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SCHOOL OF BUSINESS, ECONOMICS AND LAW

Master Degree Project in Logistics and Transport Management

# Managing dangerous goods in reverse logistics

*Addressing the challenges of transporting parcels of dangerous  
goods in the reverse flow*

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## Abstract

With the meteoric rise of e-commerce, shipments of products containing dangerous goods is extensively increasing. This, along with the easement of return policies that has developed, customers have consequently gained a habit of returning goods more frequently, which puts substantial pressure on the reverse logistics. Due to the inherent capabilities of dangerous goods, it is hard to escape the challenges that follows when dealing with it, especially from a sender with no previous knowledge of dangerous goods. Previous scholars have researched the area of reverse logistics, and transport of dangerous goods, but a gap exist where the two intertwine. The purpose of this thesis was to investigate what challenges exist in the transportation flow of parcels containing dangerous goods in reverse logistics on road, and how these challenges could be addressed. The thesis took on a interpretivist philosophy with a qualitative research method to carry out semi structured interviews, which contributed to important empirical findings from safety advisors, carriers and experts on dangerous goods. Though strict regulations exist concerning transport of dangerous goods on road, challenges have been identified in large extent in concerns to “hidden dangerous goods”, where the sender is simply not aware of correct procedures. In relation to this, challenges that have been identified concern conflicts of interpretation, lack of education and knowledge, problems at pick-up-points, the establishment of new e-commerce retailers and the catch 22 of the private individual. The outcome of the analysis is presented in a desired transportation flow of dangerous goods on road. Lastly, suggestions on how to address and improve the challenges existing in the current reverse flow of parcels containing dangerous goods is provided.

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*Gothenburg, May 27, 2018*

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### ***List of abbreviations***

**ADR** - The European Agreement concerning the international carriage of dangerous goods by Road

**DGR** - Dangerous Goods Regulations for transport of dangerous goods by air.

**LQ** - Referred to the limited quantities: Exempted Quantity, Limited Quantity or Small load exemptions.

**MSB** - Swedish Civil Contingencies Agency

**UNECE** - The United Nations Economic Commission for Europe

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### ***Definitions of this thesis***

*Parcel*, in this thesis, is defined as an object or multiple objects which is wrapped or packaged so it easily can be sent by mail eg. in a box.

*Reverse logistics*, in this thesis, is defined as the return flow of goods to the selling company from where the goods was first ordered. The selling company, and therefore the consignee of a reverse flow, in this thesis is the e-commerce retailer.

*Dangerous goods*, in this thesis, is defined as goods categorized within one of the nine classifications of dangerous goods set by the United Nations.

*Carrier*, in this thesis, is defined as a transport operator company that carries out the transport of the good.

*E-commerce*, in this thesis, is defined as the sale of physical goods from an online store, sent via mail order and delivered to customer.

*Transport flow*, in this thesis, is defined as all the activities involved in the transportation, from which a parcel is being sent from the shipper, until it has reached the end receiver.



# 1.Introduction

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*This chapter will give an introduction into the thesis by providing a general background and description of the challenge area, its purpose and the research question. This is followed by an overview of this thesis structure and delimitations.*

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## 1.1 General background

The international sale of goods is continuously increasing in both value and numbers. This phenomenon is moving forward in correlation to the meteoric rise of e-commerce, technological innovation and globalization. (White paper, 2017) In recent years, the upward trend of consumption online is showing no sign of stopping. In 2016, electronic commerce (e-commerce) in retail has had sales worldwide reaching up to approximately 1.9 trillion US dollars with an expectancy to grow fourfold until 2021 (Statista, 2017). In the European market, PostNord AB (2016) reported that the number of consumers regularly shop online is also growing. The report, including 12 European countries, shows that consumption in e-commerce increased from 2013 to the year after by 9 million euros, amounting to 189 billion euros solely for physical products purchased over the internet (ibid.). This indicates that online shopping is one of the most popular online activities worldwide and since the trend is continuously growing, so is also the transport of the physical goods (Statista, 2017).

With the effects of an increased online consumption comes also its natural companion, namely returns, which in this thesis is referred to as reverse logistics. Reverse logistics is *“The process of planning, implementing, and controlling the efficient, effective inbound flow, inspection and disposition of returned products and related information for the purpose of recovering value.”* (Srivastava & Srivastava, 2006. p 530) This increase is due to both the ease today of returning an item purchased online and many companies offering returns free of charge, as well as a higher awareness of reducing the impact on the environment by increased recycling (Edman & Marklinder, 2015). Aronsson & Huge Brodin (2006) are stating that when the flow of goods is being studied, the focus tends to be on the forward flow of goods, rather than on the return flow of goods which occasionally gets overlooked. Therefore, there are great potential of improvement for return efficiency concerning time, cost, flexibility and environmental impacts in the return flow, and the perspectives intertwine where one contributes to the other (Yoon & Le 2013).

According to Nielsen (2018), it can be identified that with the increased e-commerce there is a whole new group of senders who do not have the education nor knowledge that is needed for another increasing trend, namely transport of dangerous goods. This, not just in the traditional forward logistics, but in reverse logistics as well. Apart from the customers of for instance oils, explosives and very obvious articles that is classified as dangerous goods, many common

articles are containing dangerous goods which easily can be mistaken for 'regular goods', for instance the very popular online purchase; computers, or even beauty products, goods most often shipped in parcels. Therefore, an increased need for thorough dangerous goods management and regulations has emerged.

The transport of dangerous goods is showing a steady increase in Europe, for all means of transport, but especially when being transported on road. A dominant share of 84 % of all goods transported in Sweden, are done so on road, and when focusing on dangerous goods, Sweden has had an increase from 1 251 million tonne-kilometers to 1 794 million tonne-kilometers from the year 2012 to 2016, indicating a 43% increase. (Trafikanalys,2017; Eurostat, 2017). With this in mind, road transport is also the main transport mode capable of moving parcels directly from supplier to customer, and vice versa (Vu & Åstrand, 2012).

With this steady increase in e-commerce, spread of reverse logistics, and road freight transport being a dominant transport mode in Sweden of dangerous goods, this paper finds it highly interesting to investigate the challenges existing in the transport flow of parcels containing dangerous goods, in the context of reverse logistics on road.

## 1.2 Problem description and problem analysis

Due to the inherent capabilities of dangerous goods, it is hard to escape the challenges that follows when dealing with it. Today, carefully planned regulations exist for the handling and transport of dangerous goods. In all modes of transport there are clear rules for handling, transporting, packaging, labelling, etc. Carriers and forwarders are aware of the importance that these rules are followed. When transporting dangerous goods, an accident may have devastating consequences, which affects both the environment and society worse than an accident involving non-dangerous goods. This is one of the important reasons why safety and efficiency are highly prioritized concerning transport of dangerous goods and that all actors involved are aware of these consequences, in order to prevent accidents.

However, statistics of transport flows most often show the transport of dangerous goods from manufacturing shipper to customer. In this line of transportation, the shipper who is used to and fully aware of protocol and processes concerning every aspect of a specific dangerous good is able to follow procedure of packing, labelling etc, before passing the parcel onto the carrier, who is prepared for receiving a dangerous good and can act accordingly. What about once this dangerous good, eg. a computer containing lithium batteries and therefore are classified as dangerous goods, is sent to be returned from the end customer for some reason? Is there sufficient knowledge on how the return process is to be correctly handled, and how to follow the regulations? The likelihood that goods are sent as "hidden dangerous goods" is very high in the context of returns, and therefore a high risk of accidents. (Nielsen, 2018) This becomes a catch-22: *"customers are not required to be trained, but they still have to follow the rules. How are they supposed to follow the rules without any training?"* (Pagel, 2016). Here appears a new challenge that is overlooked in the very careful handling of dangerous goods sent by

parcel, namely, that “regular” people who will send dangerous goods in return do not have the ability or education to handle it properly.

## 1.3 Purpose

Even though regulations for different transport modes today are harmonized in great extent, and the regulation for road transport (for ADR, see 4.2) is structured in a strict and detailed way, there are still areas and challenges that needs improvement. The purpose of this thesis is to investigate challenges that arise in dealing with parcels containing dangerous goods in the transport flow of reverse logistics on road. This, because regulations and the procedure of handling, packing, labeling etc. of dangerous goods in general, has an established process with the knowledgeable shippers, but may be lacking with the customers who send goods in return. In addition, the aim is also to find ways to improve security and efficiency and therefore address these challenging aspects. Based on this, and the previously mentioned high and steady increase of consumption online, the authors find it highly interesting to investigate the handling of parcels transported via road with the following research question:

### 1.3.1 Research question

***What challenges exist in the transportation flow of parcels containing dangerous goods in reverse logistics on road, and how can these challenges be addressed?***

To answer our main research question, several sub questions is also established to guide the way to through the thesis chapters, to reach the purpose of answering the main research question:

- What does the current transport flow of parcels containing dangerous goods in reverse logistics look like on road?
- What challenges can be identified concerning rules and regulations (ADR) in Sweden in the context of reverse logistics?
- To reach a desired flow, what major conditions and implementation barriers are there?

## 1.4 Thesis structure

The research in this thesis concerns the reversed transport flow of parcels containing dangerous goods. To structure the thesis, a number of subchapters has been established, guiding the reader through the thesis. The first chapter is the Introduction, which introduces the reader to the topic, problem and research question. This is followed by the Methodology, that in detail explains the approach the authors took to carry out this thesis to answer the research question.

The research focus for this thesis was divided into four subdivisions. For *general content and theory*, this was approached by a literature study and placed in a chapter named Theoretical Framework, collecting the theoretical background and definitions of themes used in the thesis.

The *second* subdivision is the rules and regulations which is applied to the handling of dangerous goods in reverse logistics. This, as dangerous goods today are closely tied to regulations, and many might experience challenges in the handling of dangerous goods to be caused by the enforced rules. Due this, the rules and regulations have been given its own chapter in the theoretical framework - Rules and Regulations - as well as a sub heading in the empirical findings and analysis.

The *third* subdivision of this thesis is the challenges in the reverse transport flow, and the actual handling of parcels of dangerous goods in the reverse physical flow. As the two concepts of Dangerous goods and Reverse logistics are explored, they are treated under separate headings in the empirical findings and analysis. This considering that dangerous goods could be sent without the knowledge of the carriers, the authors therefore initially review particularly the handling of dangerous goods in the transport flows. This to acquire a sense of what type of good might fall under the radar when sending parcels. The review of the reverse transport flow is initially taking into consideration the reverse transport flow of non-dangerous goods. This to paint a clear picture of how parcels are normally handled, and where the hidden dangerous goods might cause challenges. Following this, the two concepts are subsequently connected and further discussed as challenges are reviewed on parcels of dangerous goods in the reverse flow. These two latter subdivisions are approached by conducting literature studies, but mainly by empirical findings through interviews.

The *fourth* subdivisions are the improvements and suggestions, to answer the second part of the main research question, which is approached through the analysis. The expected outcome of this thesis is to answer the research question, and to pinpoint existing challenges in the current transport flow of handling parcels containing dangerous goods on road in reverse logistics and suggest possible improvements to address these challenges.

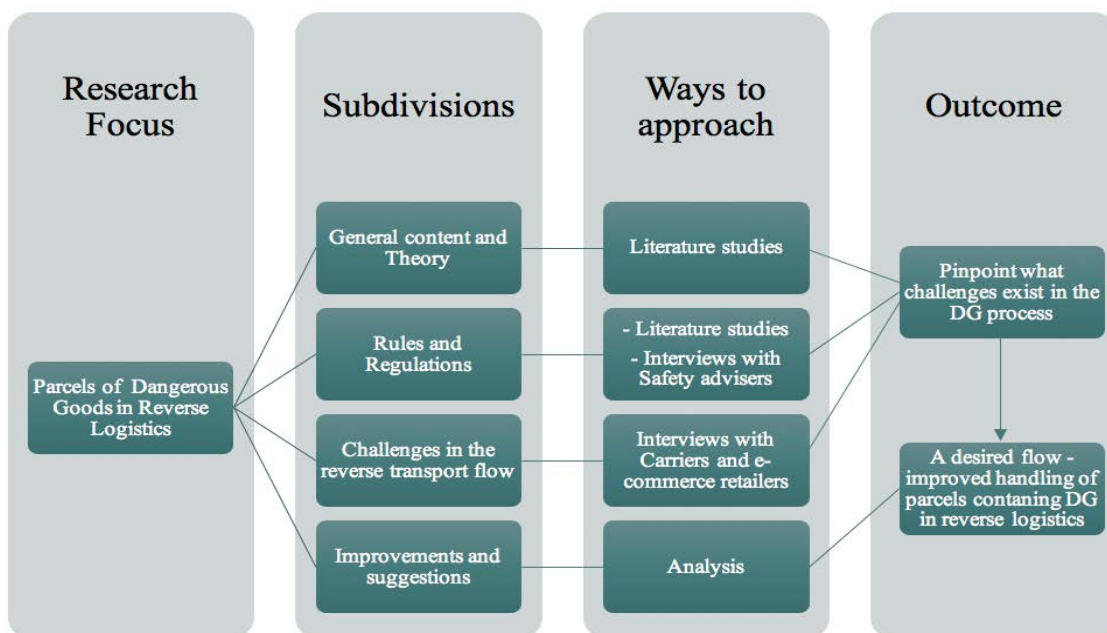


Figure 1. Thesis Structure

## 1.5 Scope and delimitations

As one focus lies on reverse logistics, defined as the return flow of goods to the e-commerce retailer, the product returns to physical stores will not be taken into consideration. The thesis will review the return of parcels, and not general cargo, unpacked cargo, bulk, tank or container. Focus of the thesis will also fall on the legislation of ADR/ADR-S - addressing road transport flows, not taking into consideration any particulars of other transport modes than road. This because of a limited time frame. All this is considered within the national geographic of Sweden. Since limitations are set to Sweden, road was highly applicable as the authors did not wish to further investigate imports/exports, that for instance occurs mostly by Air and Ocean. This also due to the limited time frame. Road was chosen over Rail due to a larger pool of selection of leading transport operators in Sweden.

A reverse transport flow of parcels containing dangerous goods is reviewed, even though it is difficult to determine an accurate statistical number of transported dangerous goods in reverse logistics. The thesis also put focus on larger operators within transportation and e-commerce for the data collection. As the larger operators have similar characteristics, the authors will avoid skewness in data, of for instance a local carrier only operating in a small town, with limited flows and experiences. The larger carriers operate on a national scale, increasing the ability to generalize the findings in the thesis, as well as increasing the likelihood of reaching knowledgeable and experienced respondents.

As we define reverse logistics as the transport flow returning to the e-commerce retailer, focus lies on the e-commerce retailer as a natural consignee of the reverse transport flow. This, since majority of parcels sent in return is ordered from an online store. Though the e-commerce retailer is at the receiving end of a reverse product flow, both the e-commerce retailer and a customer could be referred to as a sender; e-commerce retailer in the forwards transport flow, and customer as the sender in the reverse transport flow.

The thesis chooses to refrain from implementing cost estimates for eg. what a potential improvement could cost or costs for transport operators to invest in improvement suggestions. Environmental calculations are another factor that is not taken into account in this study. These factors are not within the time frame for this paper and the research question.

## 2. Methodology

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*The purpose of this chapter is to guide the reader through how data for this thesis was collected, handled and analyzed. The specifics of research philosophy, -purpose, -process, -approach is described, as well as a discussion of the research quality.*

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### 2.1 Research Philosophy

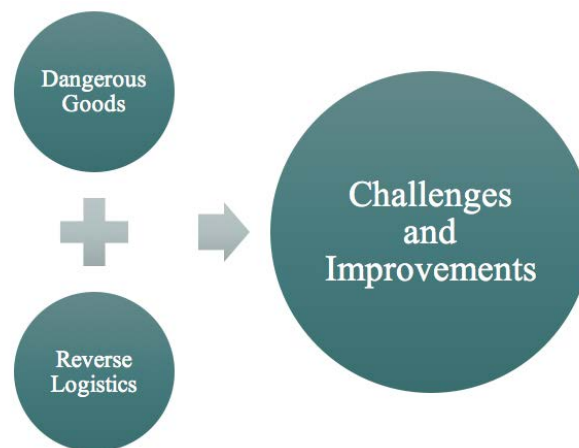
According to Collis & Hussey (2014), there are two main philosophies of research, interpretivism and positivism. Positivism intends to, despite the external impact of the researcher, to remain objective. Therefore, results must be verified mathematically, and each argument is presented with scientific reasoning, through quantitative methods. In contrast to positivism is interpretivism, a philosophy that arose from the criticism of positivists, which instead takes into account that social reality can be subjective. Thus, resulting in a study showing different results depending on the views and thoughts emerged from the researcher's opinion and influence. (ibid.) For the purpose of this thesis, an interpretivist philosophy is taken, a philosophy where qualitative methods are used, which according to Bryman & Bell (2013) is deemed appropriate to reach the deeper understanding of investigated context, something the authors aspired to achieve.

It is important when approaching research in an interpretivist philosophy to tread carefully and remain aware of the impact the researchers may have on the research (Wallen, 1996). With positivism the results will be considered unbiased, as results are verified by hard facts and indifferent by the opinions of researchers, whilst interpretivism could be believed to lead to biased results, as the research is not entirely independent of the researcher (Collis & Hussey, 2014)

### 2.2 Research Purpose

The purpose of research is different depending on what you wish to find. According to Collis & Hussey (2014) the purpose while performing research could be either; descriptive, predictive, analytical or exploratory. With a descriptive purpose, the aim is to describe the characteristics of a phenomena, answering “what” instead of “how” or “why”. Analytical, as well as predictive, is an extension of the descriptive purpose with the addition of also analyzing how the phenomena is occurring, respectively providing a forecast of current phenomena happening in the future. The exploratory approach aims instead to explore the phenomena where there are very few previous studies conducted concerning the issue at hand. (ibid.) Exploratory purpose is also used to further explore if there is a relation between two different concepts. Collis & Hussey (2014) also states that an exploratory is rather used, not for testing out a theory, but rather to create a new one.

This thesis approached two concepts, reverse logistics and dangerous goods, in which each concept contains a number of challenges to test if, how and why certain challenges occur in combination of the two. As there are limited previous research, especially in regard to online product returns of dangerous goods, this thesis took on an exploratory approach.



*Figure 2 - Combining dangerous goods and reverse logistics to find challenges and improvements.*

## 2.3 Research Approach

The reasoning of a study can primarily be designed in two ways, inductive and deductive. An inductive reasoning is based on the fact that the collection of data implemented is used as the basis for forming a theory and achieving a result. This, unlike a deductive study where the starting point consist of a theory leading to conclusions and testing of a stated theory. In addition to inductive and deductive studies there is the abductive reasoning, which is seen as a combination of the two formers. (Bryman & Bell, 2013) When the theory of the thesis research question was presented, part of the reasoning was deductive, since a gap in the research presented itself, and the authors needed to confirm that this gap represented a problem in real life. Furthermore, this thesis was also based on literature studies and data collection through interviews based on an inductive approach. With the use of both these approaches, this paper is considered abductive.

