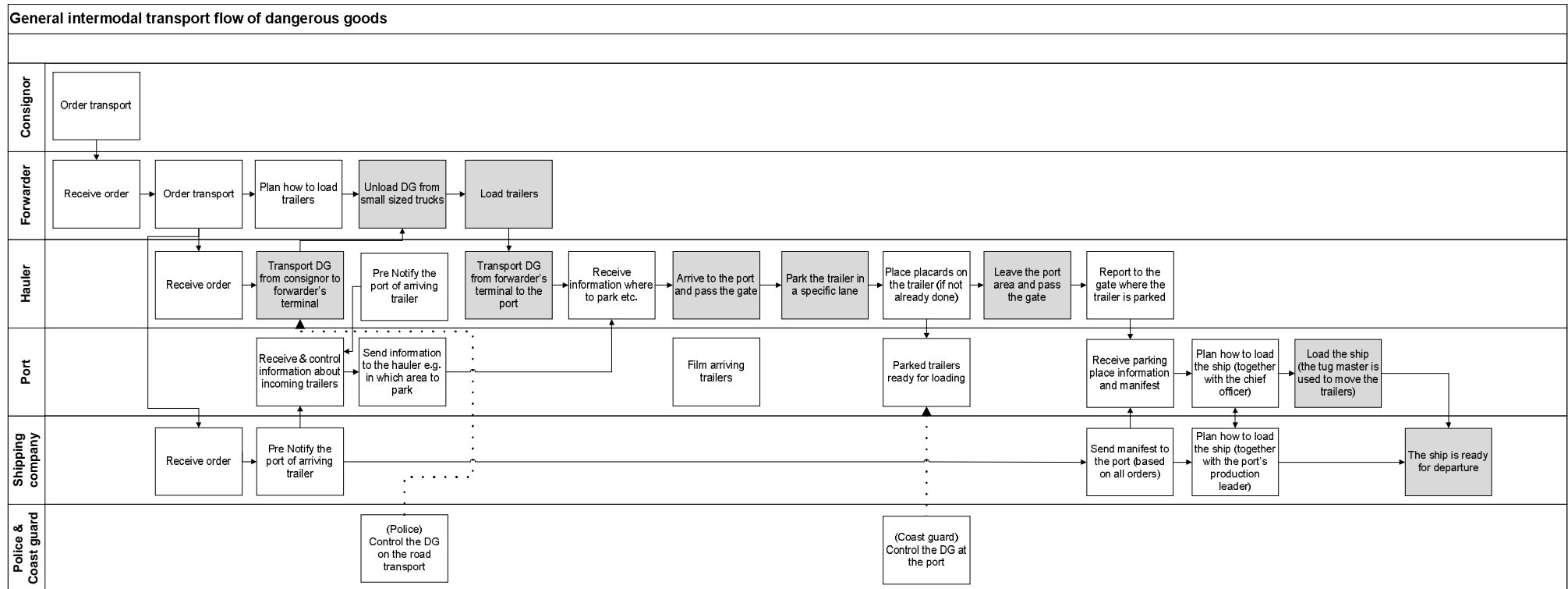


Figure 11 General Flow of DG ¹⁸⁰

5.2.2. Key Documents for Intermodal Transport of Dangerous Goods

According to the ADR regulation, the DGD and the Tremcard are the only documents that are needed for road transport of dangerous goods. According to the IMDG Code, EmS (Emergency Procedures for Ships Carrying Dangerous Goods) and MFAG (Medical First Aid Guide) are recommended to be located on the vessels. Sometimes customers demand a safety note for the products but this is not demanded by the regulation¹⁸¹.

DGD (Dangerous Goods Declaration)

When transporting dangerous goods, the consignment must be accompanied by a dangerous goods declaration (also called the dangerous goods note), declaring the description and nature of the goods. The DGD must be based on the specifications set by the specified dangerous goods regulations applied for the specific transport task¹⁸². The DGD is often included in the waybill¹⁸³.

The Multimodal Dangerous Goods Form is used as a combined dangerous goods declaration and packing certificate for intermodal carriage of dangerous goods¹⁸⁴. It is a three-part form comprising of the shipping instruction, the dangerous goods declaration and the packing certificate. The Multimodal Dangerous Goods Form enables the shipper to complete one standard document for all consignments. It gives accurate and timely information at each stage of the transport movement to everyone involved in the consignment. The greatest benefit is that all the parties in the transport chain have clear and precise information about exactly what the goods are and how they should be handled¹⁸⁵.

The DGD completed and signed by the consignor shall be included with the physical transport. The actors that are involved in the physical transport keeps a copy of the DGD document when they are done with their part of the transport. Information about the content which must be included in the DGD document can be found in the IMDG code 5.4.1 (applies for intermodal DG transport with part of the transport on sea). There is no demand that a certain formulary must be used but there exist a recommended formulary (The Multimodal Dangerous Goods Form) that many actors choose to use. If it is an international transport the information must be in English, and if it is a domestic transport the information should be in the language used in the country where the transport takes place.

Tremcard

Another document needed is a tremcard, but there has been changes regarding this document¹⁸⁶. The 2009 revision of ADR have introduced a significant change to the instructions in writing (the Tremcard), both in terms of the content and who is responsible for supplying them. Key changes can be summarized as:

- The driver / hauler have to provide the instructions in writing (Tremcard). Before the release of the new version of ADR, it was the consignors' responsibility to provide the Tremcard.

181 Forwarder 2

182 Dangerous Goods Note Completion Guide

183 Forwarding Company 1

184 ADR 5.4.4

185 Dangerous Goods Note Completion Guide

186 Hauler 1

- The instructions are only required in a language that the vehicle crew can understand
- There will be one set of instructions to cover all dangerous goods, and before the release of the new version of ADR, there must be one set of instructions for each UN number.
- The complete instructions in writing text is included in the ADR 2009

Manifest

The manifest includes information about all trailers containing DG and is sent the day before or the same day as the ship departure to the port. The production leader at the port gets the manifest for both import and export¹⁸⁷.

Additional documents needed for road transport:

- ADR certificate. (Proof for completed and approved ADR course)
- Driver's Photo ID (E.g. drivers license)
- Certificate regarding the vehicle, if needed (Applicable for some types of dangerous goods)
- Permit from MSB (Needed for class 1 explosives, class 6.1 toxic substances , and class 9 some miscellaneous dangerous substances and particles)
- Multilateral agreement, (Temporary agreements used sometimes between countries and within Sweden)

Additional documents needed for sea transport:

- **Documents of Compliance**
Cargo ships of 500 GT and over and passenger ships constructed since 1 September 1984, and cargo ships of fewer than 500 GT constructed since 1 February 1992, are required to carry a Document of Compliance if engaged in the carriage of dangerous goods on international voyages. Owners of other ships carrying dangerous goods are encouraged to obtain such a document. More recently the format of that document has been amended to show the spaces which have been categorized for the stowage of dangerous goods and to limit its validity to five years. Owners whose ships have documentation over five years old should consider reviewing its validity.
- **Dangerous Goods Stowage Plan**
For ships carrying dangerous goods in packaged form.
- **The Supplement** to the IMDG code contains the following documents that should be onboard vessels transporting dangerous goods:
 - Emergency Schedule (EMS Guide)
 - Medical First Aid Guide (MFAG)
 - Reporting Procedures
 - Packing Cargo Transport Units
 - Safe Use of Pesticides
 - INF Code

¹⁸⁷ Port of Gothenburg

5.3 Problems Identified in the Transport Flow

5.3.1. General Problems in the Physical Flow

In most cases for companies dealing with dangerous goods frequently, there are not many problems, but for those that do not deal with the DG often, it is quite common that they don't know how to handle DG, and therefore generate more problems¹⁸⁸. According to the safety advisors interviewed, in road transport of DG, 90% of the accidents are caused by human fault, and it mainly refers to the truck drivers.

The most common problem identified by shipping companies is that the unit is not marked/labelled correctly. For example, when the trailer arrives to the port, it is not labelled since according to ADR it is not needed but when entering the port the IMDG regulation applies. The driver must then place DG labels according to the IMDG regulation; sometimes the drivers forget to place one or more labels on the trailer and sometimes the labels don't stick to the trailer and fall off due to bad weather¹⁸⁹. In road transport, dirty and old labels are also a quite common problem (see Figure 13); Sometimes if the trailer is used to transport one specified DG all the time, there might be really old labels on the trailer which may not be valid due to updated regulations. When transport task is changed, the labels should always be changed, but they are not¹⁹⁰. Also the labels are quite difficult to remove from the trailer when the transport is done which are the most typical problems identified by many interviewees¹⁹¹. For rail transport of dangerous goods, missing placards is the biggest problem. The rail transport of dangerous goods can't go without placards. As for the responsibility to pay for the missing placards, according to the regulations, it is on the consignor. The rail company only needs to check the documents, and they are not responsible for checking the wagons and placards etc. If an accident occurs during the transport, the rail company is not responsible for the goods. According to the RID the consignor is responsible for the goods during transport¹⁹².

Sometimes drivers don't secure the DG i.e. the DG is not properly lashed. Since it takes long time to re-lash a trailer that wasn't properly lashed, this is seen as a big and expensive problem. One of the interviewed shipping companies says that they need to re-lash around one trailer every day due to bad lashing. Since this shipping company only controls around 10 percent of all DG trailers, the number of trailers with bad lashing is probably much higher than one per day¹⁹³. Poor lashing is also a major problem in the painting industry, because there is no good system to lash cylinder packages. Square packaging is much easier, but they are not used to package liquid flammable materials, due to the reason that square packages are easily leak. When some producers sent their DG packages in soft trailer there were arguments with the coast guard on how hard the lash must be. If it is a little bit too soft then it is not strong and fixed enough, if it is too hard, the package easily gets crashed¹⁹⁴.

Lack of knowledge or education on rules and regulations is the typical problems especially for consignors and drivers. Often, small sized companies that don't transport DG frequently are

188 Forwarder 1

189 Shipping company 2

190 Shipping company 1

191 Port of Gothenburg

192 RID 1.4.2.1

193 Forwarder 3

194 Producing company 1

lacking knowledge about the regulations. Common problems are wrong information in the documentation¹⁹⁵. Truck drivers need an ADR certificate to be allowed to drive DG. This certificate is valid for five years. According to several interviewees the ADR certificate is valid for a too long time period. The drivers should know about DG but they don't. Stories that are told are that companies that educate ADR drivers, instead of educating them, held parties for a couple of days and charges five thousand Swedish kronor and then give the drivers their licenses¹⁹⁶.

