Car carrier operational guide and proposal for an optimization system

Treball Final de Grau

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Abstract

El propòsit del present projecte és proporcionar una guia operativa vers la gestió dels car carriers, a més de desenvolupar un sistema concret que pugui ser potencialment implementat en les metodologies de treball dels diferents operadors involucrats, per tal d'incrementar la seva eficiència mitjançant l'automatització de tasques.

En general, les operatives de càrrega de vehicles en vaixells de propòsit específic són força uniformes, tant en les dimensions físiques dels seus components, com en les tasques administratives que els acompanyen. Per aquest motiu, l'objectiu d'aquest projecte és aprofitar la naturalesa repetitiva de l'operativa dels car carriers per desenvolupar un sistema que permeti polir els procediments de treball la comprenen: des d'aspectes purament operatius de la càrrega, o d'estiba i estabilitat, fins a tràmits de duanes, etc. A fi d'avaluar les possibilitats que aquesta proposta pot oferir, és necessari definir prèviament els processos sobre els quals es vol treballar, que és el que s'exposa en la primera part del treball.

Els mètodes de recerca empleats en l'elaboració del projecte han consistit majoritàriament en l'obtenció d'informació de part de professionals i operadors del sector, procés que ha estat especialment fluid gràcies a l'experiència laboral de l'autor en l'àmbit dels car carriers.

Els resultats de la primera part del projecte s'han considerat satisfactoris respecte l'objectiu inicial de servir com a suport introductori per, posteriorment, a la segona part, poder desenvolupar el sistema proposat. En quant als resultats d'aquesta última secció, tot i proveir idees innovadores i concretar el marc en el que es podrien implementar, no permeten ser plenament positius de cara a portar el projecte més enllà de l'exploració teòrica, a causa dels prerequisits econòmics i de les dificultats de consens que això implicaria.

The purpose of this project is to provide an operative guide towards the management of car carriers, in addition to developing a concrete system which can be potentially implemented onto the working methodologies of all the involved operators, so their efficiency can increase throughout the automation of tasks.

In general terms, the loading operations of vehicles into specific purpose vessels are quite uniform, both in the physical dimensions of its components and the administrative tasks that follow them. For this reason, the aim of this project is to take advantage of the repetitive nature of a car carrier's operation, and develop a system that allows polishing the procedures that constitute them: from purely operational aspects of the cargo, to stowage and stability matters, to customs formalities, etc. In order to assess the possibilities that this proposal is able to offer, a previous exposition of the procedures that will be analyzed must be carried out, which forms the first half of the present work.

The research methodologies used for the development of this project have mainly consisted in directly gathering information from professionals and operators, process that has been especially smooth thanks to the author's work experience in the car carriers' field.

The result of the first part of the project have been considered to be successful in regards to the initial purpose of serving as an introductory support for, later on in the second half, being able to develop the

proposed system. In respect to this second section, its results don't allow to withdraw fully positive conclusions for carrying the project beyond a theoretical exploration, due to the economic prerequisites and consensus difficulties that it would imply.

Keywords: car carrier, vehicle logistics, cargo operations, shipping company, automation system, efficiency, stowage, port terminal.

Agraïments

En primer lloc, gràcies a la meva mare i al meu pare per donar-me tots el mitjans necessaris per poder fer el treball i la carrera.

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Glossary of terms

AEO (Authorized Economic Operator): a party involved in the international movement of goods in whatever function that has been approved by or on behalf of a national Customs administration.

BL (Bill of Lading): document used in the maritime transportation of goods that serves as a contractual agreement between a shipper and a carrier for transporting the goods from one point to another.

CEU (Car Equivalent Unit): unit used for approaching the estimate load capacity of a car carrier through a predetermined standard vehicle size.

EDI (Electronic Data Interchange): is the electronic interchange of business information using a standardized format.

EORI (Economic Operators Registration and Identification number): is a European Union registration and identification number for businesses which undertake the import or export of goods into or out of the EU.

ENS/EXS (Entry/Exit Summary Declaration): is the declaration presented at the first/last customs office of entry/exit for goods in the EU customs territory.