## 2.4 Research Process

Since an interpretivist philosophy was undertaken in this thesis, a qualitative research method was used to carry out the collection of data in order to investigate the respondents' experiences, thoughts and opinions about a particular phenomenon. (Bryman & Bell, 2013) In this thesis, the problematic appearance of dangerous goods in the concept of reverse logistics represent that phenomenon. Empirical findings extracted from a qualitative study are an important part of creating an understanding of the phenomenon being investigated, as well as making it possible for researchers to create a potential theory. (Patel & Davidson, 2011) An alternative

had been to carry out a quantitative study focusing on structure and allows increased representativeness together with the possibility of generalization. In addition to the questionnaire and the time frame for this thesis, a quantitative study was therefore not appropriate. Starting from a qualitative method provides a good prerequisite for being able to respond to respondents' opinions and thoughts about the phenomenon to provide a good basis for analysis and results. This would not have been possible to the extent of a quantitative study, since such a study had given direct answers to questions posed without the possibility of discussion.

## 2.5 Data collection

### 2.5.1 Secondary data - Literature studies

Initializing this thesis, literature studies were conducted to gain substantial knowledge in the subject, as well as acquire a sense of what is already known of the thesis question. The basis of the theoretical framework is background material from the reports from contingency agencies in Sweden, like The Transport Agency and MSB. In addition to these sources, a widespread search of scientific articles discovered through Google Scholar, Diva and the University of Gothenburg's databases have been used to build the theoretical reference framework. As one of the focuses in this thesis is ADR, which is the United Nations treaty on how to handle dangerous goods on road, this was also reviewed in great extent, and placed in a subchapter of its own (*see chapter 4 Rules and regulations*).

### 2.5.2 Primary data

#### 2.5.2.1 Semi Structured Interviews

There are separate ways to conduct an interview and the routine differs between quantitative and qualitative research. A quantitative study is based on clear and structured interviews to achieve high reliability and validity, such as a closed questionnaire or structured interview. A structured interview is characterized by clearly formulated questions and with the aim of obtaining direct answers to a given question. In qualitative research, an interview is more generally formulated to achieve flexibility in the answers and the aspiration is that respondents' own perceptions should be revealed, and not be so strongly linked to the original interview questions. There are mainly two types of qualitative interviews, structured and unstructured interviews. An unstructured interview is "free", i.e. the respondent is allowed to deviate from given interview questions, associate freely and the interview may be similar to a conversation, and the structured allows no room for deviation from the predetermined answer alternatives. A semi structured interview is instead a combination of the two, based on an interview guide with specific questions and topics. It gives permission to ask supplementary questions and speak freely around them based on the answers provided by the respondent. (Bryman & Bell, 2013) This thesis was based on a semi structured interview, giving the authors the opportunity to ask supplementary questions if an interesting or thought wakening answer is given. It also gave



respondents the opportunity to respond freely with own motivations, which contributed to a greater depth of the interview results and the analytical material.

### 2.5.2.2 Purpose of interviews

The purpose of the interviews was to acquire information for which was lacking from the literature research. This to also obtain a current picture of the flows of dangerous goods in reverse logistics from actors with current and updated knowledge. The goal of interviews with both actors actively working within the transport flow, and the “experts” of the rules and regulation, was to have input, views and insights from both perspectives of the challenges. Both “sides” might found challenges in either similar or different areas, both of which was interesting to investigate.

External Safety Advisor _____ MSB	→ Rules and regulations application in current situation and challenges of ADR
Carriers _____ Carrier with Pick-up-points	→ Transport flow → Problems with DG in reverse logistics → Challenges of ADR
E-commerce retailer	→ How dangerous goods is handled and challenges with dangerous gods in reverse logistics

*Table 1 - Purpose of interviews*

### 2.5.2.3 Selection of respondents

As this thesis was based on an interpretivist paradigm, qualitative methodology with exploratory purpose, a non-probability sampling was used. A non-probability sampling technique is used when there is no random sampling, unlike probability sampling where you can calculate the probability of getting any particular sample. Some of the most common non-probability sampling techniques are convenience sampling, snowball sampling and quota sampling. Convenience sampling is used, as the name implies, for the researchers’ convenience. There are no particular criteria to this technique, apart from that the respondent is available, and is willing to participate. Disadvantages of this is that the researcher might be biased towards whom is approach to participate in the study. With quota sampling, the researcher instead prior to reaching out to respondents have a predetermined sub groups of the population from where individuals are chosen based on a specific proportion. For example, ten males and ten females in each subgroup. In snowball sampling, the respondents are found through acquaintances, recommendations or forwarding, meaning that the sample group grows like a rolling snowball. The sample group and therefore the number of respondents is not predetermined, and therefore the sample group can grow until enough data is collected to be useful in the study. (Bryman & Bell, 2013)

For this thesis, a list was compiled of the larger carriers and e-commerce retailers in Sweden that was top-of-mind with the authors, and a snowball sampling was used in the quest for respondents with the proper knowledge necessary to answer the research question of the study. Initial identification of companies active within the field of the thesis was done, as well as active actors in the business within the scope. From the initial identification, a first email was sent out with a general request to the company for a respondent willing to partake in the interview. By snowball sampling, the researchers were then referred onwards until a respondent with proper knowledge was willing to partake. A time was set with the respondent of when an interview could be conducted. Regarding requests in the carrier companies, the researchers requested to specifically be referred to a safety advisor within the company. This, to retrieve information from a reliable source with insight and expertise in the companies handling of dangerous goods. Snowball sampling allowed the authors to get in contact with respondents whom might otherwise not be interested to respond to students directly without referral. Kind reminders were sent out to the approached company or agency seven days after initial contact, if there had been no feedback.

#### 2.5.2.4 Overview of respondents

<u>Source</u>	<u>Respondent</u>	<u>Type</u>	<u>Date</u>	<u>Time</u>
External Safety Advisor	DGM Sweden Patrick Björkman, Dangerous Goods Safety Advisor	Face-to-Face	2018-03-08	1h 23min
MSB	MSB Katarina Ström, Development of social protection	E-mail	2018-02-21	-
Carrier 1	Schenker Hans Carlheim, Internal safety advisor	Phone	2018-03-14	51min
Carrier 2	**Anonymous**	Phone	2018-03-09	49min
Carrier 3	PostNord Kent Ohlson, Safety Specialist and Safety Advisor	Phone	2018-04-09	1h 10min
Carrier 4	DHL Freight (Sweden) Mats Brodin, Manager DG Safety Advisor	Phone	2018-04-17	1h 08min
E-commerce retailer 1	**Anonymous**	E-mail	2018-02-19	-
E-commerce retailer 2	**Anonymous**	E-mail	2018-02-21	-

#### 2.5.2.5 Interview process

The interviews were mixed between face to face, phone and follow up interviews through email. In order to conduct the interviews consistently, an interview guide was created (see appendix A-C) The nature of dangerous goods also made it important to retrieve perspectives from different perspectives. However, this indicates that each group of respondents cannot answer all questions, and therefore questions were tailored to provide findings from the different perspectives, using different interview guides of semi-structured questions for each group. Each interview guide consists of a number of questions and was divided into different categories. Respondents was contacted by e-mail with the purpose of determining the time of the interview. The interview guide was emailed to respondents three working days before the interviewed in order to give respondents an opportunity to prepare and make them feel comfortable to conduct the interview, which contributed to increased validity. All information provided to the respondents via e-mail has been uniform for all respondents.

In the interview process, there have been two interviewees present who can ensure that the questions from the interview guide were asked. As the interviews was semi-structured, follow-up question and related question was asked as they were thought of. As the respondents were of Swedish nationality, all interviews were conducted in Swedish. When the interview was completed, the interview was transcribed in Swedish, where empirical findings are naturally converted to English for the purpose of this thesis. Transcription was sent to respondents to confirm that the questions and answers had been understood correctly, and no misunderstandings had occurred.

Following the interviews, after suggestions of improvements had been collected and compiled, a survey was sent out to the respondents, validating the suggestions to be tangible and applicable in reality or not. (appendix D) The purpose of the survey was to receive feedback on the suggested improvements as well as a suggestion on timeline for the improvements.

#### 2.5.2.6 E-mail

First contact with all respondents were done via email, apart from the requests for contact information to e-commerce retailer, that was instead sent through a contact form on their website. Following that, an answer returned from the e-commerce retailers to the authors via email. Two initial questions were sent to all respondents via email. With the e-commerce retailers, a continuous interview was conducted via email for a period of time to answer the authors question, as follow up questions appeared. Concerning external safety advisor and carriers, email correspondence was used as an initial contact where all respondents answered an initial question asked in an email, as well as email conversations used when follow-up questions were required to clarify or supplement a previously held discussion in the interviews. Interviews conducted via e-mail are highly criticized due to the fact that some information can be left out since tone and expression can be hard to interpret (Lee, 1994). Furthermore, because of the time gap between each mail, the quality of the conversation may be affected of unfocused answers and less likely to get answers from follow up questions (James & Busher, 2006). When choosing a semi structured interview method, this was even more relevant. However, by

combining the interview methods together with email, some of these issues are addressed. Even though body language will be excluded when conducting an email interview, it is still argued that the tone can be interpreted, especially if there previously has been a face to face interview (Lee, 1994). In the case of this thesis, one face to face interview was held, along with four interviews by phone, where tone was made clear.

## 2.6 Research Quality

When conducting a qualitative study, there are several aspects to take into consideration to maintain a high level of quality. To describe how the study was conducted and as well as the gathering of empirical findings, this can be decided by the degree of *validity* and *reliability* that the study has obtained. Validity aims to measure the right things, that is, what is relevant to be studied. (Ekengren & Hinnfors, 2012) Reliability on the other hand, concern credibility and investigating things properly. If a study has high reliability, the results of the study is not affected by who carries it out, but the outcome remains the same, and therefore can be replicated. (Lundahl & Skärvad, 1999) In a quantitative study, validity and reliability is often measured by numbers, but in a qualitative study, it concerns interpretation of data is which is executed in a consistent and just manner (Bryman & Bell, 2013).

Interview questions, respondents and surroundings are factors to be carefully considered when conducting interviews. According to Ekengren & Hinnfors (2012), the objective when interviewing is to strive for an impact to be as objective as possible, as well as achieve an impartial result. When the respondents have the same prerequisites for the interview, as well as the interview itself have been obtained, the outcome is increased reliability. To keep high reliability in this thesis, all respondents received the same background from the authors in the form of information in e-mail, and the interview guide on which the interviews were based were the same for each group of respondents. An increased reliability was obtained when the interviews was recorded and named directly after the respective respondents interview, in order not to risk interview materials getting mixed together. Since the interviews are semi structured with an interview guide, follow-up questions naturally arose as well as discussions following the respondents indicated answers, however, this can reduce reliability. This makes the result, depending on who performs the interview, not necessarily the same, since different interviewers can ask different follow-up questions. To counteract this sufficiently, the authors had one person perform the interview, and the other one taking notes.

The respondents interviewed holds a relevant position within their organization and possesses previous knowledge regarding transport of dangerous goods, considering these respondents as experts, which strengthen the significance of the opinions from the respondents. To increase the validity of the interviews, there have been two interviewers present who ensure that the right things being investigated during the interview, and to ensure correct questions were asked. One aspect that can decrease the replicability of the interviews is also that the interviews were performed in Swedish. This, because of delimitations set were within Sweden, and therefore all respondents speak Swedish. Swedish was used as a way to make the respondents more relaxed and keen on discussing the questions, rather than focusing on speaking correct English.

This makes the interviews not as easy to replicate in English, as the spirit of the questions could easily get lost in translation.

Before conducting a study, the researcher needs to take ethical issues into consideration. In general, a suggestion is to not subject the research population of embarrassment, harm or material disadvantage (Saunders, Thornhill & Lewis, 2009). As this thesis was performed strictly for academic purpose, no issues of skewness towards any party or organization was implemented, and therefore the thesis but remained an objective party. This was also made sure by collecting the perspective via questions to different actors within the focus of the research question, not just only carriers that handle the dangerous goods, but also the governmental side. An issue needed to be taken into consideration was the issue of transparency. There have been argues regarding respondents feeling deceived if not told the full purpose of the study, or even a negative impact on them or their careers (Blumberg, Cooper & Schindler, 2005). In respect to this view, all the respondents were fully informed about the purpose of the study and the reason of why these specific questions in the interview guide were asked. Furthermore, respondents were given to chance to remain anonymous if they sought to. One of the respondents consequently asked to remain anonymous.

As the responding carriers operate on a national scale, this gives a high generalizability of the findings in the thesis. What could decrease this somewhat is the semi-structured interviews providing different opinions depending on the special circumstances of the respondents, unlike the strict quantitative study which allows increased representativeness. To further strengthen research quality of this thesis, both authors fulfilled a 1.3 education at the start of this thesis. This is an education required for eg. drivers, forwarders to be allowed to handle dangerous goods. (*see chapter 4.2 ADR*) Both authors are now certified in 1.3 allowing them to handle, package, label or send dangerous goods according to ADR.

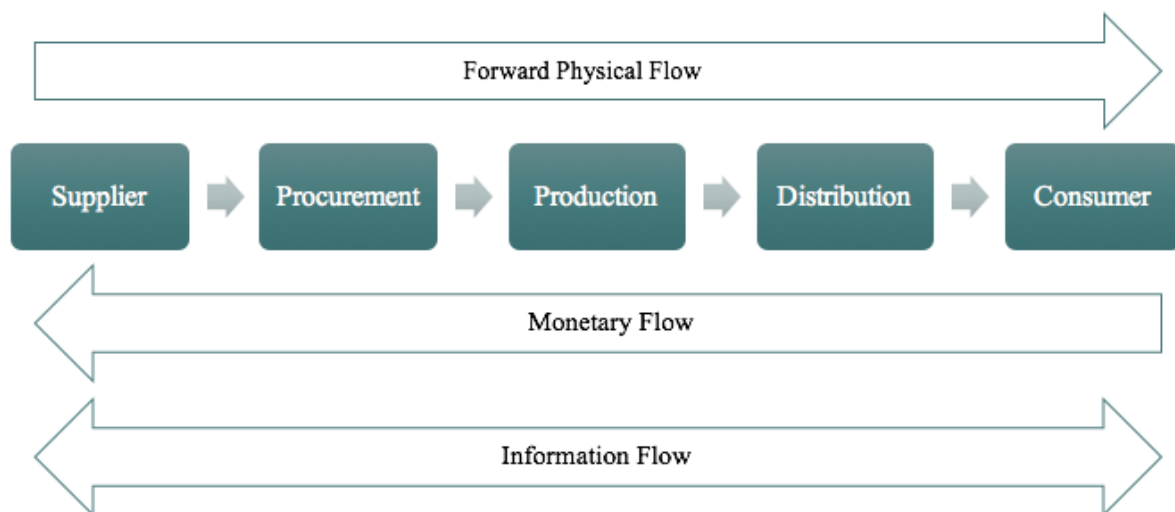
### 3. Theoretical Framework

*The purpose of this chapter is to explain and evaluate the available academic literature and theoretical concepts regarding the scope of the thesis. In the scope are the concepts of Supply Chain Management, Reverse Logistics, Parcel Logistics and E-commerce. With this chapter, readers will receive an understanding in the theoretical fields captured in the thesis as well as the general content.*

#### 3.1 Supply chain management

Supply chain management (SCM) is a relatively new phenomenon which appeared in scientific articles in the early 80s with the purpose of strategically trying to optimize the flow of goods and information between the different organizations in the distribution chain (Bertelsen & Koskela, 2004). Houlihan (1985), was one of the very first authors writing about SCM, and found out the need for a new approach within the area of material management. This, in order to avoid a sub-optimal utilization of assets.

Supply chain management is the handling of flows of goods and service, and involves everything from planning and handling of processes and activities within purchasing, production and logistics, from producer to final consumer (Simchi-Levi, Kaminsky, Simchi-Levi & Kaminsky, 2007). It is also entailing control over information and all the economical resources which have a relation with the flow and handling of goods and services from supplier to the end customer, with the purpose of achieving, or even surpass the expectation the end customer have on a specific company (Lindberg, 2016).



*Figure 3 - Interpretation of the supply chain flows as described by Simchi-Levi, Kaminsky, Simchi-Levi & Kaminsky (2007)*

### 3.1.1 Physical flows

The physical, or material, flow has typically been seen as primary flow of logistics, travelling from supplier to consumer. The flow involves activities from procurement to manufacturers receiving raw materials to delivering finished good. Along this flow, material is travelling through warehouses, distributors and dealers to its final customer. Also, finished goods can also flow via agencies and 3PLs from customer to their customer. For repairs, exchanges or end-of life products, the physical flow instead travels in a reverse physical flow, from customer to supplier. (Jonsson & Mattsson, 2011).

### 3.1.2 Information flows

For both the own company and supplying companies, subsequently the actors connected to the physical flow, it is important to be able to receive and send fast and correct information. This, to be able to establish an efficient physical flow, and provide information of available resources, customer demands, inventory levels etc. A tool for used for this is an ERP-system, which help gather, and organize the information to help ease the flow of information and process of planning (Jonsson & Mattsson, 2011).

### 3.1.3 Monetary flows

The natural consequence of the physical flow is the monetary flow, generated from the sale of a product, where the physical flow goes in one direction and the monetary flow the opposite direction. When on the other hand a return flow of the physical goods is directed toward the seller, the monetary flow instead travels from seller to customer (Jonsson & Mattsson, 2011).

## 3.2 Reverse Logistics

Included in reverse logistics are Product return, Recycling, Reuse, Recall, Repair Remanufacture and Waste treatment. (Autry, 2005) As this thesis puts main focus on the concept of product returns within the reverse logistics, this part of the main term will be more closely reviewed in the theoretical framework in the subchapter 3.2.2 Product Returns.

### 3.2.1 Definitions and background

To simply handle the forward logistics can be hard enough, but it is also important to understand the total impact of return products integrated in the reverse flow of the supply chain. The pure definition of reverse logistics has undergone various phases since its emergence in the 1980's, where it was merely defined as the reverse direction of material flow. (Rogers & Tibben-Lembke, 2001) Today, it involves to a much greater extent the re-capturing of value or disposal of products that is travelling in the reversed logistics channels. (Hawks, 2006) One of the definitions being;

*“The process of planning, implementing, and controlling the efficient, effective inbound flow, inspection and disposition of returned products and related information for the purpose of recovering value.” (Srivastava & Srivastava, 2006. p 530)*

The concept has now evolved to an often necessary process of a large number of products. The growth is due to two main aspects, governmental and economical. Governmental is referring to the stricter regulations in regards environment and social aspects. The growing trend of reverse logistics is also due the economic benefits that comes from companies that can recover value in the reverse channels, trough recovery, repairs or reuse of products (Grabara, Man & Kolcun, 2014).