Figure 12 shows a trailer that is labeled wrong. This might be due to the reason that the labels are hard to remove from the trailer when the transport is done or simply because the driver is lazy.



Figure 12 Picture of a Trailer Labeled Wrong¹⁹⁷

195Forwarder 2

196Forwarder 3

197 Port of Gothenburg



Figure 13 Old Labels¹⁹⁸

5.3.2. Problems at the Interfaces

At the consignor's place, the most common mistake for tank business is that the drivers load the wrong liquid. The most common mistakes happen when loading Class 3 which is called by some safety advisors and drivers as the cocktail error. The drivers have education on how to load and unload, but the time stress is a common reason for such mistakes. Spillage or leakage is another common mistake. The reason for it could be technical reasons. If a spillage or leakage incident occur during the transport, or while loading or unloading, the driver call 112, or the appropriate emergency services for help¹⁹⁹.

Since it is usually the driver's responsibility to load, it is the hauler company that is responsible if an accident happens during loading. Haulers often have high insurances²⁰⁰.

Problems can occur when loading different classes of DG with different UN number together, also called mixed DG transport. It could be a problem since some classes are allowed to be loaded together and some classes are not. Usually some party (e.g. the consignor) plans how to load the different classes together, but sometimes they might be wrong and realize the problem very late. Then the driver has to reload it again. For professional DG producers that are frequently sending DG, this seldom happen and usually the consignor will tell drivers what and where to load each pallet²⁰¹.

At the port, Trailers with dangerous goods often arrive late. Almost every day at least one trailer misses its ship due to delay according to port of Gothenburg²⁰². The reason why trailers arrive late might be due to time optimistic haulers, which means that the actual transport time is longer than the planned transport time. Some hauler companies also intentionally advertise that they can deliver the goods within a certain time just to get more customers or to be able to provide better customer service i.e. haulers and forwarders wants to be able to accept

198 Port of Gothenburg

199 Hauler 1

200 Hauler 1

201 Forwarder 2

202 Port of Gothenburg

customer orders for as late as possible. An example of how a forwarder can advertise; “If you order before 16:00 your trailer will be in UK the next day”. Another reason might be because the truck drivers don’t know which time the ships departure. Sometimes the truck driver arrives with the trailer on time but because the driver doesn’t know when the ship actually departure, he might not park the trailer right away. The driver instead goes to the bathroom, reads a newspaper, or has some coffee before he parks the trailer²⁰³.

Another problem at the port is the classification of dangerous goods. The current signs at the ports (see Figure 9) only classify the cargo according to the class and not according to the UN Numbers. There exist a lot of exceptions in the IMDG Code regarding those substances even in the same class but still cannot be put together. Acids in class 8 is one example²⁰⁴.

203 Shipping Company 2

204 Port of Gothenburg

5.3.3. Problems in the Information Flow

There is no demand for what the layout for the transport documents should look like for road, rail and sea, only recommendation²⁰⁵. What is demanded in the regulations is which information that must be stated on the DGD. Some specifications also exist concerning where the information should be placed and in which sequence. The information flow between the forwarding company and the consignor used to be inefficient such as lack of documents from consignor²⁰⁶. Very often the DGD notes are not issued in a proper way, for example, missing or wrong placed signatures or wrong information entered. One common mistake concerning the multimodal transport document is that it only has one signature. The document should have two signatures. It is the signature in the lower right corner that is often missing. See Appendix C for a template of the Multimodal Dangerous Goods Form. The reasons for these mistakes might be due to bookings done in hurry, ignorance, laziness, or even lack of education. Another common problem is that there is missing information in the CPC (Packing Certificate)²⁰⁷.

Missing DGDs are a common problem for shipping companies that still uses the old technique with a “ships bag”. When using a “ships bag”, truck drivers put the DGD in an envelope and put the envelope inside the “ships bag” which is located at the port’s gate. The “ships bag” is later transferred to the ship. When the ship arrives to the final destination, some DGDs are not to be found in the “ships bag”, they have simply vanished. Shipping companies that no longer use the “ships bag” but instead send and receive DGDs electronic by either EDI or email don’t have the problem with missing DGD.

Between the consignor and the truck driver, one of the main problems is language. Lots of drivers are not Swedish, many are from east Europe, and other countries and they speak neither English nor Swedish. If something happens, the driver can only call his own company as he can’t communicate with any other actor²⁰⁸.

205 External Safety Advisor 2

206 Forwarder 1

207 Forwarder1,2 & Shipping Company1,2

208 Forwarder 2

6. Analysis

The analysis chapter aims to find the solutions to the identified problems in both the application and control of rules and regulations and the transport flow, which finally leads to a desired flow with improved legal environment and reduced problems in the intermodal transport flow. The last three sub questions are answered in this chapter:

- *How to solve the problems concerning the application and control of rules and regulations and problems at the transport interfaces?*
- *What are the deployment barriers to reach the desired flow?*
- *What does the desired flow with improved legal environment and reduced problems look like?*

6.1. Rules and Regulations

Based on interview results, the ideal situation should be that only one regulation covers all transport modes. This might be nearly impossible to achieve since all modes have big physical differences among another. The different characteristics of each transport mode forms unique parts of each rules and regulations such as the different stipulation concerning stowage and segregation between the sea, road and rail transport. What's more, dangerous goods have different characteristics, and road and sea regulations value the dangerous characteristics differently. However, it stresses the trend for better harmonization among the different regulations. Things that should be more harmonized and in the end also completely the same are: packages, placards, marking and documentation. So there is still plenty of work to be done concerning harmonizing the regulations.

International cooperation and intermodal understanding is necessary for future harmonization. A fact which makes it harder to harmonize the different regulations is that different organisations are responsible for different regulations and they find it difficult to compromise, e.g. IMO is responsible for the IMDG, on a UN level. ADR and RID only applies on a European level. There might be protests from those with milder rules also, and historical reasons as well. The fact that the RID regulation was founded in the 18th century while the other regulations were founded after the Second World War, strengthen the unwillingness to combine the regulations. According to some of the interviewees, another big obstacle to make it hard to harmonize all regulations is due to sub-optimization, i.e. all organizations think that their regulation is the best one.

At present, different companies apply different regulations for the same or similar intermodal transports in terms of packaging, placards, labels, marking and documentation. Some companies apply the strongest regulation from the start and some apply several regulations for different parts of the transport. Large forwarding companies have said that they apply the IMDG from the start most of the times and small sized companies not as frequent. The port's opinion is that most of the arriving trailers are putting the placards on at the port i.e. the trailer was not prepared according to the IMDG regulation from the start. It seems much simpler to apply the strongest regulation from the beginning but one reason why there are still actors that are willing to apply different regulations for different modes is that some companies work as

ANALYSIS

they always have done and are reluctant to change routines since it is both time consuming and costly to change routines. Today (2009), ADR stipulates that it is acceptable for stronger regulations such as IMDG to be applied during road transport when part of an intermodal sea transport. However the authors suggest that concerning packages, placards, labels marking and documents, future intermodal DG transport should only apply one regulation (the strongest regulation covered by the transport) throughout the entire intermodal transport. And the responsible authority should in the future agree to make it mandatory to apply the strongest regulation concerning the intermodal transport of dangerous goods. When only one regulation is applied, problems and mistakes will be reduced since the possibility to make errors will decrease when handling fewer documents, labels and marking etc. The possibility to forget to put on the placards at the port also decreases since the placards must be placed on the trailer at the start of the transport. In order to achieve this, negotiations with the industry and further investigation by IMO is necessary.

There are different arguments for why the adaptation period for new versions of regulations is needed or not. However it will not be a problem for companies to adapt to new regulations without the adaptation period, as long as the changes in the regulations are informed a long time in advance. The authors would suggest that the authorities should provide the regulations for road, rail and sea the same way as being done with air regulations i.e. without adaptation periods and present the new regulations approximately six months in advance with clear conditions for the existing old labels and packages etc. the suggestion period of six month is based on current adaptation period of six months of ADR and RID. Another point is that concerning the application time of the new versions of the regulations. All countries should agree to apply the new versions on a domestic level at the same time²⁰⁹. Today the regulations have the same release time from the responsible authority on the European level but new versions are still implemented at different times in different countries. In this case one EU authority is needed to make the decision. If all the countries apply the new version the same time, then the confusion of different countries applying different version of the regulation at the same time will not exist.

Many interviewees agree on that there should be a condition in ADR concerning a maximum weight for a DG transport to be allowed and classified as a LQ transport. In 2008, no upper limit exists in ADR concerning weight or amount. In practise, a truck driver without DG education and an ADR certificate could transport as much DG as the trailer had room for. As long as the DG was transported in small packages this was ok. In the ADR regulation from 2009 new condition states that LQ with a weight of eight ton or more needs to be treated as a DG transport i.e. it must be labelled with placards, a DGD must follow the transport and the driver needs an ADR certificate. This upper limit of eight ton leads to safer DG transports since the driver both need DG education to be allowed to transport the trailer and the trailer must also be properly labelled which means that if an accident occurs it is easier to see what kind of DG the trailer contains. However, problems still exist concerning LQ transports less than eight tons. The new change in ADR 2009 is an improvement but LQ transports should be totally harmonized with other regulations as well. According to the IMDG LQ always needs to be labelled and treated as a DG transport, IMDG doesn't have any exceptions concerning weight or volume. A trailer that contains any amount of DG counts as a DG transport and

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must therefore be labelled and treated as such. Truck drivers shouldn't get the possibility to label the trailer correctly according to one regulation at the same time as it is considered as wrong in another regulation. And ADR should follow the same way as IMDG in the future. Since LQ is originally generated from the need of the industry, as a result, it is better to get the support and approval of the new proposal for LQ from the industry.