GM (metacentric height): is a measurement of the initial static stability of a floating body. Takes into account the center of gravity and the buoyancy center of the body.

GT (Gross Tonnage): a measure unit that refers to the internal volume of vessel, and is normally used as a means for categorizing commercial vessels.

H&H (High and Heavy): a term used for encompassing the vehicles whose measurements and weight vastly differ from what is considered a regular vehicle. Ex.: buses, trucks, caterpillars, etc.

IMO (International Maritime Organization): The United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships

LIM (Lanes In Meters): counts the lanes length times the number of lanes on each deck times the amount of decks of a vessel, with the purpose of obtaining her available loading longitudinal space.

LOA (Length Overall): is the maximum length of a vessel's hull measured parallel to the waterline.

Mafi: mobile loading platforms that facilitate the transportation of large items.

MARPOL (International Convention for the Prevention of Pollution from Ships): is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes.

PCC (Pure car carrier): is a type of car carrier vessel specially designed for the transportation of passenger cars in large quantity.

PDA (Proforma Disbursement Account): an estimate of the port charges or husbanding charges related to a ship's call, which is often sent by the agent to the owner or the charterer.

RFID (Radio-Frequency Identification): said of any technological system that uses electromagnetic fields to automatically identify and track tags attached to objects.

RO-RO (Roll On-Roll Off): are vessels designated for the transportation of cars, trucks, buses, trains, and other types of wheeled or rolled cargo.

SAD (Single Administrative Document): is the main customs form used in international trade to or from the European Union Customs Union.

SOF (Statement Of Facts): a legal memo that consists of a detailed chronological description of the vessel's timings and movements.

SOLAS (International Convention for the Safety of Life at Sea): an international treaty whose aim is to specify minimum standards for the construction, equipment and operation of ships, compatible with their safety.

T1/T2 (customs status): refers to the non-Union/Union customs status of goods, respectively.

UCC (Union Customs Code): is the customs code for the European Union and is intended to modernize customs procedures. Currently, under progressive implementation.

VIN (Vehicle Identification Number): a unique code for every vehicle that contains data such as the model, when and where the unit was manufactured and a security check digit.

1. Introduction

At some point in 2018, while the author was working on a ship's agency, M/V Nordic ACE, a car carrier vessel suffered a setback while performing loading operations at the Barcelona port. it was supposed to load a determinate number of vehicles, but amidst the operative, someone realized that the weight of the cargo caused the vessel's draft to increase to a point where it was close to reaching the depth of the water; so, if the loading operations were to continue, the vessel would not be able to sail. Consequently, an amendment operative was improvised, consisting in discharging enough vehicles for the vessel's draft to decrease, and by this, being able to shift the vessel to another berth with a more permissive water depth, and resume the loading operations. The implications of this eventful call came to an additional time loss and economic expense, in relation to what is usually expected from an operative of these conditions, but at the same time, widely recognizing that the source of this problem was a correlation of human errors.

While the human error is natural, and these situations will keep on happening now and then, the M/V Nordic ACE affair raised a question on whether the employed working methods were suitable enough for tackling the human error issue. The negative answer to this question, induced the earliest motivation for working towards a potential solution.

In line with this, the recurring idea that the car carrier business' working procedures had room for improvement, the weariness derived from constantly doing simple, yet repetitive tasks, added indefinite ground-breaking possibilities in this field. Eventually, the combination of these two handicaps led to the formation of a slightly more precise motivation, which required a platform for its project to be developed on, and the scope of this work was found most fitting for its purpose.

Later on, with the initial stages of the development moving ahead, the necessity for delimiting the work's extent appeared. In the first place, the intended geographical reach of the project is set for it to be global, as the only limitations for the usage of the system would probably be the diverse legislative frameworks across countries. That said, the project has been developed only taking into consideration the car carrier environment in the European Union, so it would be most reliable within this territory. Secondly, the longevity of the project has also been delimited after the realization that completing all its stages, including an actual implementation, would be clearly too complex. For this reason, this work only explores the theoretical applications, implementation and design of the proposed system.