### 3.2.2 Product returns

Due an intense global competition, increased levels of expectation of customer service as well as pressure on supply chain performances, the quest for efficient product return is an important questions as reverse logistics is developing. (Srivastava & Srivastava, 2006) A product return is the return of components or raw materials which have been obtained but was deemed unqualified to be accepted. This, as well as logistics related to the inspection, the transportation and storage relevant to the return of products. (Rogers & Tibben-Lembke, 2001) Today, the reason for a product return can be caused by a numerous of different reasons. Products that have been bought may be returned due to physical damage, some are returned because of unhappy customers due to the functionality of the product (expectations not met), sometimes products can be returned in the event of an alternative product emerges with better functionality after the purchase, and sometimes customers may misuse the return policy and return it without any specific reason. These are only some of the major reasons for the return of a purchased product by majority of the customers (Reddy, 2011) The logistics and supply chain management requires mutual trust and collaboration throughout the supply chain companies. However, this is not always fulfilled, and accidents related to delays tend to happen, which usually affects the final delivery of a product. This leads to the return of products from the customer (Vlachos & Dekker, 2003) The customers status has today been enhanced in the market due to many retailers launch of improved return policy, in order for the retailer to compete on the marketplace. This, leading to a habit of the customer to purchase, only to return the product. (Davis, Hagerty & Gerstner, 1998)



Figure 4 - Interpretation of the product returns in reverse logistics, as described by Rogers & Tibben-Lembke (2001) and Srivastava & Srivastava (2006)



### 3.3 Parcel logistics

A parcel is a wrapped bundle of articles, with dimensions not exceeding those of a EUR-pallet, 120x80 cm, and that do not require a pallet for transport (Merriam-Webster, 2017). In Sweden weight restrictions of a parcel vary between carriers, often with maximum weight up to 20 kg, depending on carrier. (Schenker, 2018; DHL, 2018; Postnord, 2018) Firms that are specialized in urban parcel delivery are pick-up-points, postal-authorized players, specialized delivery service providers and players from the e-commerce retail sector (Ducret & Delaître, 2013).

Physical parcel movements considered, a popular method used is the hub and spoke system which have a main hub to receive and sort parcels, and distributes to other transfer points, such as a terminal (Meng & Wang, 2011). In such a parcel movement comes a system where merchandise flow in a linear movement from the source to the customer, ending up at the last-mile delivery solution, most often a pick-up-point, as explained by Stanley, Xin & Jagjit Singh (2014). Furthermore, pick-up-points is often also the starting point of the first-mile in a reverse flow. (ibid.) Another common way of organizing physical movements of parcels lies in the establishment of a robust reverse transport flow, which contributes to cost-effective solutions in management of transport and inventory, but also in the handling of waste disposal. (Muralidharan, 2018)

### 3.4 Electronic commerce

To fully understand the concept of electronic commerce (e-commerce), one must first grasp the relation it has to the much broader concept of e-business. E-business is based on connections and sharing information by the use of electronic means, and not just externally from the organization, but internally as well (Chaffey, 2011). This indicates that e-business concerns activities within areas revolving connecting employees through an internet platform and by so improving sharing of information, facilitating distribution of knowledge, after-sales support, and more. (Tawfik & Albrecht, 2008). In relation to e-business, the concept of e-commerce is defined more narrowly. A number of definitions has been named over the years, but the definition used for this thesis is: e-commerce is activities within economics and trade conducted via electronic methods (Qin, Chang, Li & Li, 2014).

E-commerce has had a huge impact on the process of how business is being done on a global scale. The continuous development of using the internet has been a huge driving force to push e-commerce to become a vital platform in today's business world when it comes to sharing business information internally, but also B2B and B2C (Chong & Bauer, 2000).

If companies adapt to e-commerce, the potential result from this can be an increased profit margin, heightened business volume and a more competitive pressure (Chen, Pan & Ouyang, 2013). By implementing e-commerce, other benefits besides the previous ones mentioned could be lower cost of trading, business decisions become faster and better informed, and geographical locations gets less important. Implementing e-commerce can lead to both new

opportunities as well as threats for organizations. Significant long- and short term effects can be achieved from both successful and failed implementation (Zhao, 2010).

### 3.4.1 E-commerce logistics

There are four key flows in E-Commerce logistics; Product Flow, Money Flow, Information Flow, and Reverse Product Flow. The modern logistics have grown to become vital means in order to increase efficiency of material flow, decrease costs of distribution in various industries; simultaneously, the recent development of E-commerce is a result of the logistics market expansion, promoting the development regarding technologies in relation to logistics (Bask, Lipponen & Tinnilä, 2012; Masmoudi, Benaissa & Chabchoub, 2014; Ramanathan, George & Ramanathan, 2014).

The logistics performance and e-commerce customer loyalty have a much tighter relationship in e-commerce business compared to other industries (Ramanathan, 2010). E-commerce orders have emerged to be small with increased daily order volumes, small parcel shipments and shipments with same-day delivery, but the shipment of these orders is rather complex. Thus, the scope requirement for the role of logistics is bigger and the logistics service is offered to the final customer who expect a high level of logistics service. A lot of studies conducted indicates e-commerce as an important factor when it comes to logistics performance, especially in the matter of the last mile distribution (Esper, Jensen, Turnipseed & Burton, 2003; Agatz, Fleischmann & Van Nunen, 2008).

Delivering goods to a customer's doorstep within a timely manner can be a complex activity that needs carefully planned management to control. A company's success in the e-commerce market can be highly dependent on its distribution network efficiency. That the goods in movement are effective and efficient are crucial factors in the e-commerce logistics supply chain (Huppertz, 1999; Foster, 1999; Harrington, 2000; Hill, 1999).

In the reverse product flow in e-commerce, according to Distance and Off-Premises Contracts Act (SFS 2005:59) in Sweden, when a product or service is bought at a distance the law gives the customer the right to undo the purchase within 14 days from the day of received package. (SFS 2005:59) The customer is then required to return the item to the e-commerce seller. However, the policies of returns differ between retailers depending on the generosity of the company. It can be expensive for the e-commerce retailer to offer a generous return policy and quite complex to deal with, since free returns tends to increase customers purchase frequency, which in turn leads to more returns (Lilliehöök & Parastatidou, 2017)

## 4. Rules and regulations of dangerous goods

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*Dangerous goods today are closely tied to regulations, and many might experience challenges in the handling of dangerous goods to be caused by the enforced rules. Due to this, the rules and regulations have been given its own chapter. This chapter is will provide the reader with important information in regard to the rules which the transport of dangerous goods rests upon. Chapter 4.1 provides general information of the existing rules and regulations in regard to classification and harmonization. 4.2 will focus on transport on dangerous goods on road, ADR, and provide the reader with information of packaging, labelling and documents. The particularities of parcels are also presented.*

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### 4.1 Background and general information

Dangerous goods are substances and objects that have properties so that if not handled correctly during transport it poses a risk to humans, animals or its surrounding environment. Surrounding environment means other goods, vehicles, means of transportation, air, land, buildings, water and natural environment. (DGM Sverige, 2017)

The transport of dangerous goods is based on a system, the United Nations Model Regulations (UN Model Regulations). In terms of air and sea transport, there are global regulations (DGR and IMDG). For land transport, it may vary between countries and continents. In Europe, there are common rules, for road: ADR and rail: RID. (DGM Sverige, 2017) Different transport modes require different regulations due the characteristics of that said transport mode. (Svensson & Wang, 2009)

The general notion of having certain rules and regulations to follow lies in preventing harm to people, property and the environment. At the same time, rules and regulations should be framed in such a way that it does not impede the flow of such goods, other than those that are too dangerous to be transported (UNECE, 2017a). Also, by having international regulations it contributes and helps to reduce the barriers of transport of goods across borders. Emphasizing safe trade and efficient transports of dangerous goods is one of the main underlying goals of the UN recommendations regarding transport of dangerous goods (Ellis, 2002).

Organizations which are involved in dangerous goods must be designated a safety advisor. The safety advisor is an instrument for the management team to ensure high safety in the transport of dangerous goods, by ensuring that the regulations for the transport of dangerous goods are met. Responsibilities also include to provide advice on matters relating to the transport of dangerous goods, identify dangerous goods that are left for transport, or ensure that the relevant staff are adequately trained and documented. This will ensure compliance with regulations and measures to be taken to prevent accidents (MSB.se, 2017a).

There are also dangerous goods which are forbidden regarding transport, unless provided

otherwise by the regulations. This includes all substances or articles that are likely to explode, dangerously react, produce a flame or dangerous evolution of heat or dangerous emission of toxic, corrosive or flammable gases or vapors under normal conditions of transport (UNECE, 2017a).

The transport of dangerous goods is regulated in Sweden by the following legislation:

- Law (2006:263) on the transport of dangerous goods.
- Regulation (2006:311) on the transport of dangerous goods.
- Regulations for the transport of dangerous goods by road, rail, sea and air.




The following transport authorities issue regulations for the different modes of transport:

- Swedish Civil Contingencies Agency (MSB), for land transport (road and rail).
- Transport Agency (Transportstyrelsen), for transport by sea and air.

The police are responsible for control of the transport of dangerous goods by road. The Transport Agency has supervisory responsibility for the transport of dangerous goods by rail as well as for sea and air transport. Coast Guard controls dangerous goods in port areas. The Radiation Safety Authority is responsible for the supervision of the transport of radioactive substances. (MSB.se, 2015a)

#### 4.1.1 Classification of dangerous goods

Dangerous goods are classified according to the criteria in UN Model Rules where dangerous goods are divided into different classes depending on its hazardous character. (For full classification table, see appendix E)

Class	Danger	Examples	Label
<b>Class 1</b>	Explosives	Fireworks and ammunition	
<b>Class 2</b>	Gases	Fire extinguisher, lighters and hairspray	
<b>Class 3</b>	Flammable Liquids	Alcohols and paint	







<b>Class 4</b>	Flammable Solids; Substance liable to spontaneous combustion; Substances which emit flammable gases when in contact with water	Matches and firelighters	
<b>Class 5</b>	Oxidizing Substances and Organic Peroxides	Hair coloring and pharmaceuticals	
<b>Class 6</b>	Toxic and infectious substances	Pesticides and medical waste	
<b>Class 7</b>	Radioactive Material	Smoke detectors	
<b>Class 8</b>	Corrosive Substances	Bleach and drain cleaners	
<b>Class 9</b>	Miscellaneous dangerous substances and articles, including environmentally hazardous substances	Airbags, magnets, phones and laptops, dry ice, lithium batteries	

Table 2. Classifications of Dangerous Goods (UNECE, 2017a)

#### 4.1.1.1 Class 9 - Lithium Batteries

Class 9 covers substances and objects which constitute a danger during transport, which is not covered by the definition of other classes. One particular group of dangerous goods increasing today is lithium batteries, where the capacity of the batteries is also increasing. These have very special regulations on how they can be shipped, as the shape of the battery may vary. The different authorities get more and more questions regarding what rules and regulations applies when it comes to the handling, transport and usage of lithium batteries. There is no specific law of protection against accidents specifically for lithium batteries. Instead, general fire protection requirements apply (MSB.se, 2017b) Depending on the appearance of the battery, in consideration to amount of lithium, if it is a 'loose' battery or installed in a machine during transport. These features determine whether or not the lithium battery may be transported, as there are also special exceptions which implies an omission from regulations. This exception applies for instance to a lithium (non-rechargeable) battery of no more than 2 grams and for a lithium-ion battery (rechargeable) of no more than 100Wh. (UNECE, 2017b)

## 4.1.2 Harmonization

The effort towards a greater harmonization of the regulations between the different transport modes, air, ocean, rail and road, have been in motion for quite some time. This can also be seen in the latest edition of the different regulations. ADR regulations for road transport of dangerous goods within EU have been revised to achieve greater harmonization (Svensson & Wang, 2009). Governments, intergovernmental organizations and other international organizations, when revising or developing regulations for which they are responsible, are expected to conform to the principles laid down in the UN Model Regulations, which purpose is to present a basic scheme of regulation that will allow uniform development of national and international regulations governing the various modes of transport. This, to contribute to worldwide harmonization. Furthermore, this content should be followed to the greatest extent possible in order to make it more user-friendly, to facilitate the work of enforcement bodies and to reduce the administrative burden (UNECE, 2017a).

## 4.2 ADR - Regulations for dangerous goods transport on road

When transporting dangerous goods on road, international rules including packaging, labeling and how the goods are allowed to be transported are controlled by ADR, the European Agreement concerning the international carriage of **D**angerous goods by **R**oad. The rules of ADR are applicable to both national and international transportation of dangerous goods on road and terrain, and by so covering all of Europe. (UNECE, 2017b).

The main objective of ADR is to enhance and increase safety concerning international transportation by road. Further, a primary goal of ADR is to function as an important trade facilitation instrument (Svensson & Wang, 2009). The implementation of ADR came to an agreement in Geneva 1957 and was concluded by The United Nations Economic Commission for Europe (UNECE) but entered into force as late as 1968 (UNECE, 2017b).

ADR is divided into Annex A which is about general provisions and provisions concerning dangerous articles and substances, and Annex B which is about provisions concerning transport equipment and transport operations. The main content of ADR is focusing on listing and classification of dangerous goods. It also includes packaging standard together with labeling and marking, what kind of packaging allowed for usage, different procedures regarding consignment and equipment of transport (what kind of vehicles to use, the construction of the vehicle and equipment). Further, a main part of ADR includes transport operation covering the education of drivers to receive necessary ADR license, supervision, emergency situations, loading and unloading, and placards of vehicles (UNECE, 2017b).

There is a requirement that anyone who is in any way involved in a transport of dangerous goods should have education of some kind. People whose duties concern the transport of dangerous goods by road shall have received training and determine their transport of such goods adapted to their responsibilities and duties in accordance with chapter 1.3. The training

is required for all actors involved in the transport of dangerous goods in order to know what regulations to follow. However, the education is adapted to responsibilities and tasks, so it becomes more ‘function-specific’. Therefore, there’s only a need to be trained in what concerns their specific task. (MSB.se, 2009)

To ensure that ADR is enforced, regular control stops are situated along the highways and controls are carried out. If a non-compliance arises, it may result in a legal action taken by national authorities against offenders in accordance to their domestic legislation. ADR itself does not include any penalties in the event of violation of the rules. Up to this day, there are 50 contracting countries in ADR (UNECE, 2017b). It should be noted that because of the interest in uniformity and free trading of goods within European Union (EU), Annexes A and B of ADR have been adopted by EU Member states as a basis for regulations regarding carriage of dangerous goods by road between and within their territories. Also, a number of non-EU countries have adopted Annexes A and B of ADR as the basis for their national legislation (ibid.).

Countries that follow international or national regulations of ADR are using suitable acts or legal instruments to implement the regulations to their own country. Concerning Sweden, the letter “S” in ADR-S is the Swedish edition and is administered by the Swedish Civil Contingency Agency (MSB) which publish documents in Swedish concerning national requirements (Fors et al. 2018).

#### 4.2.1 Packaging

The focal purpose of packaging is to provide the goods with protection as well as easing the process of handling the good. Packaging also provides easement for identification, durability and safe recovery in case of accidents (Guner-Özbek, 2007). Packaging should also shelter the contents from being affected negatively in regards to performance or reliability by outside mechanical forces (vibration and impact), contamination of damaging substances (water and air), and circumstance of climate (heat and cold). (ibid.). When transporting dangerous goods, this displays more risk of incidents occurring than transporting non-dangerous goods. It is therefore key for the packaging to reduce these risks, it is vital that the packaging of dangerous goods is created to withstand these outside forces. (ibid.)

Within the various dangerous goods classes, there are criteria for determining the degree of danger within each dangerous good class. Each of the packaging groups decides what kind of unit the dangerous goods can be transported in and rules regarding the limited quantities (LQ) (see chapter 4.2 ADR). The packaging group also determines to what extent it needs protective packaging. The system of packing groups is used for this purpose according to the following:

- Packing group I Great danger
- Packing group II Medium danger
- Packing group III Minor danger

(UNECE, 2017b)

Furthermore, if the characteristics of a substance has several hazardous features, the major one will decide the classification. The packaging however, must be labelled with both the primary and the secondary classification in a decreasing order. (UNECE, 2017b).

#### 4.2.2 Marking and labelling

According to ADR marking and labelling “(a) shall be readily visible and legible; (b) shall be able to withstand open weather exposure without a substantial reduction in effectiveness.” (UNECE, 2017b. p. 223) Marking and labeling is required differently in regards to which class of dangerous good a package contains, as well as the level of risk it may expose. (UNECE, 2017b.)



*Figure 5 - Marked parcel, with UN Hazard classes, warning diamond and orientation arrows (MSB, 2017)*

The marking and labelling of dangerous goods is done to alert the workers that deals with the goods that it is in fact dangerous and that caution is advised. Furthermore, it is vital that the marks and labels of the dangerous goods are noticeable during transport and handling, as well as if accidents occur as then workers and police need to take well informed and immediate action to deal with the accident (Guner-Özbek, 2007; UNECE,2017b). The dangerous goods also need to have the UN number corresponding to the dangerous goods class it contained, preceded by the letters “UN”, which shall be clearly and durably marked on each package. UN-numbers are a four-digit number and is being used in international transportation to identify what type of dangerous goods are being transported. This, in order to increase safety and a mutual understanding of each classifications property to avoid confusion in the transport flow when handling dangerous goods (MSB, 2017) A favorable advantage of using UN-numbers instead of the specific name of a dangerous goods is that it can overcome language barriers and therefore confusion can be avoided. The UN-number also helps to ensure in the event of an emergency, that the correct procedures are being followed. (Svensson & Wang, 2009).

The categories of dangerous goods in ADR have the same classes as the UN recommendations. The labels which are visible on the outer package of dangerous goods are indicating the hazards of that goods and are being used to help each actor in the transport chain to understand the content. If not mentioned otherwise in ADR, each packaging containing dangerous goods shall



be provided with a visible four-digit UN-number which is preceded by the letters “UN” (UNECE, 2017b). A package should have a visible two or three-digit hazard identification number which indicates the degree of danger associated with the dangerous goods inside. The first number describes the main hazard with its classification. Repeating a number indicates an intensification of that specific hazard. The second digit is mostly either a zero which is used when the hazard is adequately represented to the first digit, or a repetition of the first digit which indicates an intensification of that specific hazard. The hazard identification number and the four-digit UN number should be in black on an orange-colored plate on a truck that is carrying dangerous goods where the hazard identification number is written on the top row, and the UN number on the second. (ibid.)