Better education is one of the most effective ways to reduce the problems and improve efficiency in the long run. The frequency for education is not stated in ADR, RID or IMDG today. In ADR it only says that personnel that are handling DG or information/documentation concerning DG needs to be educated frequently. A problem with this rule is concerning what is frequent for one company may not be frequent for another company. Different companies interpret the regulations differently and the transport chains safety and security is therefore affected in a negative way. The regulation should be more specific concerning the education frequency. The suggestions of two years from authors and interviewees are based on the facts that regulations are updated every second year and personnel change and forget. The education level needed should also depend on the responsibility level. Employees that are working with DG documentation should not get the same amount of education as employees that are handling the physical DG. Education costs money, this is a common view on education. Many companies has however realised that good educations often contribute to an increased profit. Education for the personnel that handles documents is also necessary and will help to reduce problems.

Most of the safety advisors interviewed agree that the conditions in the regulations concerning the qualification and responsibility of safety advisors and truck drivers should be highlighted. There should be higher requirements on the skills to obtain a license for safety advisor. However, it might be difficult to get an understanding of more stringent requirements than the present situation. The DG safety advisors must be assured to be active in the company for what he/she should be responsible for. This is not only referring to good plans for paper terms but also continuous monitoring at the implementation level.

6.2. Controls

The contribution of control can be seen both in security and efficiency. By correcting the problems in the chain, security will be improved and the controls urge actors to perform better and follow rules and regulations. Thus help to improve efficiency. The obvious effectiveness of control pointed out by most interviewees from the whole transport chain has further highlighted the validity of control. In order to lead current transport flow to the desired flow, controls must be one big emphasis.

It is necessary to increase the current control frequency for both the police and the coast guard to achieve a more secure and efficient transport chain. This is based on feedback from most interviewees that the control frequency is not enough. As for how frequent the control should be, the authors suggest that a conference meeting among Swedish Transport Agency, police, the coast guard and leading transport actors of dangerous goods should discuss this fact. The desired control frequency is not just a priority issue. It requires more increased resources and money for the control authorities.

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MSB should control that safety advisors and truck drivers have enough knowledge about rules and regulations. The authors suggest more and better structured random controls for both registered safety advisors and certified truck drivers. Drivers' license could be certified every fifth year but drivers should update their knowledge frequently according to the regulatory changes. One bad situation is that the ADR instructor for drivers' license is too weak. A driver/hauler can buy the certificate. In the future the authorities must get resources to be able to do all the tests themselves. Based on such, operationally, more resources are needed for MSB's controls. And strategically, there is a need for clear ambitions from the Parliamentary Government with specialized money or resources to build the business to a desired level.

Joint controls has received very positive feedback and it would be a good idea if there could be one organization, above the police and the coast guard, that makes holistic control plans concerning intermodal transport. The authors suggest that the Swedish Transport Agency should be responsible for the holistic controls. This suggestion should be discussed and decided by the government. It would be an improvement to authorize the coast guard more rights, such as the right to fine and open sealed transport units. DG transported by sea is one big share of the total amount of transported DG and by giving the coast guard more rights intermodal DG transports will be more secure and efficient. The costs to make mistakes should be emphasized in order to reach improved compliance.

It would always be good if DG transport controls can be made at the beginning of the transport at the consignors' place. Since problems are easiest to avoid if doing the right things from the start. Gold in gold out or garbage in and garbage out²¹⁰. However it is too hard to implement this in practice. Instead of suggesting controls at the consignors, it would be a good idea to increase controls at forwarders terminals. Current control authorities need to have one systematic control plan especially for those forwarding companies that have their own terminals. According to the interviews, some private terminals are nearly never checked while others are checked quite frequent. Probably the police don't have a complete list of forwarders that handles DG. In order to solve this problem a central database concerning actors' information is necessary. Since MSB currently has a list of companies that handles DG, it could be MSB's responsibility to further update the information of forwarding companies with own private terminals. And it is necessary for the control authorities to cooperate with MSB for getting access to the database.

Random penalty concerning the most common problems is a good idea which could help to reduce the deficiencies rates, such as penalty to those haven't updated fire extinguisher, bad lashing and improper labels. And since it is hard to control the "black deal" of those that don't report dangerous goods transport, it would be a good idea for different governments to decide the amount of penalty concerning the "black deal". Due to the different situation of each country, it is much easier that the decision on the amount of the penalty should based on national level but this in turn increase the difficulty to control international "Black Deal" of DG.

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Better continuity and frequency of the education for controlling personnel is recommended both for the police and the coast guard. According to many interviewees, they don't have enough knowledge.

As a complement, the statistics from the Swedish Transport Agency can be better used for risk control especially as some kind of "black list" to help control authorities to focus on the "worst" actors. A joint discrepancy database for DG would make it possible to do controls based on risk analysis. Better analysis of those data will help to identify the control focus and better categories the problems etc. Present, in 2009, the statistics is already shared among different European countries. But in order to further improve the usage of statistics, conditions on secrecy law is necessary which enable the free exchange of information between supervisory authorities and transport authorities.

6.3. Intermodal Transport Flow of Dangerous Goods

Ro-Ro loading and unloading at the ports are seen as quick handling which only takes a couple of hours. The short handling time makes Ro-Ro transport by sea especially vulnerable to time delay, and all the problems or mistakes that appears before the trailers arrive at the ports may affect the transport lead time. And there is a big cost to correct the mistakes as well.

One of the main problems between the consignor and the truck driver is the language barrier. Many truck drivers, mainly from the east Europe, speak neither English nor Swedish. If the DG transport works smoothly without any unplanned disruptions, the language barrier is not seen as a big problem. But if something should happen e.g. an incidents or a problem occur, it can have tremendous effects that the driver can't communicate with e.g. the rescue agency. When an accident happen the truck driver can only call his own company as he cannot communicate with any other actors²¹¹. This problem can be eliminated by demanding and stipulating in the ADR regulation that truck drivers that transport DG must be able to communicate with the actors he has direct contact with.

A way to reduce human mistakes is by having automatically controls in the IT-system that reacts and informs that the wrong information has been entered. Similar to the controls that some of the interviewed shipping companies have when entering information about DG. When entering the UN numbers a control is done to see if the different UN numbers are allowed to be transported together, if not the system informs the user.

One solution for the documentation problems for example, wrong documents, missing documents, might rely on the further simplification and harmonization of the documents in the rules and regulations. This is especially important since today many transports are intermodal transports, the different requirements on package, placards, marking, labeling and documents are only making actors more confusing and the documents more complicated. If the requirement for packages is harmonized between all modes it will be easier for producing companies to prepare the DG with proper packages.

Another solution is to replace paper documents with electronic information; the new version of ADR (apply from July 1st 2009) already allows electronic DGD, and it would be good if

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IMDG will accept this as well. The electronic documentation will not only greatly avoid the problems found in paper documents but also increase the efficiency of the entire transport time. Meanwhile many supports are needed such as technical equipment and investments for the paperless documents, education for those operate the facilities etc. At present there are already leading forwarding companies investing on mini-computers in each truck for paperless documents, one of the interviewed companies is such an example. However, for the whole industry it might be something that could be achieved in the future.

Missing DGDs is seen as a problem especially for shipping companies that still use the “ships bag”. To reduce the problem with missing DGDs, the “ships bag” should be removed and the DGDs should instead be sent electronically by EDI or email. The reason why some documents are missing signatures or UN numbers could be both due to lack of knowledge and also due to laziness. Many times wrong information in documents is due to that consignors use old DGD templates without updating the information in the DGD template. A common mistake is that the wrong year is stated on the document. If this is the case the document is not valid and a new document must be created. Improved efficiency concerning documentation can be achieved by demanding that actors that handle DG must update their education more frequently and also by improving the information flow between involved actors in the DG transport chain. If a problem occurs the responsible actor must be informed so the problem can be avoided in the future.

As for the placards, using fixed plastic folders/pockets to put the placards in could effectively solve the problems of dirty and old labels, labels hard to get rid of, and labels falling off during the transport. (See Figure 14, a trailer with plastic folders/pockets) Currently there are quite few companies using this kind of plastic folders and it might be good to promote this solution in the transport industry. Another point is that it does not cost much for companies to apply this and it just increases the profits more. The plastic folders can be further developed to make them stick better to the transport units.



Figure 14 Trailer with Plastic Folders/Pockets²¹²

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Another reason why trailers have wrong or even missing placards is because ADR and IMDG have different rules concerning how and when labels should be on the trailer. It would be good to delete the step of changing placards from the transport process. Since it is one extra step and it affects the efficiency of intermodal transport. Sometimes truck drivers forget to put the labels on. If the rules and regulations concerning the placards is harmonized, or the relevant authorities make it mandatory for the industry to apply one regulation starting from the beginning concerning intermodal transports as mentioned before, the problem with wrong or missing placards would be reduced. However, the time period and the possibility of the acceptance of the proposals are uncertain. The reason why trailers arriving to the port are not secured enough or properly labelled for the sea transport might be due to unattentive or forgetful truck drivers. Major reasons according to many interviewees are because the hauler and the drivers do not have enough knowledge on how to do this. Therefore more education for truck drivers and haulers are emphasized again.

Proper lashing is necessary for secure and efficient transport. Poor lashing affect the lead time in a negative way. There should be requirements in the regulations stating that the consignors must have proper knowledge about lashing rules for all transport modes so they can prepare the DG better for intermodal transports. It would be especially necessary to enhance the knowledge and awareness for the consignors that don't handle dangerous goods frequently. Since these consignors are the ones that generates a big proportion of the total mistakes and problems. There should also be conditions on the rules for the truck drivers that they should have proper knowledge about IMDG's lashing rules. Another good solution especially for liquid products, with cylinder small packages which are quite hard to lash, is to replace the soft covered trailer with the box covered trailer And this has been seen successful for one big painting company. The UK changed the rules to replace the soft trailer with box trailer for paint transports as it is much safer²¹³. However, it cost more money to use boxed cover than soft cover. It might be difficult to persuade the whole painting industry to change to boxed covered trailers without demanding it through a mandatory rule in the regulations.