Lastly, the third delimited dimension is the level of technical depth which the project is approached with. In present vessel operations, pragmatism is prioritized in front of technical pretension. For this reason, this project is developed along the same lines. This approach is also shared in the first half of the work, where a general but useful view of the car carrier context is provided, as its purpose is to serve as a background for understanding the mechanics of its follow-up counterpart.

Having determined at this point the scope of the project, another aspect to take into consideration is the existence of similar systems and technologies, and to what extent they can overlap with this project. In this sense, the research provided results that confirmed the existence of different systems in the automotive industry that address similar issues to the Control Device Appliance. For example, some car makers use RFID tags, for increasing the efficiency on their factories and logistic chains. This is the case for Audi, Seat and Mercedes among others, or Volvo, who takes the implementation of these systems a

step further, and integrates the RFID technology inside the design of the some of its models. car manufacturers are not the only operators interested in these innovative systems, as some vehicle terminals, like Bremerhaven, also use them for having a tighter control over their stored stock.

However, the common pattern in the currently implemented systems, is that, because they are developed by private corporations, their benefits and accumulated intelligence is not shared among operators, and their implementation is not fostered outside their inner walls. For this reason, the Control Device Appliance aims to extend these advantages and other new potential applications, so all operators can benefit from its advantages and, thus, the improve the overall efficiency of the car carrier business.

2. Understanding car carriers

2.1. The context of the car carrier

Car carrier ships, also known as Roll-on/Roll-off ships (RO-RO), are vessels designated for the transportation of cars, trucks, buses, trains, and other types of wheeled or rolled cargo. Vehicles are usually driven in and out from the vessel's decks by its own means through stern/quarter main ramps. The purpose behind car carriers is to be able to load the maximum number of vehicles with the highest possible efficiency, both with respect to space and time, but this concept has come a long way since its initial interpretation.

The idea of carrying rolled cargo onto a ship is believed to be first conceived in 1842 when a Scottish railway company was set to connect the cities of Edinburgh and Dundee. At that moment the bridge technology was not ready to hold that infrastructure, so custom-built vessels were crafted in order to be able to transport the trains from one shore of the estuary to the other. This type of train-ferries was widely used during World War I because it provided a very effective solution for transporting heavy artillery and large amounts of supplies to the front. However, it wasn't until World War II, when more modern lookalike car carriers began to be seen with Landing Tank Ships (LTS). LTSs were first used during the evacuation from Dunkirk in 1940, and their loading-unloading means consisted of a bow ramp that enabled tanks to disembark fast onto the beach, thanks to the shallow drafts of these crafts.

Figure 2. A car carrier nowadays. M/T Aquamarine ACE.

Figure 1. Early stages of the maritime transportation of vehicles.

After the end of WWII, many saw the potential that maritime vehicle transportation held, and in 1946, still with LTS models from the War, the first commercial voyage was carried on from Tilbury, England to Rotterdam, the Netherlands with 64 vehicles for the Dutch Government. Nevertheless, in order to find the first purpose-built car carrier, we have to move forward to 1956, when Searoad of Hyannis was assembled to carry three semi-trailers from Hyannis to Nantucket Island in Massachusetts, USA.

The first big commercial approach to RORO ships was made in Japan in the 1960s by Mitsui Osk Lines, still one of the largest shipping companies nowadays. With the building of the Oppama Maru in 1965, they vastly improved the way that vehicles were loaded and unloaded. The upgrade raised the rate of work from a previous 15 units loaded per hour to around 100 units per hour. This was possible thanks to the incorporation of features such as placing ramps at the stern and the center of the vessel, dividing the loading space into five decks with a six-stowage layer structure, and a "car lifter" technology that

allowed to move the loaded cars horizontally in order to narrow the space between them. With these, among others, the capacity of Oppama Maru raised up to 1.200 vehicles.