Figure 6 - UN number plate (UNECE, 2017b)

## 4.2.3 Transport Documents

### 4.2.3.1 Dangerous goods declaration

A Dangerous Goods Declaration (DGD) is a document created by the shipper, describing the nature of the dangers of the goods, with eg. UN-numbers, packing group and shipper/consignee name. The shipper and carrier are obligated to save the declaration for each articles and substance for a minimum of three months to be able to be used in an investigation if requested by the police. The declaration can also be stored digitally provided that it can be produced under request. (MSB, 2017) In regard to road,” *When the dangerous goods transport information is given to the carrier by EDP or EDI techniques, the consignor shall be able to give the information to the carrier as a paper document, with the information in the sequence required by this Chapter.*” (UNECE 2017b, p.245)

### 4.2.3.2 Written instruction

In the event of an accident or incident, aid in the form of written instructions should be present in the transport vehicle containing dangerous goods. The instructions consist of information on what actions to be taken if the accident or incident occurs, and what kind of equipment to be carried. Furthermore, the instructions include type of warning label and placards related to a hazardous characteristic and laid out measures to be taken for each characteristic (MSB.se, 2017c).

#### 4.2.4 Segregation

Dangerous goods have many different characteristics, as they come for instance in different forms; gases, liquid, or packages, and there are provisions for how different types of dangerous goods can be co-loaded with each other or with other goods in one and the same cargo space. It is therefore vital that the different types of dangerous goods that is not permitted to be co-loaded together is segregated during transport or storage. (MSB, 2017) The rules for loading are based on the goods labels and are done either by using barriers or placing them with a suitable distance between each other, and some classes may not even be loaded on the same vehicle. (For table on separation of different classes, see appendix F)

#### 4.2.5 Parcels and exemptions of limited quantities

The application of the ADR regulations depends on what type of goods it is, in what quantities it is transported, what packaging it is to be transported in and the hazardous properties of the substance. For parcels, it should be labeled as required to indicate what it contains, it shall also be accompanied by a declaration of goods, and information is to be provided that the contents are of dangerous goods. (MSB, 2017) To be able to ship dangerous goods in parcels, there are exemptions based on quantity in ADR-S; *Exempted Quantity, Limited Quantity or Small load exemptions*. When dangerous goods are transported in accordance with these exceptions, ADR license is not required. On the other hand, other conditions of education may be required, for example, the requirements for 1.3 education must be met if limited amounts are applied. (MSB.se, 2009) Packages containing a limited quantity may be grouped with other packages containing limited quantities in all hazardous goods classes except Class 1, explosives (MSB.se, 2015b). Common items sent as LQ could for instance be smartphones, laptops and hairsprays.

##### *Exempted Quantity*

Exempted quantity indicates allowance to transport relatively small amounts of different dangerous substances without the following of all requirements in the legislation. The exempted quantity varies depending on which substance and class, and packages are not required to be labelled by hazard label, but instead by a warning label, as below (MSB.se, 2015b):

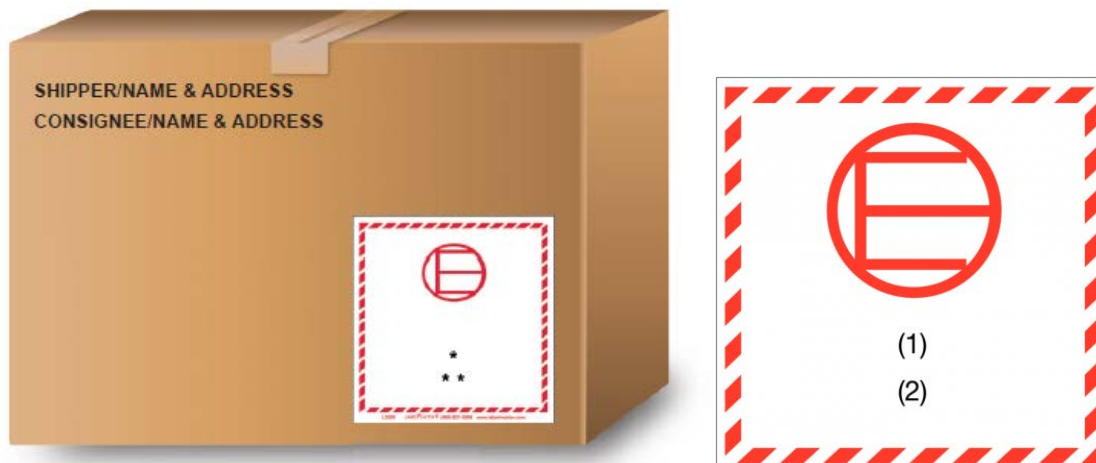


Figure 7 - Exempted Quantity label (MSB.se, 2015b)

Amount of goods must follow strict packaging limitation to be allowed as exempted quantity and is required to be in combination packages (e.g. a bottle in a box). Each dangerous good, i.e. UN number, is assigned a code. Dangerous goods with the code E0 may not be transported as an exempted quantity. If dangerous goods with different codes are to be packaged together, in the same outer packaging, it is the most restrictive code that determines the quantity of outer packaging that may contain at most. (MSB.se, 2015b)

Code	Highest net amount per inner packaging (grams for solids, ml for liquids)	Highest net amount per outer packaging (grams for solids, ml for liquids)
E0	Not allowed in exempted quantity	Not allowed in exempted quantity
E1	30	1000
E2	30	500
E3	30	300
E4	1	500
E5	1	300

Table 3 - The amounts limited per inner package and per outer package. (MSB.se,2015b)

### Limited Quantity

There are some transports of dangerous goods of certain classes that are packed in what so called Limited Quantity. Here, there is no need to follow all the normal packaging and labelling regulations, and there is no necessity for a dangerous goods safety advisor if transporting Limited Quantity of some dangerous goods. As Exempted quantity, Limited Quantity needs to be packed in combination packaging, either in boxes or in shrink-wrapped trays. The total gross weight of a parcel containing Limited Quantity may not exceed the limit of 30 kg, 20kg for shrink-wrapped trays. Small quantities of packing groups II and III can be sent in Limited Quantity. However, not all hazardous classes can utilize this exemption. Classes that are prohibited to be sent in Limited Quantity are: Class 1, Class 6.2 and Class 7. Packages containing dangerous goods which are packed in Limited Quantity shall wear the mark shown in figure below (UNECE, 2017b).



Figure 8 - Limited Quantity label (UNECE, 2017b)

### *Small Load Exemption*

Unlike transportations in the mean of Limited Quantity and Exempted Quantity, the dangerous goods do not need to be packed in smaller inner packaging when *small load exemptions* are applied. It is the total amount of dangerous goods on the transportation unit that decides if small load exemptions can be applied or not. Since this is within ADR, a transportation unit is referred to a vehicle on road. In ADR, the highest allowed total amount for each respective dangerous good is being laid out. The amount may not be exceeded if this exemption is to be made. This exemption can only be made if the dangerous goods is being transported in parcel, intermediate bulk container or big packaging. (MSB.se, 2015c)

These limited quantities, Exempted Quantity, Limited Quantity and Small load exemptions, will henceforth be known as LQ in this thesis.

## 5. Empirical Findings

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*This chapter contains a compilation of the empirical findings based on the answers from the various interviews with respondents. This chapter provides the answers to the sub questions “What does the current transport flow of parcels containing dangerous goods in reverse logistics look like on road?” and “What challenges can be identified concerning rules and regulations (ADR) in Sweden in the context of reverse logistics?”*

*For further reading into the interviews, transcripts are available upon request.*

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### 5.1 Presentation of respondents

#### *External Safety Advisor - DGM Sweden*

DGM Sweden was founded in 1988. The company strive towards increased safety in transport and handling of dangerous goods. Globally DGM has more than 57 offices in 32 countries and offer global expertise in dangerous goods and services. DGMs portfolio ranges from product services and products is based on knowledge, trust and practical experience of dangerous goods and hazardous substances. The interviewed respondent is Patrick Björkman, Dangerous Goods Safety Advisor.

#### *MSB - MSB (Swedish Civil Protection Agency)*

Established in 2009, MSB, the Civil Protection Agency, is a Swedish government agency with the task of developing society's ability to prevent and deal with accidents and crises. MSB exercises operational supervision of safety advisory and transport protection regulations. In addition, the MSB carries out supervision of training instructors for the education and examination of drivers. In addition, the MSB has the task of coordinating the supervisory authorities' activities in the field of transport of dangerous goods. The respondent is Katarina Ström at the department for Development of Social Protection, Unit for safe handling of hazardous substances.

#### *Carrier 1 - Schenker AB*

Schenker Logistics is a German transport and logistics company operating globally and was founded in 1872. Schenkers operations include transport by land, sea and air and logistics linked to this activity. Schenker was first established in Sweden in 1921. Schenker in Sweden has sales of SEK 12 billion (2013) and has 3,800 employees and is the largest actor in regards of road transport in Europe. The interviewed respondent is Hans Carlheim, Safety, Claim and Security SE, Safety Adviser and Supervisor at Schenker AB. Hans have actively been working with dangerous goods since 1989.

#### *Carrier 2 - Anonymous*

Carrier 2 is a worldwide shipping company offering international postal services, as well as document and package transport. Carrier 2 was established in Sweden in 1982 and currently have roughly 400 employees in Sweden. The interview respondent is a safety advisor employed at the carrier company, with many years in the industry.

#### *Carrier 3 - PostNord AB*

PostNord AB is a Nordic postal operator established in 2009 after the Swedish Post and Post Denmark merged. PostNord operates within mail and parcel services and had in 2015 approximately 35 000 employees. The interview is with Kent Ohlson, Safety Specialist and Safety Advisor. Kent has been Safety advisor of dangerous goods formally for PostNord Sweden since May 2017 but worked many years with DGR - dangerous goods for air.

#### *Carrier 4 - DHL Freight (Sweden)*

DHL is part of the world's leading post and logistics group, the Deutsche Post DHL Group, and includes business units: DHL Express, DHL Parcel, DHL e-commerce, DHL Global Forwarding and DHL Supply Chain. DHL in Sweden has close to 5,200 employees and about 70 offices, terminals and stations around the country. The interviewed respondent is Mats Brodin, Manager Dangerous Goods Safety Advisor. Mats have been a Safety Advisor at DHL since 2013.

#### *E-commerce retailer 1 - Anonymous*

Founded in Sweden 1989, the Nordic retail chain focuses on selling gadgets in all its forms - ranging from high tech smartphones and tablets to wood puzzles and masquerade masks. Today, E-commerce retailer 1 have roughly 130 stores in Sweden, Norway and Finland. In addition to the physical stores, the chain also operates as an online retailer for these countries. The respondent work as a logistics manager.

#### *E-commerce retailer 2 - Anonymous*

Founded in Sweden 1918. This Swedish retailer is a hardware store chain and mail-order firm that specializes in hardware, home, leisure, electrical and multimedia product. Sales and services take place in over 200 stores in Sweden, Norway, Finland, Great Britain and Germany, as well as e-commerce, catalog, telephone and social media. The respondent work as a Product Compliance Manager.

## 5.2 The handling of dangerous goods

Considering that dangerous goods could be sent without the knowledge of the carriers, the authors therefore initially review below the perspectives of the carrier and the e-commerce retailer, on how the carriers handle dangerous goods and limited quantities (LQ) in the transport flows, as well as thoughts of challenges that might occur in said flow.

### 5.2.1 The carriers perspective on dangerous goods and LQ

The role of the carrier when handling dangerous goods or LQ, is to transport the good from A to B, whether it is in the forward logistics or in the reverse flow. All the carriers have to abide by ADR when transporting. As long as ADR is complied with, it is up to the service of the carrier to decide what to allow to be transported. All responding carriers are equipped and have educated employees to handle goods which requires full ADR license, as well as all carriers allowing all dangerous goods except for class 7 in their full services. The carrier companies can choose which UN-numbers to transport, and usually every company exclude some UN numbers as exceptions, like toxic gas or substances that are toxic by inhalation, as well as explosives. In consideration to parcels however, all responding carriers allow for limited amounts of the hazardous classes to be sent as LQ, though not from private individuals.

As far as the parcel business is concerned, Carrier 1 transport all goods allowing LQ, but in terms of the class 1 limits to only certain items. Another concern for Carrier 1 is also with class 8, where driving corrosive fluid as LQ is prohibited. This, due to the severe damage if leakage would occur and it is therefore avoided in the parcel management because here the risk is at its peak. Carrier 2 mention in regard to LQ, that they often choose to exclude certain classes that can not be co-loaded onto one truck. Companies that run cargo handling often want to be able to co-load, it can become quite difficult when transporting some goods that may need to have a protection plan written for it.

For Carrier 3, the only way a good can be sent in parcel is in LQ. In cases where the regulations state that it is okay to send a class of good, but Carrier 3 services does not, the attempt to make an exception and waive the terms of service is made. This, to allow for certain customer satisfaction solutions. Carrier 4 mentions that they operate within the own established limitation where a parcel may not exceed 20 kg, which differs from the rules laid down in ADR. Even when transporting goods that exceeds LQ, Carrier 4 does not allow transports which is considered to have high risk potential of dangerous goods.

	<b>Transport dangerous goods in full ADR</b>	<b>Allow LQ in transportation of parcel</b>	<b>Do <u>not</u> allow LQ from private individual</b>	<b>Exceptions</b> (more in 6.1.3.2 Pick-up-points)
<i>Carrier 1</i>	X	X	X	Exception can only be made for private individuals if the LQ is in original box
<i>Carrier 2</i>	X	Some - often choose to exclude classes as they can not be co-loaded	X	-
<i>Carrier 3</i>	X	X	X	Certain customer satisfaction solutions
<i>Carrier 4</i>	X	X	X	-

*Table 4 – Perspective on Dangerous goods and LQ*

### 5.2.2 The e-commerce retailers perspective on dangerous goods and LQ

E-commerce retailer 2 mentions that they possess a number of products classified as dangerous goods, for example lithium batteries larger than 18W, which is placed in their products of electrical bikes, but these are usually shipped on pallets, not parcels. E-commerce retailer 2 also mentions that they do have other products that are shipped as LQ, but no special routine exists for the handling of dangerous goods in the reverse flow. Parcels with LQ is labeled at the company's warehouse and if the customer uses the same carton sent out with the original order, then the LQ label will, by E-commerce retailer 2's assumption remain on the parcel and could be used for a return.

### 5.2.3 Hidden dangerous goods

In regard to hidden dangerous goods a challenge discovered has often to do with e-commerce retailers and these actors with insufficient knowledge. (Carrier 4) Further, one of the biggest challenges lies in carrier companies offering services aimed at private individuals. The likelihood that the parcels sent by services of this kind e.g. pick-up-points will be "hidden dangerous goods" is very high in the context, generating high risk of accidents. Parcels are being sent without realizing its' actual content, concluding that most of the challenges are unawareness when it comes to the hidden dangerous goods. (Carrier 4) Concerning unawareness, without being provided a labeled parcel and information, the only way to notice dangerous goods in the transport flow is if the carrier discovers it in one way or another, making it a challenge of hidden dangerous goods. (Carrier 3) Often, according to External Safety Advisor, it is in the reverse flow where dangerous goods can go easily undiscovered and



therefore hidden. An example is when a customer receives a parcel ordered, open it and later the box is being disposed of, without consequently thinking through possibility of wanting to return the item bought. External Safety Advisor mention that along with the original box, often a return slip is attached, as well as dangerous goods having labeling requirements. If a return is allowed only by the original box, like Carrier 1 allows, already at this point the dangerous goods is perceived as hidden if chosen to be returned without the original box. Another concern to the challenge hidden dangerous goods, is when carriers want to load as much cargo as possible in the truck. Carriers only get a small portion of what is paid for a shipment, therefore meaning carriers desire to fill their trucks, potentially not checking if it is dangerous goods or not. (External Safety Advisor)

#### 5.2.3.1 Lithium batteries

For parcels shipped, one of the most common classes when transporting dangerous goods, and LQ, are class 9, where lithium batteries are included, as every respondent has mentioned. This is also where the highest number of unawareness is being acknowledged by all responding carriers. An example of lithium batteries being a difficult matter of transportation comes from Carrier 3, who reminds that with lithium batteries there are several ways of determining classification, depending on the characteristics of the battery. An example is the “Power Bank”, a portable charger, because there's a lithium battery inside the Power Bank, so a private individuals perception of this might be that the battery is inside an electronic case, when in fact the entire Power Bank is considered a loose battery used for charging other electronic devices.

MSB was asked specifically concerning the example of a return shipment of lithium batteries potentially being defect in equipment, like a laptop. In the example, the laptop is to be returned to the retailer, and the retailer will supply packaging, labels and instructions on how to package the equipment correctly. The question in this scenario relates to private individuals or small companies that return lithium batteries to the retailer, do they require 1.3 education? (Carrier 2) According to MSB, this scenario is possible in theory. An instruction of how the equipment should be packed, and that information about the equipment from the retailer itself is included, is considered enough information equal to a 1.3 education. This opinion of MSB was anchored with the trade organization RECHARGE, The European Association of Advanced Rechargeable Batteries. MSB further adds that supervisory authorities are accountable for the final say. (Carrier 2) MSB comments in the matter of retailer supplying packaging, as well as instructions and labels being a relatively expensive solution and maybe not entirely environmental friendly.

### 5.3 The reversed transport flow

The reversed transport flow of parcels starts at the customer sending products in return to an e-commerce retailer. According to all responding carriers, the return flow for carriers are in the world of dangerous goods the same flow, no matter what the purpose of the goods, it still poses the same dangers. Below, the reverse flow of parcels in regards to dangerous goods and LQ is reviewed, also taking into consideration the reverse transport flow of non-dangerous goods, where the hidden dangerous goods might cause challenges or fall under the radar. This, as well

as reviewing the respondent’s opinions in regard to the catch 22 of the private individual that is not allowed to send parcels without the training. Also, as a pick-up-point become a natural start of a reverse transport flow, the carriers that has pick-up-points in their service today where asked what challenges they would associate with the pick-up-points.