There is a need for better time planning by haulers. Incoming trailers arriving to ports too late are seen as a common problem by the port of Gothenburg. Late arriving trailers can contribute to hurry loadings and therefore generate more problems in the chain. Sometimes the trailers even miss the scheduled shipping time. There are several reasons why this problem occurs e.g. it could be due to time optimistic haulers and the fact that some hauler and forwarding companies intentionally advertise that they can deliver goods within a certain time just to get more customers i.e. haulers and forwarders wants to be able to accept customer orders for as late as possible. The point is that even though late arriving trailers happens all the time, the port seldom or has never informed the forwarders that trailers arrive late. It seems that the costs for the delays are not interest to the port. Therefore, the forwarding companies have no chance to improve this problem due to lack of information. Another fact which makes this problem even more invisible is that trailers are allowed to be stored at the port up to four days without being charged an additional cost by the port. If a trailer misses its ship it is almost always shipped the day after and is therefore not charged an additional cost. The only consequence for trailers that miss the ships departures is a delay in the physical transport. In

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order to improve the efficiency of the whole transport chain, the problem with late trailers should be better solved; the authors suggest that shipping companies should be responsible to inform forwarding companies about late arrivals, since a late trailer often mean a loss for the consignors and the shipping companies. The information flow between the shipping company and forwarding companies must be better. If a problem arises, the company that causes it and the ones that are responsible for the problem must be informed. The forwarder will then have a possibility to improve and reduce the number of late arriving trailers. Forwarding companies and shipping companies should constructs clear routines for what to do and whom to contact when such a problem arise.

One of the interviewed shipping companies who have their own port had tried a pilot project that made customers pay extra for late booking cancellations. This project was at the time of the interview 2009, seen as a great success. However if similar concepts are applied to other shipping companies, there are risks that haulers and forwarding companies will use a different shipping service if one starts to charge an extra cost for late trailers. Even though there might be possible to make all the shipping companies agree to charge a late delivery fee. This might still not be a good solution in practice e.g. different ports have different deadlines and haulers have different possibilities to keep deadlines. It is not good to charge a forwarder or a hauler for late arrival due to traffic jam. But it might be good to give the truck driver the time schedule of the latest time that ports requires and the shipping departure time. It might be even better if this information is presented in the IT or register system. The information about ships' departure time could even be presented in a monitor at the port. By having a better time schedule in mind, truck drivers can adjust more flexibly and most importantly, the unnecessary time such as reading newspaper etc will be deleted if the drivers know that there is not sufficient time left until loading.

The responsibility concerning involved actors in a DG transport flow already exists in the regulations but it should be made clearer. In particular, the responsibility of control and checking at the terminals and the ports are blank at present. Current rules and regulations have stipulated nothing about this. However, when considering the fact that incidents rate at terminals is the highest of the whole transport chain, it is apparently necessary to put great efforts at the terminals. Increasing controls at forwarding companies' terminals and at ports could be one very effective way to improve the efficiency by identifying the problems as early as possible and reducing the problems. Forwarding companies should be better motivated to put efforts on further fixing routines and instructions for how to handle the DGD and documents. As for the port, the ID service might be an ideal actor to be responsible for the control of documents and labels i.e. ID service should control all DG trailers before they enter the port area. And if the port's ID service is paid for this service there will be no difficulty to achieve this change. All in all, it might be a good idea that the rules and regulations stipulates the responsibility of forwarding companies and ports for checking and control at the transport nodes.

EDI, track and tracing, online booking etc are common effective tools that is used by big actors to improve efficiency, the efficiency will be further improved if those tools are more applied in the whole industry. It is never easy for companies to invest in such technology and especially not today due to the financial crisis. The fact that DG can be seen as a necessary evil is one reason why it needs to be prioritized at top management level. If not, no one wants

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to take responsibility for the DG. E.g. in a DG producing company, top management must be committed and understand that DG regulations are not only something that cost extra money to follow but in fact companies should save money if they apply the rules and regulations in an efficient way. By following the rules and regulations, transports are getting more secure which leads to more efficient transports, meaning saved money for the transporting companies if they follow the rules and regulations.

6.4 Desired Flow and Deployment Barriers

Table 17 presents the desired flow which describes the improved legal environment, more efficient and effective controls from competent authorities and better solutions to reduce the problems in current transport flow. The information in the table is based on the current flow and improvement suggestions from both the interviewees and the authors. In the first column a suggestion is presented, the second column describes what is needed to implement the suggestion. Column three presents which barriers and obstacles that exist and column four shows how long time it should take to implement the suggestion.

Nr	Desired Flow	Major Conditions needed	Major Deployment Barriers	Possible/Expected years to achieve		
				1-2	2-5	Over 5
<i>Rules & Regulations</i>						
1	No adaptation period for ADR, RID and IMDG (half year for ADR & RID, one year for IMDG).	<ul style="list-style-type: none"> Changes or proposals must be informed a long time in advance Suggested time period: New regulations to be presented aprox. six month in advance 	<ul style="list-style-type: none"> There are different opinions from different industries. 			X
2	All countries will agree to apply the updated versions of regulation on a domestic level at the same time	<ul style="list-style-type: none"> Needs to be agreed by most of the individual countries One regional competent authority is needed to make the decision. Suggestion: EU 	<ul style="list-style-type: none"> Working process and practice differs among different countries, might be difficult to internationalize 			X

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3	The conditions of packages, placards, labels, marking and documentation will be harmonized among ADR, RID and IMDG	<ul style="list-style-type: none"> • International cooperation • Intermodal understanding • Improved collaboration among responsible organizations 	<ul style="list-style-type: none"> • Different organizations, hard to compromise • Historical reasons, all organizations think their regulation is the best • Protests from organizations with milder rules 			X
4	The rules on Limited Quantity will be harmonized among ADR, RID and IMDG	<ul style="list-style-type: none"> • Industry to accept • Improved collaboration among responsible organizations • Intermodal understanding 	<ul style="list-style-type: none"> • Negotiate with industry • Different organizations, hard to compromise • Protests from those with milder rules 			X
5	It will be mandatory to apply only one regulation (the strongest) during the entire intermodal transport for packaging, labels, marking, placarding and documents	<ul style="list-style-type: none"> • Investigations by IMO • Negotiations with the industry 	<ul style="list-style-type: none"> • It might be hard to decide who shall determine this 			X
6	Different education frequencies (e.g. two years) will be added for all actors that handles DG (Today, no frequency is stated in the regulations)	<ul style="list-style-type: none"> • Actors must think in a long term basis • Acceptance from all actors 	<ul style="list-style-type: none"> • Actors only see education as a cost. • Might be hard to decide how frequent and who should cover the costs. • Business and Management look very different, the needs are varied. 			X

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7	Higher requirements on the qualification and responsibility for Safety advisors to gain the licenses will be added in rules and regulations	<ul style="list-style-type: none"> Agreed by competent authorities from member countries 	<ul style="list-style-type: none"> Resources needed from MSB Difficult to get an understanding of more stringent requirements than there are now Resistance from actors that supports softer rules 	X	
8	Requirements in ADR that consignors must have proper knowledge about lashing rules for all transport modes will be added. Truck drivers will have proper knowledge about IMDG's lashing rules.	<ul style="list-style-type: none"> Agreed by competent authorities from member countries 	<ul style="list-style-type: none"> Resistance to change current regulation Resistance from actors that supports softer rules Protests from those with milder rules 	X	
9	The responsibility of terminals and ports for checking and control at the transport nodes will be added in ADR, RID and IMDG	<ul style="list-style-type: none"> Agreed by competent authorities from member countries 	<ul style="list-style-type: none"> Resistance to change current regulation There are different opinions from different industries. Protests from those with milder rules The ports might not want to be assumed with more responsibilities 		X

Dangerous Goods Controls

10	MSB will improve the supervision and control for truck drivers to get their certificate	<ul style="list-style-type: none"> • Clear ambitions from the Parliamentary / Government. With earmarked money / resources to build its business to the desired level. • Give authorities resources 	<ul style="list-style-type: none"> • Difficult to get enough resources • Government funding 		X	
11	MSB will control that safety advisors and truck drivers have enough knowledge about rules and regulations more frequent	<ul style="list-style-type: none"> • Increased resources or resource optimization is required • Structured and detailed control plan 	<ul style="list-style-type: none"> • Difficult to get enough resources • Government funding 		X	
12	Suggestion: MSB should make more and better structured random controls at registered safety advisors and certificated truck drivers	<ul style="list-style-type: none"> • Clear ambitions from the Parliamentary / Government. With earmarked money / resources to build its business to the desired level. • Increased resources or resource optimization is required 	<ul style="list-style-type: none"> • Difficult to get enough resources • Government funding 		X	
13	The police and coast guard will increase the frequency of their controls (the police controls DG trailers on road)	<ul style="list-style-type: none"> • Clear ambitions from the Parliamentary / Government. With earmarked money / resources to build its business to the desired level • Resource changes and more education of police are required. Not just a priority issue 	<ul style="list-style-type: none"> • Difficult to get enough resources • Government funding • Cost to educate 		X	

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14	The coast guard will have the right to fine	<ul style="list-style-type: none"> Decision of Government 	<ul style="list-style-type: none"> No deployment barriers, as long as governments authorize the rights to the coast guard 		X
15	One agency will be responsible to make holistic control plans for the Police and the Coast guard	<ul style="list-style-type: none"> Collaboration between agencies Approved by Government 	<ul style="list-style-type: none"> Hard to agree on which agency 		X
16	The control authority will have a list of all companies that handles DG so they can better plan which companies to control especially for those forwarding companies that have their own terminals	<ul style="list-style-type: none"> Updated central database containing actors' information More resources needed by MSB to update the lists. control authority should cooperate with MSB to access the database 	<ul style="list-style-type: none"> information access resource prioritization 		X
17	There will be conditions in ADR, RID and IMDG concerning fines for companies that transport DG as ordinary goods	<ul style="list-style-type: none"> Different countries have different rules and fines. It should be up to different countries to decide fines 	<ul style="list-style-type: none"> Hard to implement for international transports of DG since different countries have different laws e.g. national laws can regulate international transports from other countries 		X
18	Better continuity and frequency of education for control personnel, both police and coast guard.	<ul style="list-style-type: none"> To allocate the resource in relation to other requirements. More resources for the police and coast guard. 	<ul style="list-style-type: none"> Limited resources hard to decide the satisfied frequency the possibility to get funding 		X

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19	The statistics from the Swedish Transport Agency for risk control will be better utilized.	<ul style="list-style-type: none"> • Agreement from competencies authorities among member countries • Secrecy law (and PUL) – make it possible to exchange of information freely between supervisory authorities and transport authorities. • Government support 	<ul style="list-style-type: none"> • Reluctant to share data e.g. people are more willing to share good information than bad information 		X	
20	The statistics will be used to make a "Black List" (this list could help the controlling authorities to focus on the "worst" actors)	<ul style="list-style-type: none"> • Agreement from competencies authorities among member countries • Access to sources of data and resources necessary to collect the data • Government support 	<ul style="list-style-type: none"> • Reluctant to share data e.g. people are more willing to share good information than bad information 		X	

Intermodal Dangerous Goods Flow

21	Paper documents will be replaced with electronic information in order to reduce handling mistakes	<ul style="list-style-type: none"> • Education, equipment and heavy investments 	<ul style="list-style-type: none"> • Different companies have different IT systems • The willingness to invest is key point • Financial crisis 			X
22	DG safety advisors will be active in the company for what he/she should be responsible for. Not only have good plans - paper	<ul style="list-style-type: none"> • More motivation to the industry • More control from MSB meaning more resources needed 	<ul style="list-style-type: none"> • Hard to decide the satisfied responsibility level for safety advisors • Hard to control • Hard to ensure the controls' 		X	

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	terms, but also continuous monitoring at the implementation level.		effect			
23	Trailers will have fixed plastic folders/pockets on the sides where you can put the placards	<ul style="list-style-type: none"> influence manufacturers and customers to use the fixed plastic folders Further technique improvements for plastic folders 	<ul style="list-style-type: none"> Should not exist any barriers, only increased profit 	X		
24	The soft covered trailer will be replaced with the box covered trailer, especially for painting industry to solve the problem of lashing cylinder units	<ul style="list-style-type: none"> Industry to accept and realize the benefits with boxed trailers 	<ul style="list-style-type: none"> Cost money. Forwarders can buy this equipment but industry is not willing to pay. Short term thinking, actors only see it as an expense and not as an investment 		X	
25	Language criteria will be added for truck drivers of DG	<ul style="list-style-type: none"> Industry agreement Agreement among decision making levels 	<ul style="list-style-type: none"> Free moving across country borders makes it hard to achieve Discrimination issue 		X	
26	EDI, track and tracing, online booking etc are more promoted to the whole transport industry for DG transport	<ul style="list-style-type: none"> Investment on facilities and technologies Education to employees 	<ul style="list-style-type: none"> Difficult to industrialize, especially for small actors 			X

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27	The Port's ID service will be responsible for the control of documents and labels at the port, meaning that ID-service will control all DG trailers before they enter the port area	<ul style="list-style-type: none"> • Pay the extra cost to the port's ID service • Resources and education needed for port personnel 	<ul style="list-style-type: none"> • Might be hard to decide who should pay for this. 		X	
28	Forwarding companies are encouraged to fix better routines and instructions for how to handle DG and documents at their private terminal	<ul style="list-style-type: none"> • Support from top management level • Resources and investment needed 	<ul style="list-style-type: none"> • Some players might be short term thinking and not willing to invest the money, resources and time needed 		X	
29	Better information flow between shipping company and forwarding company concerning late trailer notice	<ul style="list-style-type: none"> • Improved routines on how to act and whom to contact between forwarders and shipping companies 	<ul style="list-style-type: none"> • Different IT-systems • The problem is ignored and seen as a minor problem 		X	
30	Truck drivers will be informed about ships' departure times, this will lead to a decrease in the number of late arriving trailers to the port	<ul style="list-style-type: none"> • Efficient and convenient ways to communicate • Monitors at the port showing ships' departure times 	<ul style="list-style-type: none"> • Reluctant to change existing routines • Difficult to decide which actor should be responsible for the investments needed e.g. for the monitors 	X		

Table 17 Desired Flow²¹⁴

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7. Conclusion

Based on previous chapters' answers to the sub questions, this chapter aims to give the readers one holistic view of our research outputs and to emphasize the most crucial changes needed to improve the security and effectiveness of an intermodal dangerous goods transport. By implementing the improvement suggestions found in this chapter a more secure and efficient intermodal DG transport flow will be the result.

The problems concerning the safety and security of intermodal DG transports in this thesis are based on experts' opinions and thoughts through interviews. This fact gives the conclusion high validity and reliability as it is based on DG experts which are working with DG on a daily basis.

7.1. Rules and Regulations

In the optimal world there would only be a joint organization that gives out one regulation that covers all transport modes. To have only one regulation might in practice be very hard to achieve. A more realistic change that can and already is happening is that there is an ongoing harmonization between the different regulations. The regulations are getting more and more harmonized which makes the intermodal transporter easier to follow. However, the harmonization is going very slowly due to heavy resistance, compromising difficulties and unwillingness to change old regulations. The organizations that are responsible for the regulations must collaborate more to harmonize the regulations even further. Another possible and necessary change is to apply the strongest rule for the entire intermodal transport of DG concerning the packaging, placards, marking labeling and documents etc which will not only simplify the handling process, concerning both documents and DG, but also help to reduce the problems in the transport chain. Since when simplifying the rules, it is much easier to follow them.

A major finding in this thesis was that some conditions should be totally harmonized among the regulations. Limited Quantity was one such hot subject that was discussed and should be totally harmonized. LQ was seen as a sensitive topic since it was created based on industry demands. Knowledge levels concerning regulations differ greatly between different actors that are transporting DG. How good a company is at transporting DG doesn't depend on how big the company is but on how frequent DG is transported.

To conclude the rules and regulations part the authors would like to quote one of the interviewees; "current rules and regulations have reached a level that is good enough according to what the society expects. The focus now should be to control that the regulations are followed"²¹⁵.

7.2. Controls

Existing controls are very effective but they are not frequent enough. This is the common opinion concerning controls. More frequent controls are needed since it is proven to be a sufficient method to find and reduce problems. Every time a control takes place many problems are found. Another effect controls have on the transporting actors is that it often pushes them to put more effort into following the rules if they know that they are being watched or controlled.

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More controls should also be done earlier in the transport chain e.g. at forwarders terminals. By making controls earlier in the flow transports will be more secure since they will be in accordance with the regulations from an earlier point in the transport flow. Earlier controls will also lead to more efficient transports. E.g. a common problem found at the port is poor lashing. This problem is very time consuming to fix at the port since the port must notify the forwarder/hauler that a trailer is poorly lashed. Then the forwarder/hauler must go to the port and re-lash it. If the problem instead had been found at the forwarders' terminal it would have gone much faster to fix it i.e. improved efficiency.

It would be a good idea if there could be one organization, above the police and the coast guard that makes holistic control plans concerning intermodal transport. And the police should get one complete list of the actors that are within the control scope, especially those forwarding companies having their own terminals. As a complement, the statistics from the Swedish Transport Agency can be better used for risk control e.g. as some kind of "black list" to help controlling authorities to focus on the "worst" actors.

The police and the coast guard are making sure that rules are being followed concerning the physical flow and the information flow. What is not controlled or at least not controlled enough is actors' knowledge and competence level concerning DG. MSB is doing some random controls to check if safety advisors have enough knowledge and if companies have proper routines to handle DG, but they are by far too few. More resources should be put on these controls since it will lead to more efficient DG transports. To achieve more frequent controls it need to be government prioritized. The government must understand the importance of these controls and that more controls will lead to more secure and efficient transports of DG. In practice the government needs to reserve money to finance these controls.

Both safety advisors and truck drivers need to update their DG certificates every fifth year. New versions of the regulations come out every second year. In practice, this means that a safety advisor or a truck driver can be positive that they are working in accordance with a regulation when in fact they are not. Safety advisors should naturally update their knowledge by themselves without being forced to take an exam, because it is their job to have knowledge about regulations. MSB should spend more resources on the test of drivers' licenses for DG, according to many interviewees today truck drivers can even buy the licenses.

7.3. Intermodal Transport Flow of Dangerous Goods

Most of the problems that occur in an intermodal DG transport are due to human mistakes and it stresses the fact that education and training is needed for actors that transport DG. Since a big part of all accidents happens when loading or unloading focus should be placed on such locations i.e. on terminals and ports. When combining the human mistake factor with the area where problems arises, it is quite clear that more and improved education is needed. Also by stipulating the responsibility of ports and terminals to check and control labels, marking placards and documents etc, mistakes can be further reduced with improved efficiency as an effect.

The most common problems at transport interfaces are concerning wrong or missing placards on the trailers. This problem should be quite easy to reduce. All interviewees and the questionnaire agree on this fact. When using plastic folders/pockets that are placed permanent on the trailers, it is easy to place and remove placards inside the plastic folders/pockets. This solution is also in compliance with the IMDG regulation that states that the placards should be able to stay on the unit for at least 90 days.

Poor lashing which is already mentioned in the control chapter, is a common problem found both by the Port of Gothenburg and the coast guard. When transporting cylindrical units a boxed trailer is much better to use from a lashing point of view. Companies might think that boxed trailers are more expensive than soft covered trailers. This might be true if only seeing the investment in a short term but in the long run companies should in fact save money if they use the boxed trailer. The need to go to the port for re-lashing goods will not happens as frequent as for soft trailers and the lashing job it selves' take less time. Using boxed trailers therefore lead to more secure and efficient DG transports.

Missing or wrong information in the documentation is also a very common problem. This problem can be dealt with in a number of ways. Companies should strive to send information electronically by e.g. EDI. When sending information electronically the opportunities for human mistakes are reduced. The most fragile part in the information process then is when the consignor manually enters the information in the system. It is very important that the information is entered correct at the beginning otherwise the wrong information will be sent through the entire process. Gold in Gold Out, and Garbage in Garbage Out. One way of reducing human mistakes is by having automatically controls in the IT-system that reacts and informs if the wrong information has been entered. To conclude, it should be enough that information is entered manually into an IT-system only once. The entered information should then be sent electronically to the next actor in the chain who then doesn't need to manually enter it again.

One problem between the consignor and the truck driver is the language barrier. This problem can be eliminated by demanding and stipulating in the ADR regulation that truck drivers that transport DG must be able to communicate with the actors he has direct contact with. This question should be discussed by the organizations that are responsible for the regulations.

8. Future Research

The authors have found two areas that are interesting for future research.