### 5.3.1 The carriers reverse transport flow

The reverse transport flow of parcels begins with the cargo being picked up at pick-up-point or private individual, to be often loose-loaded onto a truck. From a large city, there will be a lot of delivery vehicles doing pick-ups in the afternoon at the pick-up-points. (Carrier 3) This is done in the larger flow between terminals, where the parcels are loaded in the truck with a big net to hold them tight. After the parcel are collected, often in cages, it enters the larger terminal, or collection sites. (Carrier 3) Parcels are sorted by machines or manually (Carrier 4) and once sorted, parcels are loose-loaded into the next truck for local transport and finally being transported to service points where individuals or customers pick up their parcel. (Carrier 4) In most cases, if it is not a special or dangerous cargo, parcels are lifted by hand and then stuffed. (Carrier 3)

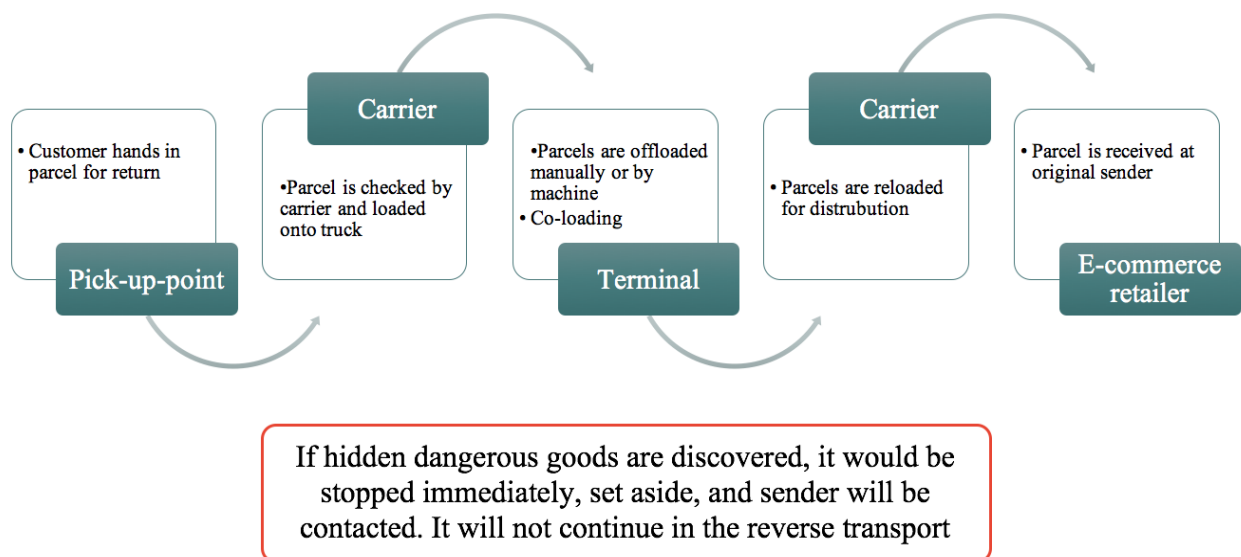


Figure 9 – Reverse transport flow from the carrier

When introducing the concept of a parcel of hidden dangerous goods in the reversed transport, it will not be discovered until the parcel is for instance accidentally dropped on the ground or the parcel breaks for some reason. Assuming that the parcel will be unbroken, the carrier will never find out what it was in it. (Carrier 1) Unless a parcel is labelled, there is no way of discovering parcel containing dangerous goods. (Carrier 4)

All carriers mention that if such an event were to occur, the discovery of hidden dangerous goods in the reverse transport flow, it will immediately be stopped and set aside. The shipper is contacted and fully informed of the situation and what is required for the shipment to be able to continue. Consequently, it is then up to the sender to arrange for this or to retrieve it. (Carrier

1) If the parcel is not picked up or the sender decides to leave it, Carrier 2 mention that the parcel will be sent to be destroyed, as the carrier does not take any responsibility for the parcel at that point.

### 5.3.2 Catch 22

Regarding the dilemma of the sender of the reverse flow being a private individual, and that the private individual is not required to be educated, but they still must follow the rules. How are they supposed to follow the rules without any education or training?

All respondents begin stating that the sender is always responsible for a shipment. External Safety Advisor mentions that in the transport industry today, private individuals are exempted from sending dangerous goods, which leaves out the necessity of an education. In contrary to this, a carrier that transport the private individuals parcels from the pick-up-point to destination, however, do. The carrier must have sufficient education to handle dangerous goods, but still, the private individuals is to be responsible for the shipment. The private individual is therefore also responsible for disclosure of information regarding dangerous goods or LQ to the carrier, but the private individual must never write any document or label dangerous goods parcels where sufficient education has not been acquired. This challenges that External Safety Advisor describes further becomes somewhat of a circle, a catch 22.

To this catch 22, the responding carriers agree that accepting dangerous goods from private individuals is not allowed in their services. LQ is accepted in parcels, but not from private individuals, due to the lack of knowledge. (Carrier 1) It is added from Carrier 2 that in order for them transport a return a parcel containing dangerous goods in LQ, it has to be done in the original package. Returns with the purpose of repairs for example is not acceptable if it is not being sent in the original package. In other words, if this package is thrown away or damaged in the extent of not being able to use anymore, a return can not be made. Then the customer might have to contact the retailer to purchase a new package. (Carrier 2) Carrier 1 also mentions that exceptions in this matter has been made simply when a private individual is returning goods of LQ in its' original package.

An additional suggestion when a private individual, without education in the technical sense, is not allowed to send dangerous goods or LQ, a suggested scenario where it could be allowed is if a written instruction is available. (Carrier 1) This is exemplified with the DGR - the regulations of dangerous goods for air - where it is applicable in some cases where direct education is not necessary, but a very clear instruction is instead required. To this end, Carrier 1 also announced to several e-commerce retailers that it falls on them to properly leave such clear instructions to their customers, so that the customer will be able to send the goods in return via the carrier. Then, in Carrier 1s opinion, the customer will with that have obtained the required knowledge.

To add to above suggestion, Carrier 4 adds that one way this challenge could be managed is if the retailer that is to receive the parcel sent in return, sends out from start an approved

packaging with marking and an instruction. The question raised here by Carrier 4 is if the original sender, the e-commerce retailer, could stand as responsible for the return of the parcel once they have provided proper packaging, and labeling for a return of the parcel?

### 5.3.3 The pick-up points

If the reverse flow is initiated by a private individual, the reverse flow most often starts with a customer handing in the return goods to a pick-up-point to be sent in return to the e-commerce retailer (as shown in figure 9). It is important that the start of a reverse flow is handled correctly. The responding carriers with pick-up-points in Sweden today are Carrier 3, Carrier 1 and Carrier 4, with pick-up-points located for instance in grocery stores or convenience stores. The pick-up-point functions as a service where individuals can hand in their parcels for transport onward to e-commerce retailer via carrier.

Pick-up-points of Carrier 1 and Carrier 4 are informed that it is not allowed for LQ to be sent by private individuals or for the pick-up-point to receive any packages labeled with dangerous goods labels. If the customer reuses packaging that has been labeled previously with dangerous goods labels, they must be removed before submitting the packages, unless it is an original box going back to the e-commerce retailer. (Carrier 1) The pick-up-points has, according to Carrier 1, received information to handle LQ, which can be managed in the pick-up-points package system. With their own pick-up points in Sweden today, Carrier 3 explains that the employees of the pick-up points are educated on dangerous goods and LQ, therefore know how to handle and help those who want to submit a parcel. Though they do not have 1.3 education, every employee working in a pick-up-point is trained and certified to handle parcels and mail. In the aforementioned training, a chapter concerning dangerous goods is included. This means that their employees therefore have the knowledge of what should and shouldn't be allowed to receive and send from the pick-up-point. (Carrier 3) Carrier 4 roll out an education on a regular basis, due large staff turnovers at the pick-up-points. Concerning the pick-up points of Carrier 3, located at the pick-up-point desk is a small sign that says "Farligt Gods?" ('Dangerous Goods?'). This to raise awareness to private individuals, to think twice on what they are about to send in their parcel, and the sign also refers to Carrier 3s customer service by phone number or email, as well as to their website. If dangerous goods were to be detected at the pick-up-point, the personnel will refer to the customer to customer service.



Figure 10 - Information sign on dangerous goods at carrier 3. (Picture taken at a local grocery stores pick-up-point, 2018-04-18)

An adversity at pick-up-points is the hidden dangerous goods. If a parcel is not labeled, the employees cannot decide if the parcel is nothing else but a regular 'brown' package. One possible improvement from at this point in the transport flow takes notice from when parcels are sent abroad, where there is a requirement for a customs declaration, where the value of goods and content must be entered. (Carrier 3) Applied to the pick-up-point, a small information note at the pick-up-point would suffice where the customer sending the parcel would have to write down the content which would be a standard requirement that also applies for domestic shipments. It needs to be clear that the customer has to write, for instance 'kerosene stove' as content, and not the general 'camping equipment'. As an employee at the pick-up-point, kerosene stove should then raise a red flag, and a follow-up question should be asked regarding if it is classified as dangerous goods or not (Carrier 3) Alternatively, fill in a form that asks of content or '*Is your parcel containing dangerous goods?*', with the answers of "yes" "no" or "do not know". If the customer checks "yes" then a red flag should be waving, as well as if the check "do not know", something that also should also raise suspicion. (External Safety Advisor) Another suggestion is the question "*What is the content of your package?*" External Safety Advisor thinks that employees at pick-up-points should ask this question to everyone handing in parcels. However, External Safety Advisor adds that these suggestions will create extra work for employees, which they are probably not interested in.

To further address the handling of parcels in these matters at the pick-up-points, employees need to have the proper knowledge needed to explain to an uncomprehending customer that dangerous goods can not be sent and that this is due to the label on the goods which indicates the dangerous goods inside the parcel. (Carrier 1) Carrier 1 also state that those who do in fact have knowledge of dangerous goods and intend to send dangerous goods through the pick-up-points knowingly, have indeed probably torn away the labels already at home, intentionally sending hidden dangerous goods. From a security point of view, Carrier 4 suggest removing pick-up-points altogether, to instead have more specific extradition sites if higher demands are made on the pick-up-points. If stricter rules are approaching in a near future, then there is a need to redo the entire product and flow.

## 5.4 Responsibilities

As it is particularly important to reassure that transport and handling of dangerous goods is managed properly, a good way is to make sure the party responsible have a chance to send it correctly, but also prevent the ones who are not allowed to send it. Reviewed below is the respondent's opinions of the responsibilities of parties involved in the reverse transport flow of parcels with dangerous goods.

### 5.4.1 The carriers responsibility

The sender is always responsible for the shipment; this all respondents agree upon in accordance with ADR/ADR-S regulations. In the ADR regulation, the carrier has a certain responsibility to always have the right education as well as the vehicles being equipped

correctly to drive dangerous goods as well as having correct processes in place. However, it is first at the point of booking or pick-up where a carrier could potentially identify dangerous goods, which is not always possible. (Carrier 2) Added, the only part that falls under the carrier's responsibility is when a parcel has been surrendered to the driver, the carrier will check for the right labeling, packaging and that good declaration is correctly filled out. If a deviation occurs, then the carrier does not accept the goods. (Carrier 3)

#### 5.4.2 The unaware sender

*“A bad sender gives zero prerequisite for a well-carried transport.” - Carrier 1*

It is the sender's responsibility to have the knowledge. If the sender does not possess the proper knowledge, the sender must seek advice from a safety advisor who will assist with classification, or companies that help with packaging labels. Despite this, if the sender is a private individual, sending the parcel without education is not allowed, even though this individual has been instructed on how to do so. (Carrier 3) As it is the sender's responsibility, it is neither the safety advisors who assist the sender that take responsibility of the goods, nor is the carrier's responsibility to know if a sender has the right education or has been using a safety advisor to classify goods or to mark it. (Carrier 3) External Safety Advisors first mention of a challenge within the handling of dangerous goods in the reverse transport flow of parcels is that of unawareness as well as the human factor.

The right conditions for carrying out the transport properly is given by the sender, according to Carrier 1, and therefore the senders also constitute a big challenge with dangerous goods. If those at the start of the transport chain are unaware or ignorant, the carriers in turn do not get the right conditions to carry out the transport properly. In those cases where the sender does not inform the carrier, and in turn driver, that the package contains dangerous goods, the goods is sent as non-dangerous goods. (Carrier 1) This is done by correct labelling, and declaration, and without the correct labeling on these parcels, the carrier does not know what they are dealing with if an incident was to occur. For the most part, the parcel stays unharmed for the whole transport, contributing that the carrier is kept in the dark by the fact that it could contain potentially accident-causing substances. (Carrier 1)

External Safety Advisor says when looking to small companies as the sender, they sometime rather turn a blind eye to the fact that their shipment might contain dangerous goods, as it might induce an extra cost, or the extra time to properly label the parcel. External Safety Advisor constantly inform customers on how the rules of ADR will apply but is very often met in response with a mindset that External Safety Advisor is not authority, and therefore not worth listening to. Apart from these type of ignorant senders, there are also those senders who for instance has previously experienced having goods interfered with and want to learn. In response to this, External Safety Advisor requests that the authorities take a more active role of informing senders who are companies or e-commerce retailers. The aforementioned respondent has also called MSB with the request to audit all of External Safety Advisers 165 customers.

Further regarding authority, Carrier 4 expresses that the responsibility of the government is to carry out controls of companies that send or are expected to send dangerous goods. Even though carriers are aware of whom the faulty senders are, authorities might only perform around ten audits per year even after repeated reminders. This causes a lack of word of mouth between companies. (Carrier 4) It is also added that the police today only perform half of the 7 200 controls of dangerous goods per year they should be making. Carrier 4 concludes this with a statement that the occurrence of a serious accident must happen to move forward with increased controls, even though there is a lack of resources for this.

As the rules of ADR grew tougher, the requirements became tougher while lacking the available information (External Safety Adviser). Establishing an e-commerce company today, who will start sending out parcels of goods, that might be of dangerous classification, receive little information from the authorities to keep in mind when they handle dangerous goods. (External Safety Advisor) The authority who writes regulations, should be forced to inform newly started companies of said regulations, and External Safety Advisor therefore suggest that Bolagsverket (The Swedish Company Registration Office) should, when registering a new company, not only have information of what the business entails, but also if it has items that are UN classified. Already at this point, MSB should 'intervene' to make sure newly established companies are handling their shipments correctly from start.

#### 5.4.3 New e-commerce retailers

The e-commerce retailer is one starting point in a forward flow, as well as the endpoint of a reverse flow, as it is to the original sender a parcel gets returned. Therefore, many of the respondents, carriers and safety advisers, expressed that e-commerce retailers, as they send out dangerous goods of LQ by parcel, is part of the problematic challenges. Hence, the authors review below the respondent's opinions of responsibilities of the e-commerce retailers in regards to the forward - and reverse transport flow of parcels.

A specific area where MSB has received indications that there are challenges, is within newly established e-commerce, especially when a retailer or company is not used to handling dangerous goods, contributing to the steady increase in the flow of dangerous goods that is "hidden". Many internet companies sell goods or items that contain dangerous goods but have little or no knowledge of the fact that the transport can be surrounded by regulations. (MSB) External Safety Advisor mention that the new e-commerce companies are unaware in matters of dangerous goods, one reason being as ADR is falling 2-3 years behind in regard to technological development, and the way transport are managed. An example is Wish.com, an online shopping marketplace, that many Swedes has visited today. Imagine how many transports originates from that website, e.g. a watch, that is under the exemptions of LQ, but is still dangerous goods. This, as well as a radio-controlled car with the lithium batteries, which according to External Safety Advisor 2, Wish.com can say: *'yes we just send it, it is no problem!'*.

The example of cosmetics, it is part of those dangerous goods that can be sent as a LQ, but by doing so it requires correctly done procedures. (Carrier 1) A colleague of Carrier 1 placed an order of beauty products with an e-commerce retailer, as a test, and the person who ordered called to inform the retailer on how the good should be correctly sent. In turn the colleague had received an unwillingness to listen from the retailer, and the items ordered was sent as hidden dangerous goods. (Carrier 1) Even though it was “only” nail polish, acetone and hairspray, this approach from e-commerce retailers give them competitive advantages by unscrupulous management of it all. There are many carriers that are skilled and many carriers just as bad in the same way as there are unsolicited senders, and there are senders who are just unaware. (Carrier 1)

When asked what challenges they see in the handling of dangerous goods or LQ in the current flow from them as an e-commerce retailer, E-commerce retailer 2 saw no challenges in the handling of dangerous goods from them as an e-commerce retailer today and mentioned that improvements are unnecessary as the E-commerce retailer 2 do not have many returns, about 0.8% in Sweden. Looking at parcels containing dangerous goods, the rate of return was even lower for E-commerce retailer 2. E-commerce retailer 1 simply responded that “*We have no dangerous goods in our flows.*”

## 5.5 Rules and regulations

Since the purpose of the regulations is to maintain transports as safe as possible, considering the specific characteristics of the good concerned, reverse logistics transport of goods is not regulated in any other particular way than with forward logistics of ADR (with the exception of class 7) - the dangers are the same. (MSB) Therefore the following empirical findings review the respondent’s opinions regarding how ADR affect the dangerous goods transport flow, as well as the challenges the respondents find due to this.

One challenge mentioned is that ADR is somewhat open to interpretations. It is suggested to remove all the interpretations as well as adding additional text to specify the meaning of the rules. (External Safety Advisor) However, this solution might also be problematic as many UN numbers has exemptions to control them. This, since it is too complex to specify text for each UN number. The rules for air are superior the regulations of other transport modes, this since there are no ‘if’, but rather ‘here's how to do it’. (External Safety Advisor) In the ideal world, External Safety Advisor wish to make all four rules homogeneous with each other. Today, you can look at it as a stairway, with road and rail at the bottom, ocean rules one step up, and air at the very top. This for instance in regard to the rules of separation. Example of this is class 8, corrosive acid, and class 8, corrosive base. These react to each other but can be placed together on a truck. In contrary, in ocean regulation the substances must be separated, and for air are not even allowed to be present together at the same place. With this example, there is a wish to see the different regulations more homogeneous, as there is a common thread. (External Safety Advisor)



As there are many similarities between transport modes, all regulations put together in one book would make them homogenous and truly harmonize the transport regulations. The European countries are getting more involved in the process of constructing the regulations, making trivial issues influence the bigger picture of the rules, according to Carrier 1. An example of this, as a result of neighboring country votes, is that a copy of the goods declaration has to be saved for three months after transportation has been completed, in case an accident investigation needs to be conducted. This implementation was translated and included in include ADR from DGR - the regulations for air - where the UN has decided that the goods declaration will be saved for three months in case of a crash, and a copy of documents should be kept on the ground. (Carrier 1) This means extra work for carriers, according to Carrier 1, who mention that it is possible to recreate the document in another way. All the documents and information the driver carries when transporting dangerous goods can be digital, if the police can access them within 10 minutes. (Carrier 1) ADR has, in Carrier 1s, opinion no difficulty with digitalization, but instead the challenge lies with the practitioners. It is also added that this could be a question of generation, as many are not used to managing digital aspects, but rather used to a managing physical paper. In the matter of digital copy versus paper document, it is possible to have e-documents when transporting dangerous goods, but the option of printing it must be available. This in the event of an incident which brings up the need for an investigation, as the truck might not be installed with a printer. (Carrier 2)

Further added regarding the digitalization, if it is possible to produce a barcode for the side of a parcel that indicates that this package has a dangerous goods declaration attached to it, the sender could print a declaration physically on paper and leave to the driver who collects the goods. (Carrier 1) When the driver then loads at outgoing terminal where parcels and goods are co-loaded, the barcode could be scanned to make the terminal aware of what goods they possess with a DGD connected. Since handheld computers are used, the driver who unload a parcel, scans the parcel and if it has a DGD, it appears on the handheld computer, or perhaps a blinking red light. When loading is finished, a simple check out of the terminal is made, with all the DGD digitally in their handheld computer following on to the truck. Adding that it would be possible to leave a copy stored at the terminal they leave, throughout the transport. This suggestion is stated by Carrier 1, in hope of making transports of this sorts electronic instead.