- *Improved harmonization among rules and regulation*
- *Improved controls*

8.1. Improved Harmonization among Rules and Regulations

The fact that rules and regulations are based on different competent authorities and therefore are hard to change makes it an interesting and challenging area to study. A future research should include process mapping how current competent organizations work and also collaborate with one another, both domestically and internationally. It would also be interesting to further investigate the necessity for organization changes. Particularly it would be interesting to see how IMO collaborates with the responsible organizations for ADR and RID. Since all results from this thesis points out the fact that there is a clear sub-optimization among the organizations. The future research should also aim to improve the collaboration among the organizations. This study should be suitable for students that have a background in business laws and organization.

8.2. Improved Controls

The controls, both concerning road and sea are today seen as efficient but not frequent enough. Based on the problems the authors found in this thesis a future research could include analyzing how the police and coast guard work to control DG transports. The research could include how the controlling authorities should collect and use data and statistics about DG transports to better utilize available resources. I.e. if they have available information about all actors that handles DG and can see which actors that don't follow the rules and regulations. If they have this information they can better prioritize whom and where to control. Strategic plans for control are also needed as well as further collaboration. Suitable background for students concerning this study depends on which focus area the study will have. If it focuses on how the processes should be formed to be as efficient as possible a logistics background is preferred, but if the focus is on finding a technical solutions for handling the data an engineer background would be better.

References

Literature

Bichou, K. Bell, M. & Evans, A. (2007) *Risk Management in Port Operations, Logistics and Supply Chain Security*, London: Informa Business.

Björnland, D. Persson, G. Virum, H. (2003) *Logistik för konkurrenskraft*, Lund: Wallin & Dahlholm Boktryckeri AB
ISBN: 91-47-06491-9

Bryman, A. Bell, E. (2003) *Business Research Methods*, Oxford university Press: Oxford UK.

Coulson-Thomas, C. (Ed.) (1995) *The Responsive Organization. Re-engineering New Patterns of Work*, London: Policy Publication

ECMT, (1998), *Terminology on Combined Transport*, European Conference of Ministers of Transport, Paris, France, p. 21

Ejvegård, R. (2003), *Vetenskaplig metod* Lund: Studentlitteratur
ISBN: 91-44-02763-X

Ellis, J. (2002) *Risks in dangerous goods transport an analysis of risk in road rail and marine transport*, Gothenburg, Sweden, Department of Transportation and Logistics Chalmers University of Technology.

Hartman, J. (1998), *Vetenskapligt tänkande Från kunskapsteori till metodteori* Lund: Studentlitteratur
ISBN: 91-44-00318-8

Janic, M. (2007) *Modelling the full costs of an intermodal and road freight transport network*, Transportation research Part D- Transport and Environment, Vol. 12 Issue 1, p33-44.

Kettinger, W.J. Teng, J.T.C. and Guha, S. (1997) *Business process change: a study of methodologies, techniques, and tools*, MIS Quarterly, March, pp. 55-80.

Lumsden K., (1998) *Fundamentals of logistics*, 2nd edition, Lund: Studentlitteratur

MacHaris, C. Van Mierlo, J. Van Den Bossche, P. (2007) *Combining intermodal Transport With Electric Vehicles: Towards More Sustainable Solutions*, Transportation Planning and Technology, Apr2007, Vol. 30 Issue 2/3, p311-323.

Mattsson, S-A. Jonsson, P. (2005) *Logistik: Läran om effektiva materialflöden* Lund: Studentlitteratur
ISBN: 91-44-04182-9

Povey, B. (1998) *The development of a best practice business process improvement methodology*, Benchmarking for Quality Management & Technology, Vol. 5 No. 1 pp.27-44.

Rodrigue, JP. Comtois, C. & Slack, B. (2006), *The Geography of Transport Systems*, Routledge

Rondinelli, D. Berry, M. (2000), *Multimodal Transportation, Logistics, and the Environment: Managing Interactions in a Global Economy*, European Management Journal Vol. 18, No 4.

Simchi-Levi, D. Kaminsky, P. Simchi-Levi, E. (2008) *Designing and managing the supply chain*, New York: McGraw-Hill

Sixteenth OSCE Economic and Environmental Forum (2008) *Transport of dangerous goods* 19-21 May 2008 Prague, Czech Republic.

Szyliowicz, J.S. (2003), *Decision-making, intermodal transportation, and sustainable mobility: towards a new paradigm* Blackwell Publishing Ltd

Internet

ADR applicable as from 1 January 2009

http://www.unece.org/trans/danger/publi/adr/adr_e.html
2009-04-06

An Introduction to the IMDG code

www.imdgsupport.com/imdgintr.ppt
2009-03-26

Dangerous Goods Note Completion Guide

<http://www.sitpro.org.uk/trade/dangerous.html>
2009-05-10

Räddningsverket Dangerous goods

http://www.raddningsverket.se/templates/SRSA_Page_20935.aspx
2009-03-10

EIRAC, Strategic Intermodal Agenda for 2020, December 2005

http://www.eia-ngo.com/file/EIRAC_SIRA_Intermodal.pdf
2009-03-18

European Conference of Ministers of Transport (2001) *Terminology on combined transport*.

<http://www.internationaltransportforum.org/europe/ecmt/intermodal/pdf/termcomb.pdf>
2009-03-09

ICIS Chemical Business; 9/10/2007, p19-19, 1p

<http://web.ebscohost.com.ezproxy.ub.gu.se/bsi/detail?vid=1&hid=101&sid=a3676f24-56f6-4ebb-9acd-41d5b54ef397%40sessionmgr103>
2009-03-18

International Maritime Dangerous Goods (IMDG) Code

http://www.imo.org/Safety/mainframe.asp?topic_id=158
2009-04-03

Process mapping techniques and organizational analysis
Business Process Management Journal; Volume: 8; Issue: 1; 2002
www.emeraldinsight.com/10.1108/14637150210418629
2009-03-23

The Swedish Transport Agency Website
<http://www.transportstyrelsen.se/en/About-us/>
2009-05-12

UNECE 2009, the United Nations Economic Commission of Europe 2009) the UN Economic Commission for Europe and the Transport of Dangerous Goods (online)
<http://www.unece.org/trans/danger/what.htm>
2009-03-25

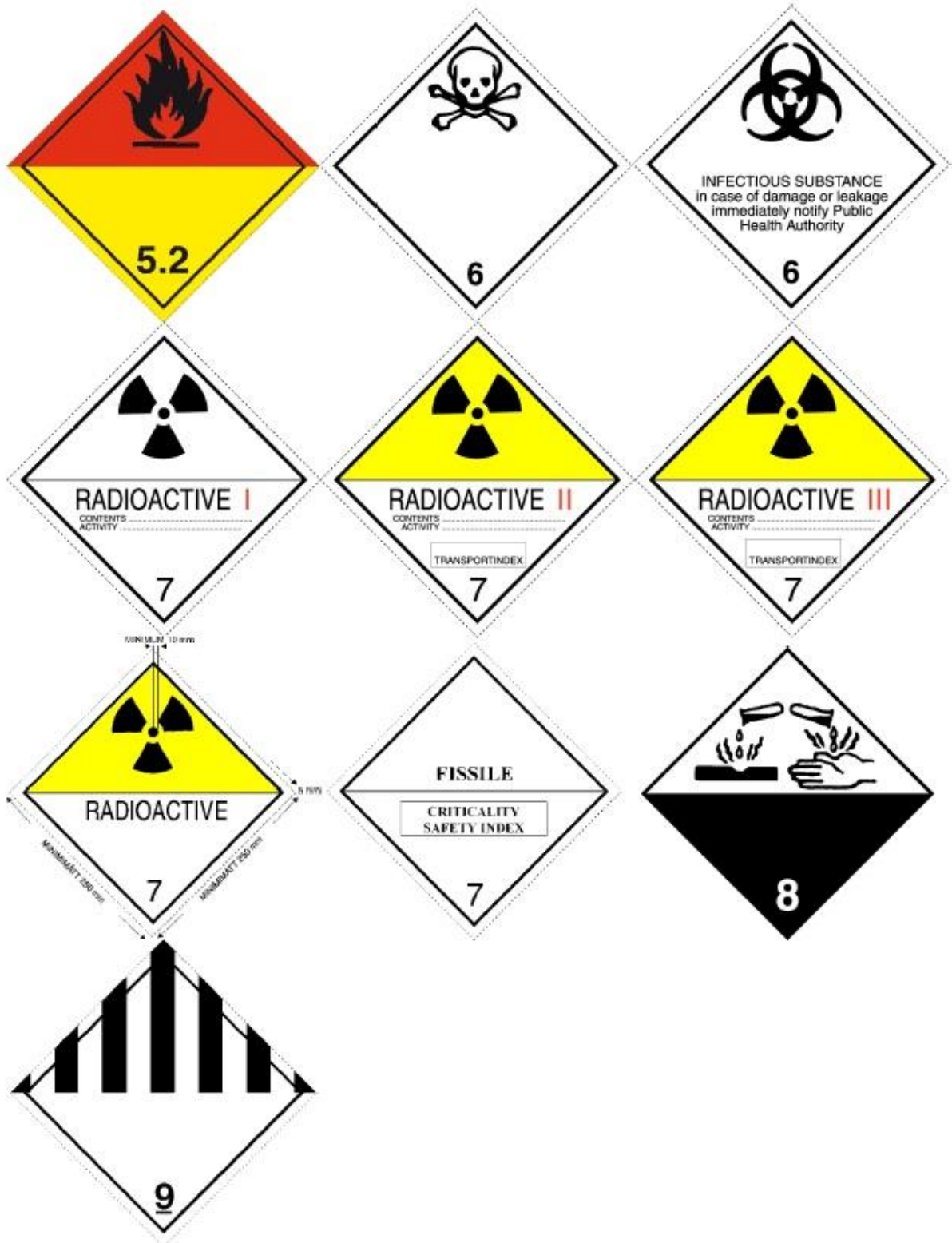
UNECE secretariat, Transport of dangerous goods - Sixteenth OSCE Economic and Environmental Forum 19-21 May 2008 Prague, Czech Republic
http://www.unece.org/trans/osce/osceunece/16th_OSCE_2008_Final.pdf
2009-03-25

Appendix A – Dangerous Goods Labels²¹⁶



²¹⁶ ADR 5.2.2.2.2

Appendix B – Dangerous Goods Labels²¹⁷



²¹⁷ ADR 5.2.2.2.2

Appendix C – Multimodal Dangerous Goods Form

This form may be used as a dangerous goods declaration as it meets the requirements of Solas 74, chapter VII, regulation 5; MARPOL 73/78, Annex III, regulation 4.