In ADR, there is as of now insufficient information regarding e-commerce. The transport from e-commerce retailer to customer is considered the same as from physical stores, but there are no specific rules governing it, as well as no definition of e-commerce written down in ADR (External Safety Advisor). This could, in External Safety Advisors opinion, make it harder to apply the rules on e-commerce retailers. One instance where e-commerce retailers are the focus of the transport flow is if the e-commerce retailer sends products to a private individual, that decides to return it. (External Safety Advisor)

## 6. Analysis and Discussion

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*This chapter discusses the different views and ideas of empirical findings, contrasted against the theoretical framework, along with the thoughts of the authors. The analysis aims to find a solution to the identified challenge areas of both the of rules and regulations and the current transport flow. These findings will lead to a desired flow, which will be presented along with major condition and implementation barriers in 6.2, and therefore also answer the sub question “To reach a desired flow, what major conditions and implementation barriers are there?”*

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### 6.1 Discussion of challenges in the current dangerous goods flow

#### 6.1.1 Handling of Dangerous Goods

The following subchapter will discuss the challenges of parcels containing dangerous goods or limited quantities(LQ). Even though parcels of dangerous goods are usually sent in LQ, it is not certain that a parcel is sent correctly. One big challenge is the parcels sent that is not labeled or packed correctly, that might not even contain LQ, but actual dangerous goods. Considering that dangerous goods are dangerous by nature, these leaves the fact that dangerous goods are being sent without sufficient knowledge. Therefore, the authors below discuss the challenges of handling dangerous goods. Also, a deeper approach on a class 9 product, namely lithium battery, will be taken.

##### 6.1.1.1 Hidden dangerous goods

When discussing the challenges of dangerous goods, hidden dangerous goods is the umbrella term which throughout the chapter empirical findings are covering several areas. As the content of the parcel can be considered unknown or hidden to the carrier, and as the inherent qualities of dangerous goods can cause accidents, the challenges of having dangerous goods sent without the knowledge of the carriers must be addressed.

All carriers agree upon that a large number of the hidden dangerous goods originates from an unaware sender. Apart from agreeing on the source to this challenge, the opinions of where the unaware senders are located in the transport chain varies. To Carrier 4, the biggest challenge of hidden dangerous goods lies with the pick-up-points, while others underline the sender being careless with the original packaging. (External Safety advisor, Carrier1) The most dangerous scenario of hidden dangerous goods, according to External Safety Advisor though, is the carriers urgency to fill up their truck. Here the discussion of co-loading and the rules of segregation is opened, as ADR (UNECE, 2017b) requires dangerous goods to be stored separately during transport. This applies to parcels containing LQ that is transported in the same truck. As carriers only get a small portion of what is payed for a shipment, carriers strive to drive fully loaded trucks as much as possible, making carriers possibly exclude different

classes due to the difficulties of co-loading (Carrier 2). Since the carriers can choose which UN-numbers to transport, there will naturally be an exclusion of UN-numbers, like class 1, explosives. This could lead to one out of three scenarios;

- The carrier would have to apply to the segregation rules in ADR, leaving space between parcels containing certain classes of goods
- Intentionally not accept the parcel, due that they can not fill the truck
- Intentionally bend the rules of not checking if it is dangerous goods or disregard it, to be able to load on to the truck

It would seem as all scenarios would lead to a loss for someone. The carrier would either lose space, the customer would not get their shipment sent, or the carrier would directly expose vehicle and other goods to possible dangers of transporting hidden dangerous goods. As scenario three though will not lead to direct consequences, but only consequences if incidents occur, one could understand the concerns expressed by External Safety Advisor.

#### 6.1.1.2 Lithium Batteries

The dangerous goods class 9, and specifically lithium batteries, stood out when discussed with the respondents. A good that is most often transported by the responding carriers, but also identified as the type of good that might most often be transported as hidden dangerous goods, often though as LQ. Revisiting the challenge of the unaware sender, part of the challenge can be due that it only seems natural to many people to be able to return what is purchased online. A mindset of the private individual that say 'If it can be sent one way, I must also be able to return it the same way.' The interpretation of this matter for a private individual sending a parcel can be quite confusing, for them as well as for the carriers and e-commerce retailers. With the example of a Power bank, as there are several ways to classify a lithium battery, depending on if it is a battery or a cell, rechargeable, or not rechargeable, shipped loosely, or if the battery is installed in the electronic equipment etc. (MSB.se, 2017b), it might be hard to establish how a Power Bank should be sent. However, since the entire Power bank is considered as a power source containing lithium batteries, it should be sent as a dangerous good with all its documentation with labeling etc. Due to insufficient knowledge among, dangerous goods are being sent as non-dangerous goods making the risk of accidents increase throughout the entire transport flow.

#### 6.1.2 The reversed transport flow

Since the rules of ADR allow for all classes of dangerous goods (except for class 7) to travel in a reverse transport flow, it is up to the carriers to determine which classes they allow to be handled and transported in their services, and whom is allowed to submit such parcels into eg. a pick-up point.

Managing the supply chain properly is important (Simchi-Levi et al., 2007) and when involving dangerous goods in this supply chain, it becomes even more important. As Johnsson & Mattson (2011) mention, the physical flow is typically from a supplier to a customer, but once the

products travel in a reverse flow, for the purpose of returns, exchanges or repairs, it travels from customer to the supplier. For all of the responding carriers, there is no distinct difference made between a forward transport flow and a reverse transport flow. This means, when considering the transport of dangerous goods, and LQ, the general notion is that the rules of ADR/ADR-S apply in both directions and exist to prevent harm to property, environment, but most of all to prevent harm to people. As long as these aspects are taken care of, the regulations of ADR has been framed in a manner to assist a smooth flow of physical goods, both forward and in reverse. (UNECE, 2017a). Since the growth of reverse logistics is due to governmental aspects as well as economical ones, according to Grabara et al. (2014), this affects how retailers adapt their business today. The governmental aspects refer to the increase in stricter regulations, to care for both environmental and social aspects (Grabara et al. 2014), something more companies today have to address to contribute to the positive environmental and social image of their company. The improved social image for one being the improved return policies that retailers launch to remain in the customers good grace. This will lead to, as Davis et al. (1998) mention, that the customers role in the market has been strengthened. Consequently, though leading to customers habit of purchasing goods, only to later return it, worsening environmental aspects with the increasing number of shipments transported.

#### 6.1.2.1 Catch 22

Today, a major challenge of sending parcels with dangerous goods or as LQ, is that a private individual is not allowed to send it. (External Safety Advisor) Furthermore, the current regulations require anyone who handles dangerous goods to have an education, 1.3, while the sender of the dangerous goods have the responsibility of labelling and packaging the parcel correctly (MSB.se, 2009). As a private individual do not normally possess this kind of education, and therefore cannot handle a parcel correctly, how is a customer of an e-commerce retailer ever going to be able to return the purchase of an e.g. hoverboard that was ordered online? Adding to this that by law in Sweden the customer has the right to return a purchased product within 14 days from the day of delivered parcel. (SFS 2005:59; Lilliehöök & Parastatidou, 2017) Even though return policies vary, meaning if the customer has to provide payment or not for the return, the right by law is still that a return can be made. A private individual can in theory contact safety advisors to receive necessary information on how to handle the parcel correctly but is still not allowed by ADR regulations to handle it without proper education. As well as the private individual is not allowed to send, the responding carriers are neither willing to accept a transport of dangerous goods from the private individuals.

This creates a catch 22, where the private individual has the rights to send back the dangerous goods, but according to regulations and carrier policy, is not allowed to. This will then constitute as hidden dangerous goods, as the uneducated private individual will accidentally, or intentionally, send the parcel without the right labels and without the carriers knowledge. Furthermore, even if a private individual does have a 1.3 education, this could be counterproductive due to the fact of using that knowledge in the process of sending dangerous goods. Instead of acquiring all the information required and get in contact with the authorities,

it could instead generate a shortcut for the private individual to intentionally send the parcel as “hidden dangerous goods” to make the process less of a hassle. This is further strengthened by the choice from the carriers to not allow sending of parcels containing dangerous goods, other than LQ. However, even a parcel of LQ must be handled correctly and labeled according to the regulations of ADR-S, and requires someone with 1.3 education (MSB.se, 2009).

If one were to try and dissolve the Catch 22, to allow a parcel of LQ to be sent by a private individual, the potential of further harmonization between regulations today is one suggestion. Carrier 1 exemplifies this with DGR - the regulations of dangerous goods for air - where it is applicable in some cases where direct education of an individual is not necessary, but instead requires very clear instructions for what is to be done. Such an instruction would have to come from the retailer, as they possess the relevant information of the dangerous good. In addition, multiple carriers also imply that the only time accepting a transport of LQ would be if the shipment is sent in its original box. In regard to this, considering that both Carrier 1, Carrier 2 and Carrier 4 suggests that the e-commerce retailer should be responsible for supplying clear instructions on how to handle the good along with the correct return packaging, label, and to include a goods declaration, this could prevent incorrect returns from the private individual. This implies however that the e-commerce retailer would have to take on the responsibility in terms of the product return, a flow that the retailer might not be expecting to be responsible for. As most e-commerce retailers focus on sales (Zhao, 2010), placing focus on packaging, labeling, and handling could become an expensive process that neither the customer or retailers are willing to pay for. Consulting E-commerce retailer 2 in this matter, the low number of dangerous goods in their current assortment makes the probability of them wanting to invest in reassuring that people are able to return the goods in a correct matter by marking them and informing the customer that the only way to return the goods is by sending it back in its original pack, is very low. Another point, apart from issue of costs, are the increased packaging materials to be sent out. This could from a marketing aspect reflect poorly upon the retailer, as it affects the environmental aspects.

A scenario was presented to MSB where a private individual returns a laptop to the retailer, where the retailer will be supplying packaging, labels and instruction on how to package the equipment correctly, in accordance with ADR and LQ. The question that arose based on this, is if private individuals that return lithium batteries to the retailer need 1.3 education, or if an instruction might be enough? (Carrier 2) According to MSB, this scenario is possible in theory. An instruction of how the equipment should be packed, and that information about the equipment from the retailer itself is included, is considered enough information equal to a 1.3 education. However, MSB adds that supervisory authorities have the final say in regards to this specific question. This indicates that even though MSB allows this type of solution to the catch 22 issue, it might still be a case settled in a courtroom, as interpretations of the rules still could be questioned, even though the rule maker(MSB) concur to the solution of the scenario. Furthermore, if the authorities would enforce rules to achieve a suggested solution like this, it still does not eliminate the extra amount of effort and resources the e-commerce retailer will have to put in, with minor output to the own company, perhaps apart from the reputation of excellent customer service.

Regarding the reverse transport flow of parcels containing dangerous goods, it sometimes seems as though what can be done is not to have individuals package and label correctly to send their dangerous goods, but rather to prevent them from sending it at all. The question is what to strive for, the easement of transportation, or the safety of transportation? It is clearly understandable why the exemptions and LQ has come to be, to improve efficiencies, but by allowing only a handful to utilize them, presumably small companies, as private individuals are exempted. The rest is simply sent in the dark.

#### 6.1.2.2 Pick-up-points

As Stanley et. al (2014) mentions, pick-up-points are not only the end point of a linear movement of physical flow, it is also the starting point in a reverse flow. Carriers today have extended their services of transportation, in order to also be able to operate these pick-up points. The easement of product returns has progressively been developed with the concept of free returns and improved policies (Davis et al., 1998). To be able to handle this increase flow of parcels pouring into the pick-up-points, respondents and authors concludes the knowledge of dangerous goods to be a determining factor.

Pick-up points in Sweden have employees which have been educated and know how to help those who want to submit a parcel, meaning employees have knowledge of what is allowed to send or not. (Carrier 3). However, this education is not a 1.3 education, which would mean that the employees cannot accept or handle dangerous goods and the employees are instructed not to do so. (Carrier 1) As stated by MSB.se (2009), the education in this case is ‘function-specific, meaning that the employees at a pick-up-point only need to be trained in what concerns the task at hand. The only thing that employees at the pick-up-point do in a current flow is to identify if a parcel has labels on them indicating dangerous goods, to then decline them to be sent. The potential of discovering hidden dangerous goods is in this scenario lost in the current flow. On the other hand, as employees continuously are switched out, it would be time consuming and costly to provide 1.3 education for every employee that starts working at a pick-up-point.

Concerning LQ, Carrier 1, Carrier 3 and Carrier 4 allow parcels to be sent at their pick-up-point, but not from private individuals. However, Carrier 3 attempts to make an exception and waive these terms of service, but still follow the rules according to ADR, to allow for customer satisfaction solution. Also, Carrier 1 mention that an exception can only be made for private individuals if the LQ is handed in its original box. It seems as though the only occasion when a private individual is allowed to submit a parcel of LQ to the pick-up-point, is when a parcel is already labeled by the retailer, the carrier therefore put trust in the retailers knowledge. The theoretical background of ADR mention that when dealing with LQ, ADR license is not required, but a 1.3 education is. Therefore, with background of the requirement of the education, when Carrier 1 allows for a private individual to hand in a parcel of LQ, will it automatically mean that the pick-up-point employee now moves outside their functions-specific task, from identifying if it is dangerous goods, to handling it?

In consideration to the strictness of ADR, carriers can apply internal rules regarding what to allow to send via their pick-up-points, but the carriers automatically supply different options for the customer sending a parcel. If a private individual visits the nearest pick-up-point, being Carrier 4s pick-up-point, anything that is classified as dangerous goods is not allowed to be sent, not even LQ. However, if this individual would walk further down the street to Carrier 1s pick-up-point, the individual would be able to send the parcel brought in its original box to be sent in return to a retailer. Consequently, a situation of competition between the carriers with pick-up-points has presented itself, meaning that when a carrier determines what goods to allow, a potential trade-off could emerge with cutting out a certain risk or losing potential customers.

To further improve upon the handling of parcels in these matters at the pick-up-points, employees need to have the proper knowledge to be able to explain to an uncomprehending customer that dangerous goods is not allowed to be sent and that the label on the parcel indicates dangerous goods. Downside to this is that those who gain or previously possess knowledge of dangerous goods and intend to send it through the pick-up-points knowingly incorrect, have indeed probably torn away the labels already at home, intentionally sending hidden dangerous goods. (Carrier 1)

Instead of supplying education, increasing controls already at pick-up-points as well as carriers terminals in some cases, could be one very effective way to improve the efficiency of identifying the challenges as early as possible. For one, to already at the pick-up point make it mandatory to disclose information regarding the content of a parcel. One way of obtaining this information is to present a small information note at the pick-up-point desk, where information about the content has to be provided. This would be a standard requirement that applies for domestic shipments. (Carrier 3) It also needs to be clear that the customer has to write in specifics of what is being shipped and not a generalized term of goods. As the employee at a pick-up-point have some education in this matter, a red flag should be raised if the note reads something suspiciously sounding like dangerous goods, to follow up with the customer. If the sender does not know, customer service should be contacted and consulted before sending.

External Safety Advisor also agree that a short note at the desk of the pick-up point should be filled out, or even more simply; a quick question asked to the customer; “*What is the content of your package?*”. A reason why this has not been implemented before is notable due to that no major accidents of hidden dangerous goods in parcels has yet emerged. (Carrier 3) This indicates that currently there is no incentive to implement this and consequently add an extra cost for a more thorough process when sending a parcel. From the customer's standpoint, the process would have an additional step when sending parcels, and a solution like this could therefore lead to the customer just stating “not sending dangerous goods”, to be able to make the process easier, or even to send hidden dangerous goods intentionally. With this kind of improvement, extra work will be created for the employee at pick-up-point, which they probably will not look enthusiastically upon. Contrasting what Ducret & Delaître (2013) mention, regarding services such as pick-up-point tends to be innovative and more

environmentally friendly, this suggestion would indeed promote innovativeness but not so much the environmentally friendly aspect of it.

### 6.1.3 Responsibilities

As Carrier 1 stated: “*A bad sender gives zero prerequisite for a well-carried transport*”. For the e-commerce retailer, this means to possess proper knowledge of their goods to send it out correctly. If the retailer fails to properly send something, that is dangerous goods or LQ, it becomes nearly impossible to start to correctly return the good.

#### 6.1.3.1 The unaware sender

In accordance with MSB, as well as that of ADR regulations, it is the responsibility of the sender to ensure that the regulations are followed when the transport is to be sent, thereby also being responsible to make sure the sender can pass on the necessary information in the reverse transport flow. The carrier has responsibility to always have the right education as well as the vehicles being equipped correctly to drive dangerous goods. (Carrier 2) The same is true for a reverse transport, and since the packaging should be labeled, information needs to be given to the carrier if the contents are dangerous goods. (MSB) It is added that a carrier’s only responsibility when a parcel has been surrendered to them, is to check for the right labeling, packaging and that the goods declaration is correctly filled in. If a deviation emerges, the good is not accepted (Carrier 3), and if it is not labeled at all, the carrier has no responsibility of checking if it indeed could be dangerous goods (Carrier 2). This means that the carrier who pick up the goods have no way of knowing if the parcel contains dangerous goods or not, unless that specific information is given along with a DGD. The DGD, providing all necessary information of the dangerous goods which the carrier and shipper must save for each article and substance for three months (MSB, 2017). Since the police can request this information to be used in an investigation, it can put the carrier and shipper in a difficult situation if it turns out that dangerous goods have been transported, but no document related to it exists. Not only will this result in the lack of transport documents, but in a where the parcel contains dangerous goods a carrier company can not fulfill their responsibility of providing a driver with ADR-license, a written instruction or the correctly equipped truck, without the proper information from the sender.

A driver transporting dangerous goods must have written instructions available in the vehicle in the event of an accident or incident to be able to act accordingly (MSB.se, 2017c). Since the written instruction consist of actions to be taken depending on what kind of dangerous goods being transported, and what equipment to carry, it can put the driver in a dangerous situation when being unaware of the characteristics of the dangerous good. Indeed, it is not the drivers’ responsibility of checking the good, but in the case of the parcel actually containing dangerous goods, the driver may not be prepared for it, putting him at risk. This creates a challenge as the carrier, in current application of ADR, need to simply trust that the parcel being transported does not contain any dangerous goods. This factor of human error and unawareness can be high, but the carrier will never know unless incidents occur. If a non-ADR educated driver were to discover a parcel containing dangerous goods whilst in transport, a challenge identified



is not only that the driver is unpreparedly transporting something of danger but could also be the cause of a delay. A driver on a tight schedule might also disregard the fact that he is transporting dangerous goods and continue. (External Safety Advisor) The consequence of this brings either danger for the driver, delays of transport or damage of other parcels. In concern to this challenge, it is suggested that authorities, such as MSB need to take responsibility of informing the unaware senders as well as the police performing more frequent controls on the road. (External Safety Advisor) The natural barrier presents itself in a lack of resources and manpower, displayed for instance in MSB performing only half of all controls.

If the challenge at hand revolves around the sender, who is responsible for the shipment, being unaware regarding how the parcel is to be correctly sent, the authors see the option to remove one out of the two; either the unawareness, or the responsibility of the sender. This can be achieved in two ways, either the sender need to be properly informed on how a shipment is to be handled when dangerous goods is involved, information from MSB. The second alternative is that the retailer will have to be responsible for making sure that a return is properly managed, as discussed in 6.1.3.1 catch 22.

#### 6.1.3.2 E-commerce retailer

Many times, the challenge of the reverse transport flow start at the original shipper in the forward logistics flow. A company's success in the e-commerce market can be highly dependent on its distribution network efficiency (Huppertz, 1999; Foster, 1999; Harrington, 2000; Hill, 1999), and today it may seem to be operating smoothly, but a major challenge according to MSB as well as External Safety Advisor, is the large number of newly established e-commerce retailers that sell products online with insufficient knowledge that they sell dangerous goods, consequently increasing the hidden dangerous goods in circulation. Though, e-commerce retailer 2 mention that when products are sent out, parcels are labeled at the warehouse as they have a safety advisor, but in the reversed flow, their customers do not have the same possibilities. During the thesis, it became evident that it is possible that some e-commerce retailers might not have the proper knowledge regarding dangerous goods. E-commerce retailer 1 said that there were no dangerous goods being sold, while the product catalogue suggested otherwise. This, since in their current catalogue have items such as hoverboards and Power banks, both of which is containing lithium batteries. As this response from e-commerce retailer 1 was discussed with several of the responding carriers, multiple answers therefrom indicated that the e-commerce retailer indeed could be sending dangerous goods unknowingly. This raises the question, and the issue of, if a supplier sends out hidden dangerous goods to start with, it would be nearly impossible for the product to be sent in return in the reverse flow correctly. Further to the presented challenge of e-commerce retailers, it could be added that the information flow will not be transparent and neither communicated correctly to logistics companies nor end customers.

As numerous physical stores are gravitating towards an online business, Chong & Bauer (2000) mention the rapid development of internet as staggering, really pushing companies to establish themselves online. This in turn have had a huge impact on the number of parcels sent every

day, and indeed the amount that is sent in return. (Chaffey, 2011; Tawfik & Albrecht, 2008; Qin et al., 2014). As by law in Sweden, the customer has the right to return a purchased product within 14 days from the day of delivered parcel. Depending on the generosity of the e-commerce retailers return policy, it can be quite expensive and a complex process for the retailer due the correlation between increased sales frequency and increased returns. (Lilliehöök & Parastatidou, 2017; MSB) This indicates that the process of returns overall is a complicated process and does not become less complex by introducing the aspect of dangerous goods in the mix. Revisiting MSBs statement regarding the part e-commerce retailers plays in the responsibility of sending dangerous goods, the rules and regulations aspect adds an additional factor to the complexity of returning parcels containing dangerous goods from the customer.

Apart from adding complexity to a reverse flow, implementing e-commerce can also lead to several advantages for a retailer, those for example of lower cost of trading, as well as business decisions being made quickly (Zhao, 2010), now that the retailers have to send parcels via mail order, with a new set of rules to apply. Concerning cosmetics, it is part of those dangerous goods that can be sent as a LQ, but it requires certain procedures done correctly (Carrier 1). If an e-commerce retailer is unaware of this, or find it too difficult to comply with, another aspect of the challenge entails the competitive advantages the e-commerce retailer might gain by incorrectly handling a shipment. This, by promising customers that they can send them the goods, when in fact ADR has strict regulations place upon the shipment. As e-commerce retailers are highly influenced by the final customer, which in turn have high expectation on service levels, (Esper et al., 2003; Agatz et al.,2008), this might consequently have the e-commerce retailers sending dangerous goods to further their own prosperity. Although, this has potential for a competitive advantage, it will most certainly be a short-term one. Like stated in the ADR, legal actions can be taken by national authorities, but ADR itself does not involve any penalties when violating the rules (UNECE, 2017b).

If looking at this challenge of e-commerce retailers proactively, to reduce the number of newly started e-commerce companies with knowledge gaps, then Bolagsverket (The Swedish Company Registration Office) should from registering a new retailer, not only provide information about what the business is, but also if the retailer has articles that are UN classified. (External Safety Advisor; Carrier 4) Already at this point, MSB could “intercept” these retailers, and be involved from the start in order to make sure that the new companies are handling the shipments of parcels correctly. It should be MSBs responsibility of making sure that the rules they enforce, are also being communicated to those potentially entering a business where this knowledge is highly needed. (External Safety Advisor) If MSB also where to start performing more extensive audits on customers, the word of mouth would start to spread between companies and could potentially increase the awareness of how important this issue really is. Since MSB only perform roughly ten audits per year amongst all the companies dealing with dangerous goods, it is not being taken too seriously. The authorities work towards audits in a greater extent is not looking too bright. (Carrier 4) The main challenge seems to be a lack of resources and that no severe incident has occurred which would draw enough attention to highlight this issue.

## 6.1.4 Rules and regulations

As the rules of ADR allow for every type of dangerous goods to be transported, whether it is in forward logistics or in the reverse flow (from the exception of class 7), the following discussion will analyze the challenges that affect a transport flow concerning the rules of ADR, as well as the ADR effects on the flows efficiency and security, concerning the influence this might have over parcels, as well as the practitioners that handle the parcels in the transport flow.

### 6.1.4.1 Interpretability of ADR

The ADR framework exists to determine how actors involved in the transport flow are obligated to act and be equipped to correctly proceed with a transport. (UNECE, 2017b) As an established international regulation, many contracting countries has uttered opinions in the matter, with adding of rules and as well as exceptions to this framework. (External Safety Advisor) By this, it would seem the regulations today have entries of rules that might seem clear to some, but open for interpretation by others. One of the challenges identified from the empirical findings is indeed the interpretability of the current regulations. The rules of ADR with statements appear clear, nevertheless, respondents with up to 30 years of experience in the field are disagreeing on bullet points in the regulations. This matter is exemplified of whether DGD should be on physical paper or not. While ADR have a written paragraph stating the rules (UNECE, 2017b), opinions among the carriers are divided. While one carrier thinks a digital copy of a DGD is sufficient, another's interpretation is that the driver needs to be able to produce a physical copy of DGD. (Carrier 1; Carrier 2) The authors believe a misinterpretation of the word paper document to be the villain as it may have been lost in translation. It might also be a question of generation traditionally using paper or that ADR needs to be revised in order to diminish interpretability. (External Safety Advisor) This reverts back to Jonsson & Mattsson (2011) statement that it is truly important for the flow of information to run smoothly. Concerning interpretations, External Safety Advisor emphasized the action to remove interpretation by adding additional text to further specify the meaning of the rules. Setting a good example of this is the rules for air, where there are no IFs, but rather 'here's how to do it', which furthermore supplement the wish for further harmonization, discussed in *chapter 6.1.4.2 Harmonization*.

This demonstrate that if a rulebook is open to interpretations, these could be taken advantage of in other contexts, especially if the private individual is sending parcels of dangerous goods in the reverse flow. Building on the fact that carriers today set their own restriction on who is allowed to send, they always have to base their restriction on following the rules of ADR. As handling of dangerous goods requires 1.3 education, and Carrier 1 for instance allow private individuals to send parcels in its original box, it becomes up to the carrier to interpret when a parcel has been 'handled', and in the case of the original box, Carrier 1 must not interpret so, or otherwise it would conflict the rules of ADR. To interpret the ADR in this particular way would allow carriers or actors in the transport flow to perform the deliveries or pick-up of

parcels without thoroughly checking the paperwork or providing a loophole to not segregate the parcels on the truck.

#### 6.1.4.2 Harmonization

When using more than one mode of transport, it can become quite complex to handle dangerous goods, since they fall under different regulations. The ideal world, according to External Safety Advisor and majority of the carriers, would be to make all the regulations homogenous with each other, where one regulation covers all the transport modes. This, as the many similarities of the transport modes regulations is already laid down in the “model regulations on the transport of dangerous goods” by UNECE (2017b). If aspects such as labeling, packing, documentation, placards etc. would be the same for all transport modes, it would contribute to a worldwide harmonization. (Svensson & Wang, 2009) It will, however, be quite difficult to achieve since all the transport modes have major physical differences. Thus, a continuous work towards a much greater harmonization of the regulations between each transport mode is still an ongoing issue.

There are many aspects in other regulations that ADR could benefit from, for instance from the precision of DGR - the regulations of dangerous goods for air - where it is applicable in DGR in some cases where direct education is not necessary, but instead only clear instructions on what is to be done is needed. An aspect that was discussed as a way to address the challenge of the Catch 22, *see 6.1.2.1 Catch 22*. Contrasting harmonization, as ADR today is not as complex and precise as for instance DGR, harmonization can also make up a lot of extra work if imposed upon all modes of transport. The example being that nowadays a copy of documents should be kept for three months, a rule adapted to ADR from DGR. It makes up much extra work for carriers that it is possible to recreate the document in other ways, for instance electronically. (Carrier 1)

#### 6.1.4.3 Technology

The challenge for many new e-commerce companies is that ADR is falling 2-3 years behind in regard to technological development today. (External Safety Advisor) This is further strengthened by a majority of the respondents. As the logistics market expand, promoting the development of new technology in logistics will have a direct effect on the transportation flow (Bask et al., 2012; Masmoudi et al., 2014; Ramanathan et al., 2014). However, some argue that ADR has no problem with digitalization, but rather that the problem lies in the practitioners. (Carrier 1) This could be true, as when it becomes easier for customers to order technological items containing dangerous goods, e.g. a laptop, the reverse flow of parcels increases. Furthermore, a digital barcode connected to a dangerous goods declaration could be one solution for the "practitioners", making it possible for the driver to scan the parcel and receive all the necessary information (Carrier 1). However, as ADR is a UN regulation, revising the technological aspects will require governmental decisions. This type of process could make the statement from External Safety Advisor true, that ADR is 2-3 years behind in technological development. Apart from revising ADR in regard to technological aspects, External Safety Advisor miss a clear definition of e-commerce in ADR. Since e-commerce is such a rapidly

growing trend with no significant indicators of decreasing (Statista, 2017), it might be an additional way to tackle obstacles regarding interpretation and add clarity to the implication of this matter, especially for generations whom still have a more traditional approach of the transport sector.

## 6.2 Suggested improvements to reduce challenges of a desired flow

By establishing a current process of the reverse transport flow, this enabled us to generate and discuss solutions to address the existing challenges. The information in the table is based on the current flow and improvement suggestions from both the respondents and the authors. The suggested improvements were sent out to the respondents, validating if the suggestions were tangible and applicable. (appendix D) In the first column a suggestion of improvement is presented, the second column describes what is needed to implement the improvement, and column three review which major barriers there are for implementation of the improvement. The fourth column estimate the expected time it should take to implement the suggestion.

Desired Flow	Major conditions needed	Major implementation barriers	Expected years to achieve
<b><i>Handling of dangerous goods</i></b>			
<i>MSB will perform audits in greater extent in companies, to reassure that the retailers are updated on current information in regards to ADR</i>	-MSB needs a number of inspectors who work full time with audits	-MSB own resources and priorities of its commitment as an authority.	>5 years
<i>Digitize handling at loading, stuffing and unloading as well as DGD</i>	-A standard is required that works throughout Europe - Takes advantage of modern IT technology. -Customization of software. -Stable and secure IT systems.	-In a number of countries, eg. drivers do not have access to scanners -negative attitudes towards change	>5 years

***The reversed transport flow***

<p><i>Return packaging, labels, DGD is included from retailer</i></p>	<p>-Retailer should then take on responsibility for the return -Clear demands on the e-commerce company, to be governed by clear requirements that apply equally to every retailer.</p>	<p>-The cost the will fall on e-commerce companies -environmental cost -regulations and supervisory involvement</p>	<p>3 years</p>
<p><i>Clear instruction from retailer is enough to send Dangerous Goods as a private individual</i></p>	<p>-A very clear, concise and simple instruction is required. On the instruction, there must be check boxes where the customer ticks the actions. This ticked instruction is signed and submitted with the product at the pick-up-point. -When leaving dangerous goods for transport follows criminal liability</p>	<p>-retailer refuse due extra work or cost</p>	<p>3 years</p>
<p><i>When parcels are left at the pick-up point, a note has to be filled out with specific content</i></p>	<p>-approval from the regulator PTS, to make it standard, or the single carrier can make the decision. -International implementation. -making it easy to fill out, to tick boxes on a note -education and reference card placed at the employees at pick-up-point</p>	<p>-Comments on the Law on Postal Secrecy -Costs of implementing -National provisions -Only introducing it to Sweden would only solve the top of an iceberg as a lot of packages are ordered online from other countries. -People might learn how to lie to make goods slip through controls -Responsibility is shifted from the sender to the carrier. It also means that all service places become a control body</p>	<p>1 years</p>

<b>Responsibilities</b>			
<i>MSB will reach out to and inform all newly established companies handling dangerous goods to inform them of the regulations.</i>	-Changes in the regulations business registration; newly established companies will have to name what type of products they work with when they register their new company at Bolagsverket.	-Only improvement towards companies that are not established yet, not existing ones. -Ignorance of the company of what it is actually sold - MSB own resources and priorities of its commitment as an authority.	>5 years
<i>The police will increase the frequency of controls of Dangerous Goods on road</i>	- Clear ambitions from the Government/Authorities - Earmarked money / resources to build its business to the desired level - Resource changes and more education of police are required, not just for a priority issue	- Difficulty to acquire enough resources - Government funding - Cost to educate	3 years
<b>Rules and regulations</b>			
<i>Improved interpretability of ADR</i>	- UN decision on common transport standard -European countries would have to vote	-Government decisions and possibly associations will always affect any decision	>5 years
<i>Revised regulations in ADR in regards to the technological aspects.</i>	-This, as there have been an increase in electronic devices and lithium batteries that are transported today. -More needed if lithium batteries become more powerful. -Need to be carried out at a more general level than ADR, as the transport should also work in multimodal transports	-Government decisions and possibly associations will always affect any decision. -As 50 countries are involved, conditions of the social and political aspects of each country must be considered.	>5 years

<b>Rules and regulations cont.</b>			
<i>Definition of E-commerce to be included in ADR</i>	-If specific e-commerce regulations are entered, it is likely that a definition of the term is also likely to be entered.	-Is the need for a definition is deemed necessary to introduce in ADR? -If included, it will have an effect on current rules	3 years
<i>Further harmonize the regulations of all transport modes. Ideally, to make all the regulations homogenous with each other, one regulation covers all the transport modes.</i>	-UN decision on common transport standard	-Depending on the regulatory framework that would be governing, you have major differences in ADRs, such as Europe, the United States and Australia. -to imply that in all contexts the strictest regulation is applied, which can not be regarded as justified. -the different characteristics for different transport modes, for instance a truck can be pulled over if there is an incident, an airplane can not as easily.	>5 years

Table 5 - Suggested improvements to address challenges of a desired flow



## 7. Conclusion

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*This chapter will answer the research question presented in the introduction. Based on experts' opinions along with the input of the authors, this chapter provides the readers with a holistic view of the research outputs and emphasizes the most crucial changes needed to address the challenges in transport of parcels containing dangerous goods in reverse logistics on road. Suggestions for future research is also presented.*

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To conclude, the authors will answer this thesis research question:

*What challenges exist in the transport flow of parcels containing dangerous goods in reverse logistics on road, and how can these challenges be address?*

First half, regarding challenges is concluded in 7.1, and how the challenges can be address is concluded in 7.2.

### 7.1 Challenges identified in the flow of parcels containing dangerous goods on road

A number of challenges has come to surface when discussing matters of handling parcel of dangerous goods in the reverse flow on road. Reverting back to the introduction of this thesis, identified early when combining the concept of dangerous goods with reverse logistics, is a gap in the knowledge of the senders not used to handling products of dangerous goods, directly aspiring unawareness on how to ship these in parcels in a correct way. Even though parcels of dangerous goods are usually sent in limited quantities (LQ), it is not certain that a parcel is always sent correctly. One big challenge is the parcels sent that is not labeled or packed correctly, that might not even contain LQ, but dangerous goods. The umbrella term identified that connects the challenges in aforementioned transport flow, is that of the *hidden dangerous goods*. Due to the inherent qualities of dangerous goods, these leaves the fact that dangerous goods are being sent without the sufficient knowledge from the carriers, with the potential of causing accidents. The distinct challenges identified and concluded below is those of; lithium batteries, the e-commerce retailer, pick-up-points, the unaware sender and catch 22. Also, the challenges concerning the regulation ADR is concluded as well.

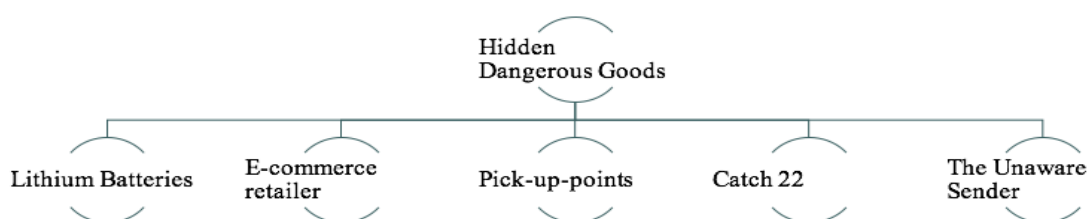


Figure 11 – The factors of Hidden Dangerous Goods

Many times, hidden dangerous goods flows could be due to the increase in certain products that conceals dangerous goods today, namely the lithium batteries. This is exemplified by e-commerce retailer 1 denying that the retailer sells and ships dangerous goods. However, the product portfolio included e.g. hoverboard, which would indicate otherwise. This also leads into the next identified problem, that of the e-commerce retailers. Related to the e-commerce retailer, it is crucial with proper knowledge of the goods being sold to be able to send it correctly. If the retailer fails to comply, whether it is sent as dangerous goods or LQ, it will be nearly impossible for a customer to later return the good in a reverse flow correctly. This challenge is also identified due to many retailers today utilize the internet for increasing their sales while cutting fixed costs. The consequence of this is a large number of newly established e-commerce retailers without knowledge of sending out parcels of LQ, a consequence partly due to that information from responsible authorities are not mediated properly.