1 Shipper/Consignor/Sender Tel / Fax no: PTC:		2 BKG REF NO :		HAZ ACCETANCE NO :	
				4 Shipper's reference	
				5 Freight Forwarder's reference	
6 Consignee Tel / Fax no: PTC:		7 Carrier / Line :		SHIPPER'S DECLARATION I hereby declare that the contents of this consignment are fully and accurately described below by the proper shipping name, and are classified, packaged, marked and labelled/placarded and are in all respects in proper condition for transport according to the applicable international and national government regulations.	
8 This shipment is within the limitations prescribed for:		9 Additional handling information			
PASSENGER AND CARGO		CARGO ONLY			
10 Vessel and date		11 Port of loading			
12 Port of discharge		13 Destination			
14 Shipping Marks *Number and kind of packages; description of goods		Gross KGS	Net KGS	Cube(m3)	
COMM: PROPER SHIPPING NAME: CLASS: UNNO: FLASHPOINT: PACKING GROUP: IMDG: EMS: IIP CODE: NO OF PKGS: Marine Pollutant: Emergency contact / no: Container type:					
				Total cube (m3)	
Other Details					
15 Container identification no.		16 Seal number(s)		17 Container size & type & NO	18 Tare kg
					19 Total gross (incl. tare) (kg)
CONTAINER PACKING CERTIFICATE I hereby declare that the goods described above have been placed/loaded into the container/vehicle identified above in accordance with the applicable provisions. **MUST BE COMPLETED AND SIGNED FOR ALL CONTAINER/VEHICLE LOADS BY PERSON RESPONSIBLE FOR PACKING/LOADING		21 RECEIVING ORGANIZATION RECEIPT Received the above number of packages/containers/trailers in apparent good order and condition, unless stated hereon: RECEIVING ORGANIZATION RE-MARKS:			
20 Name of company		Haulier's name	22 Name of company (OF SHIPPER PREPARING THIS NOTE)		
Name/status of declarant		Vehicle reg no.	Name/status of declarant		
Place and date		Signature and date	Place and date		
Signature of declarant		DRIVER'S SIGNATURE	Signature of declarant		
* DANGEROUS GOODS You must specify proper shipping name, hazard class, UN No., Packaging group, (where assigned) Marine pollutant and observe the mandatory requirements, under applicable national and international governmental regulations. For the purpose of the IMDG Code see 5.4.1. ** For the purpose of the IMDG Code see 5.4.2.					

Appendix D – Instructions in Writing

INSTRUCTIONS IN WRITING

Actions in the event of an accident or emergency

In the event of an accident or emergency that may occur or arise during carriage, the members of the vehicle crew shall take the following actions where safe and practicable to do so:

- Apply the braking system, stop the engine and isolate the battery by activating the master switch where available;
- Avoid sources of ignition, in particular, do not smoke or switch on any electrical equipment;
- Inform the appropriate emergency services, giving as much information about the incident or accident and substances involved as possible;
- Put on the warning vest and place the self-standing warning signs as appropriate;
- Keep the transport documents readily available for responders on arrival;
- Do not walk into or touch spilled substances and avoid inhalation of fumes, smoke, dusts and vapours by staying up wind;
- Where appropriate and safe to do so, use the fire extinguishers to put out small/initial fires in tyres, brakes and engine compartments;
- Fires in load compartments shall not be tackled by members of the vehicle crew;
- Where appropriate and safe to do so, use on-board equipment to prevent leakages into the aquatic environment or the sewage system and to contain spillages;
- Move away from the vicinity of the accident or emergency, advise other persons to move away and follow the advice of the emergency services;
- Remove any contaminated clothing and used contaminated protective equipment and dispose of it safely.

Additional guidance to members of the vehicle crew on the hazard characteristics of dangerous goods by class and on actions subject to prevailing circumstances is also included but not shown in this thesis.

Appendix E – Instructions in Writing

Equipment for personal and general protection to carry out general actions and hazard specific emergency actions to be carried on board the vehicle in accordance with section 8.1.5 of ADR

The following equipment shall be carried on board the transport unit for all danger label numbers:

- for each vehicle, a wheel chock of a size suited to the maximum mass of the vehicle and to the diameter of the wheel;
- two self-standing warning signs;
- eye rinsing liquid (a) ; and

for each member of the vehicle crew

- a warning vest (e.g. as described in the EN 471 standard);
- portable lighting apparatus;
- a pair of protective gloves; and
- eye protection (e.g. protective goggles).

Additional equipment required for certain classes:

- an emergency escape mask (b) for each member of the vehicle crew shall be carried on board the vehicle for danger label numbers 2.3 or 6.1;
- a shovel^c;
- a drain seal^c;
- a collecting container made of plastics (c).

(a) Not required for danger label numbers 1, 1.4, 1.5, 1.6, 2.1, 2.2 and 2.3.

(b) For example an emergency escape mask with a combined gas/dust filter of the A1B1E1K1-P1 or A2B2E2K2-P2 type which is similar to that described in the EN 141 standard.

(c) Only required for danger label numbers 3, 4.1, 4.3, 8 and 9.

Appendix F – IMDG Segregation Table

CLASS DESCRIPTION	CLASS	1.1 1.2 1.5	1.3 1.6	1.4	2.1	2.2	2.3	3	4.1	4.2	4.3	5.1	5.2	6.1	6.2	7	8	9
EXPLOSIVES	1.1 1.2 1.3	*	*	*	4	2	2	4	4	4	4	4	4	2	4	2	4	X
EXPLOSIVES	1.3 1.6	*	*	*	4	2	2	4	3	3	4	4	4	2	4	2	2	X
EXPLOSIVES	1.4	*	*	*	2	1	1	2	2	2	2	2	2	X	4	2	2	X
FLAMMABLE GASES	2.1	4	4	2	X	X	X	2	1	2	X	2	2	X	4	2	1	X
NON-TOXIC, NON-FLAMMABLE GASES	2.2	2	2	1	X	X	X	1	X	1	X	X	1	X	2	1	X	X
TOXIC GASES	2.3	2	2	1	X	X	X	2	X	2	X	X	2	X	2	1	X	X
FLAMMABLE LIQUIDS	3	4	4	2	2	1	2	X	X	2	1	2	2	X	3	2	X	X
FLAMMABLE SOLIDS	4.1	4	3	2	1	X	X	X	X	1	X	1	2	X	3	2	1	X
SUBSTANCES LIABLE TO SPONTANEOUS COMBUSTION	4.2	4	3	2	2	1	2	2	1	X	1	2	2	1	3	2	1	X
SUBSTANCES, WHICH, IN CONTACT WITH WATER, EMIT FLAMMABLE GASES	4.3	4	4	2	X	X	X	1	X	1	X	2	2	X	2	2	1	X
OXIDIZING SUBSTANCES	5.1	4	4	2	2	X	X	2	1	2	2	X	2	1	3	1	2	X
ORGANIC PEROXIDES	5.2	4	4	2	2	1	2	2	2	2	2	2	X	1	3	2	2	X
TOXIC SUBSTANCES	6.1	2	2	X	X	X	X	X	X	1	X	1	1	X	1	X	X	X
INFECTIOUS SUBSTANCES	6.2	4	4	4	4	2	2	3	3	3	2	3	3	1	X	3	3	X
RADIOACTIVE MATERIAL	7	2	2	2	2	1	1	2	2	2	2	1	2	X	3	X	2	X
CORROSIVE SUBSTANCES	8	4	2	2	1	X	X	X	1	1	1	2	2	X	3	2	X	X
MISCELLANEOUS DANGEROUS SUBSTANCES & ARTICLES	9	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 18 IMDG Segregation Table

Appendix G – IMDG Segregation Table (explanations)

* = Refer to special provisions for Explosives (Clause 7.2.7.2 of the IMDG Code)

X = No segregation required except if specifically indicated in the Dangerous Goods List

1 = AWAY FROM :

Effectively segregated so that the incompatible goods cannot interact dangerously in the event of an accident but may be transported in the same compartment or hold or on deck , provided a minimum horizontal separation of 3 metres , projected vertically is obtained

2 = SEPARATED FROM :

In different compartments or holds when stowed under deck. Provided the intervening deck is resistant to fire and liquid , a vertical separation , i.e. in different compartments , may be accepted as equivalent to this segregation. For “ on deck ” stowage , this segregation means a separation by a distance of at least 6 metres horizontally

3 = SEPERATED BY A COMPLETE COMPARTMENT OR HOLD FROM :

Either a vertical or a horizontal separation. If the intervening decks are not resistant to fire and liquid, then only a longitudinal separation , i.e. by an intervening complete compartment or hold , is acceptable. For “ on deck ” stowage , this segregation means a separation by a distance of at least 12 metres horizontally. The same distance has to be applied if one package is stowed “ on deck “ , and the other one in an upper compartment

4 = SEPERATED LONGITUDINALLY BY AN INTERVENING COMPLETE COMPARTMENT OR HOLD FROM :

Vertical separation alone does not meet this requirement. Between a package “ under deck “ and one “ on deck “ a minimum distance of 24 metres, including a complete compartment, must be maintained longitudinally. For “ on deck “ stowage , this segregation means a separation by a distance of at least 24 metres longitudinally.