Since the rules of ADR allow for all classes of dangerous goods (except for class 7) to be sent in the reversed transport flow, it is up to the carriers to determine which classes to approve of, and whom is allowed to submit such parcels into a pick-up point. Function-specific education is applied for the employees stationed at the pick-up points, which means education sufficient for identifying if a parcel contains dangerous goods or not, indicated by the labels, limiting the probability of discovering “hidden dangerous goods”. The employees are not allowed to handle nor accept the dangerous goods, unless under special circumstances, for instance where Carrier 1 allows for LQ at their pick-up-point, but only if the parcel is to be sent in its original box. Though a 1.3 education would allow the employees of pick-points to indeed handle the parcel of LQ, since these employees are replaced continuously, it would be quite costly and time consuming to provide a 1.3 education for the entire staff working at the pick-up-point.

As Carrier 1 said: “*A bad sender gives zero prerequisite for a well-carried transport*”. Challenges of this kind in the end comes down to the knowledge of those who are responsible. The challenge of a sender that indeed is responsible of making sure everything is correctly aligned before the next part takes over, but not knowledgeable, will create unsafe circumstances. This, for instance, causes issues of the carrier not being able to fulfill his responsibilities in turn, potentially placing the driver picking up an unmarked parcel at risk, as information has not been passed on properly. Therefore, knowledge is key in this case, whether the sender is a retailer or a private individual. Although, by allowing more people to learn about the correct way of sending a parcel of dangerous goods might not only help secure a decrease in wrongfully sent packages, but give people incentive to intentionally not label their parcels correctly, as they then know it will indeed be prevented from transportation.

One of the biggest challenges identified, not only regarding the hidden dangerous goods, but to the reverse flow overall, is that private individuals are not required to be educated on dangerous goods, but they still have to follow the rules. How are they supposed to follow the rules without any knowledge and training? A private individual can contact a safety advisor and ask for the correct information to handle a parcel containing dangerous goods correctly, but the ADR regulation still does not allow this to replace a proper education. This challenge created, the catch 22, the authors has twisted and turned in many directions, as all the

respondents try to figure out how this challenge has come to be, as it is still a great challenge that affect both carriers, the retailers, and not least the private individual wanting to return their parcel.

Reverting back to the foundation of road transport of dangerous goods, the ADR regulation, the wish for improved interpretability as well as further harmonization of the regulations has been pointed out by several respondents. These challenges are indirectly affecting the parcel flow of dangerous goods, as a more holistic view is applied when looking to these, as the ADR is relevant on a European level.

## 7.2 Suggestions to address the challenges and improve the transport flow

To counteract the above compiled challenges that has presented themselves throughout the research, the authors generated and discussed improvements to address the challenges in the current transport flow. This to achieve instead a desired and improved flow. Following that the suggested improvements was compiled, the respondents were given the opportunity to validate if suggestions indeed were tangible and applicable, and the authors could conclude concrete improvements.

As discovered, e-commerce retailers are a thorn in the side of many respondents, especially the newly established retailers. Apart from revising ADR in regards to technological aspects, as well as introducing a clear definition of e-commerce, a way to tackle this challenge is by providing better education and information to the e-commerce retailers. From a proactive point of view, an improvement suggestion is that the retailer have to disclose if they have articles that are UNclassified when registering their new company at Bolagsverket (The Swedish Company Registration Office). From a reactive side, MSB could perform audits in greater extent in certain companies, to reassure that the company know current information in regard to ADR. Consequently, two improvements that thou would require much time and resource from MSB, and potentially not be possible within the next 5 years.

To tackle the very challenging catch 22 of the private individual not being able to send LQ in return, is to have the e-commerce retailer send very clear, concise and simple instruction on how the private individual should handle the product return. MSB would also approve of this, as information wise they state it would be sufficient of a 1.3 education. Along with the instruction would also a return packaging, labels, DGD be included from retailer. A solution which has the highest chance of achieving efficient and safe transport from the private individual, but that unfortunately would demand much from the retailer, in terms of both cost and extra work, not to mention the environmental impact it would have.

There is indeed a lack of knowledge and education with the staff stationed at the pick-up-points which needs to be addressed, as well as with the customer. However, instead of further emphasizing the importance of supplying the correct education, a step in the right direction is

to implement stricter controls at the pick-up-points in order to increase efficiency of identifying dangerous goods as early as possible. Already at the pick-up-point, make it mandatory to disclose information about the content of a parcel and make it a standard requirement. This simply by having a small information note at the pick-up-point desk, where the customer specifies the content the parcel when handing it in for shipment. This system, with regards to the employee having sufficient education, can react instantly, if the filled-out note raises suspicion of a parcel containing dangerous goods. The result from an implementation like this though, would risk that the customers rather just fill in 'not sending dangerous goods' to ease the process, which leads to counterproductive measures.

With further harmonization you would indeed be able to implement the useful conditions of other regulations, for example DGR - regulation for air. However, with this would also the strictness of the other regulation be implemented, a strictness and rules that today might just cause problems for the road transportation of dangerous goods, regarding time and extra paperwork. As e-commerce has exploded, the technological challenging aspect is found both in regard to the increase in lithium batteries, as well as the easement of purchasing electronic devices online. This seem to create the wish for the regulation to be revised in regard to the technological aspects, as it would indeed be challenging if they were not up to date.

## 7.3 Further research

### 7.3.1 Other transport modes transporting parcels

As this thesis put focus on road, the other transport modes which today are capable of handling parcels containing dangerous goods are interesting to further apply the idea of this thesis. Therefore, the next step, would be to explore where challenges lie within the other transport modes of air, rail and ocean. In the instance of a reverse transport flow of goods by rail, this research could be carried out domestically within Sweden. The additional aspect that the research applied to air and ocean provides is that of import and export as well. This aspect is not only interesting since the regulations, DGR for air and IMDG for ocean, controlling these transport modes are based on a European level, but also since the strive for further harmonization between them are an ideal vision of the transport operators as of now.

### 7.3.2 Storing of parcel containing dangerous goods

Another adjacent challenge area into which future research could be done is the storage of dangerous goods. This since for instance, when goods that are placed at the pick-up-points is in waiting, as parcels must be handled and stored before the customer collects it. This brings an additional aspect of the handling of dangerous goods and LQ, the storing. Since segregation rules apply to many hazardous classes, if for instance hidden goods of these are stored together in a small room at the local grocery store, what are the dangers of this? Local employees at the grocery store may not have all the knowledge. Another example of where storage might be an issue is when it is discovered in the terminal, and set aside, since it can not continue to be transported incorrectly.

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# APPENDIX A - Interview guide - External Safety Advisor

## *Background*

- What is your job title / responsibilities / job description?

## *Dangerous goods*

- Can You estimate how much dangerous goods, and limited quantities, are transported each year on the way? And how much is transported in the reverse flow every year? (statistics)
  - If not, is there any specific reason for this?
- Which dangerous goods class is transported most frequently?
  - Does any dangerous goods class need special attention when transporting or handling? Please explain!
  - Which dangerous goods class have the greatest risk when transportation or handling?
- Are You aware of any accidents or challenges regarding dangerous goods during transport, at pick-up-points, at terminals or any challenges with the documentation flow?
  - If yes, what was the social or economic consequence of this?
- Where do You see challenges in the transport flow of dangerous goods on the road?
  - Do You have any suggestions where or how to address these challenges?
  - Are there any barriers to these improvements?

## *The return flow*

- Can You describe a return flow of dangerous goods transport from the point where the carrier receives the goods from customer to final recipient?
  - How, and when, in the transport flow, does the responsibility shift between shipper and carrier?
- How does limited amount work in the return flow? How much can be sent?
- How and where in the return transport flow are the goods identified if it contains dangerous goods or not?
  - What happens if dangerous goods are detected, which are not marked or packaged correctly by the sender?
  - If the goods are returned to the sender, is it packed and marked correctly by, for example, the terminal?
- Where do You see challenges in the reverse transport flow of parcels of dangerous goods on road?
  - Do You have any suggestions where or how to improve these problems?
  - Are there any barriers to these improvements?

### ***Rules and regulations***

- Do You think that the ADR / ADR-S regulations have an effect on transport efficiency today?
  - If yes, how?
- What challenges do You find today regarding current ADR / ADR-S regulations?
  - How can these challenges be met, or how can the regulations be further improved?
- According to ADR, customers are not required to be trained, but they still have to follow the rules. How are they supposed to follow the rules without any training? For example, how does the local grocery store handle returns of dangerous goods?
- How is dangerous goods checked/controlled in the reverse transport flow?
  - How often? What is checked/controlled? (content)
  - How do you think that the control of dangerous goods in the return flow could be improved?

***Thank you for your participation!***

# APPENDIX B - Interview guide - Carrier

## *Background*

- What is your job title / responsibilities / job description?

## *Dangerous goods*

- What dangerous goods classes do You allow to send?
  - Which classes are allowed with limited amount?
  - In which transport units do You transport dangerous goods?
- Which dangerous goods class is transported most frequently?
  - Is any dangerous goods class in need of special attention when handling or transporting? Please explain!
  - Which dangerous goods class have the greatest risk when transportation or handling?
- Are You aware of any accidents or challenges regarding dangerous goods during transport, at pick-up-points, at terminals or any challenges with the documentation flow?
  - If yes, what was the social or economic consequence of this?
- Where do You see challenges in the transport flow of dangerous goods on the road?
  - Do You have any suggestions where or how to address these challenges?
  - Are there any barriers to these improvements?

## *The return flow*

- Can You describe a reverse transport flow of dangerous goods from the point You receive the goods / parcel from customer, to final recipient?
- What is Your responsibility and role in the transport chain?
  - How, and when, in the transport flow does the responsibility shift between the sender and You as a carrier?
  - How does limited amount work in the reverse flow? How much can be sent?
- Do You distinguish between "regular transport" of dangerous goods and reverse transport of dangerous goods?
- How and where in the reverse transport flow, do You as a carrier identify if the goods are dangerous goods or not?
  - What happens if dangerous goods are detected that are not labeled or properly packaged by the sender? If the goods are returned to the sender, is it then packed and marked correctly?
- Customers are not required to be trained, but they still have to follow the rules. How are they supposed to follow the rules without any training?
- What do You do as a carrier do to help customers properly handle dangerous goods / limited amount?
- Where do You see challenges in the reverse transport flow of parcels of dangerous goods on road?
  - Do you have any suggestions where or how to address these challenges?

- Are there any barriers to these improvements?

***Rules and regulations***

- Do You think that the ADR / ADR-S regulations have an effect on transport efficiency today?
  - If yes, how?
- What challenges do You find today regarding current ADR / ADR-S regulations?
  - How can these challenges be met, or how can the regulations be further improved?

***Thank you for your participation!***

# APPENDIX C - Interview guide - Carrier with pick-up-points

## *Background*

- What is your job title / responsibilities / job description?

## *Dangerous goods*

- What dangerous goods classes do You allow to send?
  - Which classes are allowed with limited amount?
  - In which transport units do You transport dangerous goods?
- Which dangerous goods class is transported most frequently?
  - Is any dangerous goods class in need of special attention when handling or transporting? Please explain!
  - Which dangerous goods class have the greatest risk when transportation or handling?
- Are You aware of any accidents or challenges regarding dangerous goods during transport, at pick-up-points, at terminals or any challenges with the documentation flow?
  - If yes, what was the social or economic consequence of this?
- Where do You see challenges in the transport flow of dangerous goods on the road?
  - Do You have any suggestions where or how to address these challenges?
  - Are there any barriers to these improvements?

## *The return flow*

- Can You describe a reverse transport flow of dangerous goods from the point You receive the goods / parcel from customer, to final recipient?
- What is Your responsibility and role in the transport chain?
  - How, and when, in the transport flow does the responsibility shift between the sender and You as a carrier?
  - How does limited amount work in the reverse flow? How much can be sent?
- Do You distinguish between "regular transport" of dangerous goods and reverse transport of dangerous goods?
- How and where in the reverse transport flow, do You as a carrier identify if the goods are dangerous goods or not?
  - What happens if dangerous goods are detected that are not labeled or properly packaged by the sender? If the goods are returned to the sender, is it then packed and marked correctly?
- Customers are not required to be trained, but they still have to follow the rules. How are they supposed to follow the rules without any training?
- What do You do as a carrier do to help customers properly handle dangerous goods / limited amount?



- Where do You see challenges in the reverse transport flow of parcels of dangerous goods on road?
  - Do you have any suggestions where or how to address these challenges?
  - Are there any barriers to these improvements?
  -

***Focusing on parcels, You have your own pick-up-points:***

- Do you see any challenges with (return) handling of dangerous goods that pass through pick-up-points? For example, as discussed, packages that are not properly labeled as dangerous goods?
- Does it occur that dangerous goods are detected at pick-up-points?
  - Is the personnel of the pick-up-points able to handle dangerous goods, or in limited quantities?
  - Are they educated, and must they be educated?
- Is there anything at this point in the flow that could be improved, according to You?

***Rules and regulations***

- Do You think that the ADR / ADR-S regulations have an effect on transport efficiency today?
  - If yes, how?
- What challenges do You find today regarding current ADR / ADR-S regulations?
  - How can these challenges be met, or how can the regulations be further improved?

***Thank you for your participation!***

# APPENDIX D - Survey - Feedback Suggestions

*“Hello,*

*During the thesis period, we have received many suggestions for what could improve the current flow / return flow of dangerous goods, as well as focus on return of parcels. In order to validate that the improvement proposals are feasible and applicable in the real world, we need your help in a short survey. Expected to take 5-10min.*

*Below are the improvement suggestions, followed by short questions regarding the suggestion.”*

## **The short questions that followed each improvement suggestion below:**

Do you think that such an improvement is possible?

Yes    No    Do not know

If yes, within how many years?

1 years    3 years    5 years+

What major conditions do you think would be needed to implement the improvement? (eg. resources, knowledge, government decisions, etc.)

What major barriers do you think could prevent the improvement? (eg. resources, knowledge, government decisions, etc.)

## **Suggestions for improvement**

- *“Revise the regulations in ADR in regards to the technological aspects. This, as there have been an increase in electronic devices and lithium batteries that are transported today”*
- *“Include the definition of E-commerce in ADR”*
- *“To further harmonize the regulations of all transport modes. Ideally, to make all the regulations homogenous with each other, one regulation covers all the transport modes.”*
- *“A standard requirement would be that a small information note is to be filled out by private individuals who intend to send parcels at the postal service(uthämningsställe). This would include one quick question; “What is the content of your package?” This will further enhance the ability to identify if a private individual is sending dangerous goods, or at least raise a red flag with the postal service employees. “*

- *“Newly established companies will have to name what type of products they have, and if they are dealing with dangerous goods, when register their new company at Bolagsverket. Authorities/MSB will then call and inform all newly established companies handling dangerous goods of the regulations when shipping these.”*
- *“The e-commerce retailer has to include pre-labeled return packaging, and clear information to the customer, when shipping dangerous goods or limited quantities. Since private individuals are not allowed to handle dangerous goods/limited quantities, the e-commerce retailer sending the product will be the one responsible for the return shipment”*
- *“MSB will perform audits in greater extent in certain companies, to reassure that the company know current information in regards to ADR”*
- *“A clear instruction from the shipper/e-commerce retailer on how to handle the parcel will be enough to send dangerous goods in limited quantities as private individual”*
- *“Digitizing the handling of the dangerous goods by applying a barcode at the side of the package that indicates that the package has a dangerous goods declaration attached to it. Then when the driver loads or unloads you can just scan the barcodes which makes them aware that there are dangerous goods at the terminal, via their handheld computer.”*

# APPENDIX E - Classifications of Dangerous Goods

<b>Class</b>	<b>Danger</b>	<b>Examples</b>
<b>Class 1</b>	<b>Explosives</b>	<b>Fireworks and torches</b>
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	
Division 1.4	Substances and articles which present no significant hazard.	
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	
<b>Class 2</b>	<b>Gases</b>	<b>Lighters and compressed air</b>
Division 2.1	Flammable Gases	
Division 2.2	Non-Flammable, Non-Toxic Gases	
Division 2.3	Toxic Gases	
<b>Class 3</b>	<b>Flammable Liquids</b>	<b>Alcohol and Paint</b>
<b>Class 4</b>	<b>Flammable Solids; Substance liable to</b>	<b>Matches and</b>

	<b>spontaneous combustion; Substances which emit flammable gases when in contact with water</b>	<b>Firelighters</b>
Division 4.1	Flammable solids	
Division 4.2	Substances liable to spontaneous combustion	
Division 4.3	Substances which, in contact with water, emit flammable gases	
<b>Class 5</b>	<b>Oxidizing Substances and Organic Peroxides</b>	<b>Chlorates and Nitrates</b>
Division 5.1	Oxidizing substances	
Division 5.2	Organic peroxides	
<b>Class 6</b>	<b>Toxic and Infectious Substances</b>	<b>Medical and Clinical waste</b>
Division 6.1	Toxic substances	
Division 6.2	Infectious substances	
<b>Class 7</b>	<b>Radioactive Material</b>	<b>Radioactive Ores and Yellow Cake</b>
<b>Class 8</b>	<b>Corrosive Substances</b>	<b>Batteries and Acids</b>
<b>Class 9</b>	<b>Miscellaneous dangerous substances and articles, including environmentally hazardous substances</b>	<b>Vehicles, Fuel cell engines, Lithium battery</b>

Table 2. Classifications of Dangerous Goods (UNECE, 2017a)

## APPENDIX F - Segregation Table ADR

Labels 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										d								b			
1.4					a	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	X			
3		a			X	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	X			
4.1 + 1								X														
4.2		a			X	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	X			
5.1	d	a			X	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	X	X			
5.2 + 1												X	X									
6.1		a			X	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	X			
7A, B, C		a			X	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	X			
9	b	a b c	b	b	X	X	X		X	X	X	X		X	X	X	X	X	X			

X Mixed loading permitted.

a Mixed loading permitted with 1.4S substances and 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 safety devices, pyrotechnic of Division 1.4, compatibility group G, (UN No. 0503) and safety devices, electrically initiated of Class 9 (UN No. 3268).

d Mixed loading permitted between blasting explosives (except UN No. 0083 explosive, blasting, type C) and ammonium nitrate (UN Nos. 1942 and 2067), ammonium nitrate emulsion or suspension or gel (UN No. 3375) and alkali metal nitrates and alkaline earth metal nitrates provided the aggregate is treated as blasting explosives under Class 1 for the purposes of placarding, segregation, stowage and maximum permissible load. Alkali metal nitrates include caesium nitrate (UN 1451), lithium nitrate (UN 2722), potassium nitrate (UN 1486), rubidium nitrate (UN 1477) and sodium nitrate (UN 1498). Alkaline earth metal nitrates include barium nitrate (UN 1446), beryllium nitrate (UN 2464), calcium nitrate (UN 1454), magnesium nitrate (UN 1474) and strontium nitrate (UN 1507).

(Source: UNECE, 2017b. p.546)