Appendix H – ADR Segregation Table

Label Nos.	1	1.4	1.5	1.6	2.1 2.2 2.3	3	4.1	4.1 + 1	4.2	4.3	5.1	5.2	5.2 + 1	6.1	6.2	7 A,B C	8	9			
1	See 7.5.2.2 (separate table Page 503)										d							b			
1.4					a	a	a		a	a	a	a		a	a	a	a	a	a	a	a b c
1.5																					b
1.6																					b
2.1, 2.2, 2.3		a			X	X	X		X	X	X	X		X	X	X	X	X			
3		a			X	X	X		X	X	X	X		X	X	X	X	X			
4.1		a			X	X	X		X	X	X	X		X	X	X	X	X			
4.1 + 1								X													
4.2		a			X	X	X		X	X	X	X		X	X	X	X	X			
4.3		a			X	X	X		X	X	X	X		X	X	X	X	X			
5.1	d	a			X	X	X		X	X	X	X		X	X	X	X	X			
5.2		a			X	X	X		X	X	X	X		X	X	X	X	X			
5.2 + 1													X								
6.1		a			X	X	X		X	X	X	X		X	X	X	X	X			
6.2		a			X	X	X		X	X	X	X		X	X	X	X	X			
7 A, B, C		a			X	X	X		X	X	X	X		X	X	X	X	X			
8		a			X	X	X		X	X	X	X		X	X	X	X	X			
9	b	a b c	b	b	X	X	X		X	X	X	X		X	X	X	X	X			

Table 19 ADR Segregation Table²¹⁸

²¹⁸ ADR

Appendix I – ADR Segregation Table (explanations)

X= Mixed loading permitted

a= Mixed loading permitted with 1.4S substances & articles

b= Mixed loading permitted between goods of Class 1 and life-saving appliances of Class 9 (UN Nos. 2990, 3072 and 3268)

c= Mixed loading permitted between air bag inflators, or air bag modules, or seat-belt pretensioners of Division 1.4, compatibility group G, (UN 0503) and air bag inflators or air nag modules or seat-belt pretensioners of Class 9 (UN 3268)

d= Mixed loading permitted between blasting explosives (except UN 0083 explosive, blasting, type C) and ammonium nitrate and inorganic nitrates of Class 5.1 (UN 1942 and 2067) provided the aggregate is treated as blasting explosives under Class 1 for the purposes of Placarding, segregation, stowage and maximum permissible load.

Appendix J – Questions to Forwarders/Haulers/Rail Companies

Background Information/Knowledge

1. What is your job/position/responsibility?
2. In which transport units do you transport DG? Do you transport dangerous goods within Europe? Which class are they and which class is most frequently transported?
3. Do any DG class need special attention when transporting or handling? Explain!
4. Which DG class incurs the highest risks during transporting or handling?

Transport flow and contracted responsibilities

5. What is your company's contracted responsibility and roles in the transport chain?
6. Can you describe one general flow of dangerous goods transportation from the point that you received the cargo from customer to the end of delivery to the end customer? (International delivery but within Europe) How to decide the different responsibilities between different actors? How do the responsibilities move between different actors?
7. What are the common problems in the whole transport chain?
8. Do you know any DG accidents or problems during transportation or at the transport nodes, any problems concerning the documentation flow?
9. What are the most common reasons for delays? Anything DG specific?

Rules and Regulations

10. How do you identify which rules to apply on multi modal transport of DG? Does your company's import and export always follow the same rules?
11. What is the point for harmonization? What do you think of the harmonization between ADR and IMDG; could you please give some detail?
12. What is your opinion concerning existing rules and regulations' contribution to safety and efficiency? Are they good enough? Any improvements suggestions?
13. Could you think of any problems concerning current rules and regulations?
14. What are the difference between IMDG and ISPS? the cost of ISPS? Overlaps?
15. Are there any confusions concerning old and new regulations during the adaptation period(half year) are the new one difficult to adapt?
16. In Baltic Sea area, how to decide which rules to apply?
17. Concerning other regulations, have you heard of Alltrans 2007, does that also apply to international multi modal transport within Europe or just in Sweden?
18. Are there any other regulations to make it clear among the actors and activities apart from the IMDG, ADR and RID? Or concerning secure loading and unloading etc.
19. Contact information? (producing company/ shipping company)
20. How often do you have DG training/education and what kind of training? Is the training good/efficient? Improvement suggestion?

Appendix K – Questions to Shipping Companies

Background Information/Knowledge

1. What is your job/position/responsibility?
2. In which transport units do you transport DG? Do you transport dangerous goods within Europe? Which class are they and which class is most frequently transported?
3. Do any DG class need special attention when transporting or handling?
4. Which DG class incurs the highest risks during transporting or handling?

Transport flow and contracted responsibilities

5. What is your company's contracted responsibility and roles in the transport chain?
6. Can you describe one general flow of dangerous goods transportation from the point that you received the cargo from customer to the end of delivery to the end customer? (International delivery but within Europe) How to decide the different responsibilities between different actors? How do the responsibilities move between different actors? Do any DG documents replace any ordinary transport documents?
7. What are the common problems in the whole transport chain?
8. Do you know any DG accidents or problems during transportation or at the transport nodes, any problems concerning the documentation flow?
9. When and how are the dangerous goods controlled during the transport and by which agency?
10. What are the most common reasons for delays? Anything DG specific?

Rules and Regulations

11. Which rules to apply on combined road rail transport of dangerous goods? does your company's import and export follow the same rules?
12. What do you think of the harmonization between ADR, RID and IMDG?
13. What is your opinion concerning existing rules and regulations' contribution to safety and efficiency? Are they good enough? Any improvements suggestions?
14. Could you think of any problems concerning current rules and regulations?
15. Does the ISPS regulation affect your company?
16. Are there any confusions concerning old and new regulations during the adaptation period(half year) are the new one difficult to adapt?
17. In Baltic Sea area, how to decide which rules to apply coz there are Baltic Sea Agreement, ADR and IMDG. Could that be a problem?
18. Which rules do you use to identify actors' responsibilities? Does that also apply to international intermodal transports within Europe or just in Sweden?
19. How often do you have DG training/education and what kind of training? Is the training good/efficient? Improvement suggestion?
20. Contact information? (producing company/ shipping company/port)

Appendix L – Questions to Safety Advisors

Background information

1. What is your job/position/responsibility?
2. In what transport units can DG be transported in?
3. How many types of trailers are used to transport DG?
4. Which class of DG is transported most commonly in Europe?
5. Do any DG class need special attention when transporting or handling?
6. Which DG class incurs the highest risks during transporting or handling?

Rules and regulations

7. How do the regulations differ among European countries, and how does this affect international transports of DG in Europe? E.g. In Sweden we have ADR-S for road.
8. What is your opinion concerning existing rules and regulations' contribution to safety and efficiency? Are they good enough? Any improvements suggestions?
9. How do you identify which rules to apply on each transport task and at the transport nodes where two modes connect? Are they clear enough?
10. Which regulations are used, when, and why?
11. What problems exist today concerning regulations?
12. How can these problems be dealt with?
13. Do the regulations affect the efficiency of the transport? How?
14. Do you have any improvement suggestions? Concerning both your own company, and other actors in the transport chain? Cost for these improvements? Who should be responsible for these improvements?

Flows

15. Can you describe a general flow of dangerous goods transportation? (Concerning International transport within Europe. The actors, activities, and transport nodes/terminal involved. Both sequence of information flow, and physical flow)
16. What activities are there in the transport nodes? How to decide the different responsibilities between different actors? How do the responsibilities move between different actors? Are they clear enough, have they ever confused you?

Contact Information

17. Have you any contacts to DG producers, logistics companies, other?

Appendix M – Questions to the Port of Gothenburg

Background Information

1. What is your job/position/responsibility?
2. Which class of DG is transported most commonly through the port of Gothenburg/within Europe?
3. Do any DG class need special attention when handling? Can you explain in detail?
4. Which DG class incurs the highest risks during transporting or handling?

Flow at the port

5. Can you describe the actors and activities involved at the port from the DG arrives at the port to DG leaves the port? Including the information and physical flow.
6. How to decide the different responsibilities between different actors?
7. How does the responsibility move between different actors? Is it clear enough, have this ever confused you? Do you have any idea on how to improve those situations?

Rules and regulations

8. Which rules to apply at the port? IMDG/ISPS/others. Why?
9. What is your opinion concerning existing rules and regulations' contribution to safety and efficiency? Are they good enough? Any improvements suggestions?
10. How do you identify which rules to apply at the port where two modes connect? ADR/RID/IMDG/other Are they clear enough? Have you ever had some confusion about that? What kinds of problems have been generated by the confusion of which rules to apply?
11. Does overlapping/missing of regulations and responsibilities occur? Is it a problem? Is this a common situation? And how do you handle it? Do you have any idea on how to improve those situations? Who should be responsible for these improvements?
12. How often do you have DG training/education and what kind of training?
13. Is the training good/efficient? Improvement suggestion?
14. Any known incidents or accidents involving or caused by DG?
15. Do costumers ever forget to declare dangerous goods? Intentionally?
16. How many trailers on a yearly basis pass through the port with DG? More statistics?

Appendix N – Questions to the Swedish Transport Agency

Control situation and Problems

1. How is the dangerous goods transport controlled in case of intermodal transport?
2. What is the role of the Swedish transport agency? What are the major activities of the agency?
3. Who authorized the Swedish Transport Agency for the controlling of dangerous goods? Are the Checking/controlling procedures decided by rules and regulations or others? Please explain
4. How much dangerous goods are transported annually? (statistics) Background information: (The Swedish maritime administration has notification of incoming DG into their system “FRS Fartygs Rapporteringssystem”. All ships transporting DG must report to this system.)
5. How often do you check dangerous goods? And what do you check? (content) and do you contact the terminal persons when checking?(who?) or do you cooperate with the terminal persons?
6. How many times do you check per year in the last six years? Have you any statistics?
7. What do you think of the effectiveness of the control and check? What about the frequency is that enough? How to further improve the effectiveness of the control?
8. Do you cooperate with other agency such as police and the coastguard to control? Is the coordination among each other effective and efficient?
9. What are the major problems that you identified when checking?
And how do you and the transport company deal with this?
When you found the problems, is that clear enough who should be responsible for this?
What are the reasons of these problems? Lack of education? Disobey? Have you any statistics?)
10. Based on the problems that you identified in the transport nodes, How to improve the efficiency and security of the transport chain?
11. Do you think it would be a good idea to start to control dangerous goods transports at the sender?

Rules and Regulations

12. How are current rules and regulations followed? Do you have any statistics about actors that disobey the rules and regulations?
13. What is your opinion concerning existing rules and regulations' contribution to safety and efficiency? Are they good enough? Any improvements suggestions?
14. How do you identify which rules to apply on intermodal transport of DG?
15. What is the point for harmonization? What do you think of the harmonization between ADR and IMDG; could you please give some detail?
16. Could you think of any problems concerning current rules and regulations?
17. Are there any confusion concerning old and new regulations during the adaptation period (half year)? Are the new ones difficult to adapt?
18. How often do you have DG training/education and what kind of training?
19. Is the training good/efficient? Improvement suggestion.
20. How do you control the DG import/export? Is it effective?