2.1.1. Types of car carriers

The way car carriers were built continued improving during the second half of the 20th century until nowadays, where loading rates can go as high as 200 vehicles per hour and some Pure car carriers like MV Tønsberg peak at a capacity of 8.500 plus units. Also, the different needs in relationship with the cargo loaded, the distance of the voyage and other factors have been matched with the emergence of different types of car carriers:

- **Pure car carriers (PCC):** this is the principal type of Ro-Ro ship and the one that this work is mainly focused on. They are usually equipped with a main quarter stern ramp and a secondary starboard ramp that helps speed up the discharge operations while leaving the main ramp free. PCCs have the most capacity of all RORO ships, ranging from 1.000 car Equivalent Units (CEU) to 8.000+ CEU and they can also load all types of heavier bigger rolled cargo. Carriers with smaller dimensions are mostly used as feeders and for short-sea shipping services, while the larger ones cover oceanic trans-continental voyages.

- **Roll-On/Passenger (ROPAX), ferries**: these ferries have a maximum capacity of 1.000-1.500 CEUs, and can carry both rolled cargo and passengers, which are commonly used for attending island services. They commonly carry small amounts of brand-new cars, as well as used vehicles, and trucks loaded with goods for covering the insular demands.

- **Roll-On/Lift-Off (ROLO)**: equipped with onboard cranes, ROLOs can carry both self-driven vehicles and lifted cargo. Another variant is the Roll-On/Container (ROCON), capable of loading wheeled cargo and containers, usually without having onboard cranes. ROLOs and ROCONs capacity is not as big as their single-purposed counterparts, and they are generally designed for feeder duties.

2.1.2. Specific characteristics of the car carrier

As a result of their specific purpose, car carriers have their very own design, which differs from that of other cargo ships. The first feature that probably comes to mind when trying to picture such a vessel is its size, which for car carriers' usually ranges from a Length Over All (LOA) of 100 to 200 meters, with a beam up to 40 meters and draughts of 10 meters at a maximum load capacity.

Having these measurements in mind, it has to be taken in account that the aim of car carriers is to be able to load the largest possible amount of units. Thus, in order to exploit the available space as much as possible, PCCs are designed with a parallelepiped-like shape, or as they are casually referred to: shoe boxes. Therefore, this almost cubic profile will cause the block coefficient to be very high, nearly reaching 1.

The fact that car carriers' shape has such straight lines directly affects their seaworthiness: the huge amount of the ship air draught surface causes the wind to have a notable impact on the vessel's behavior, so the effect of the leeway is always at its maximum. Furthermore, the horizontal compartmental design of car carriers, as opposed to the more common vertical subdivision system, makes them very flood prone; once the water enters a hold it has free way to occupy the whole deck. This was, for example, proven on the infamous case of the sinking of the MS Estonia in 1994, when the

bow ramp disgracefully opened during the voyage causing the holds to quickly fill with water and get the craft sunk in less than an hour.

Having in mind accidents like the one of the MS Estonia, special attention should be paid to the importance of the correct lashing of all the loading ramps once the port operations have been completed. Moreover, the entering of water inside a car carrier is especially dangerous compared to other types of ships due to the huge amount of free surfaces that it has, and the consequent cargo shifting that can be produced, aggravating this way the danger situation and the stability loss.

Another factor that has a noticeable impact on car carriers' seaworthiness and safety is the large freeboard they possess. On the one hand, it magnifies the effects of the swaying at the more elevated parts of the vessel like the bridge, making the sea sickness worse for those who suffer it, for example. Nevertheless, on the other hand it has a positive effect on the safety side, because it allows the vessel to list to a lot of degrees without having the main deck submerged below the water line. This way, it is harder for a PCC to sink due to listing than for other types of merchant ships.

This was noted during the accident suffered by MV Cougar ACE in 2006; an exchange of ballast water produced a loss of stability and caused the vessel to list 60 degrees to port. With a list this severe, the vast majority of vessels, e.g. a containership, would have sunk, but after the due salvage efforts were made, the ship was re-stabilized and was able to continue with its duties, to the point where a lot of the vehicles that were stowed inside the vessel could be sold later on (thanks to being properly lashed) and, at the date of this work, the MV Cougar ACE is still operative.

Figure 3. M/V Cougar ACE after suffering a stability loss back in 2006.

On today's car carriers, avoiding issues such as the one the MS Estonia suffered is easier because the correct lashing of the ramps is tested and monitored from the bridge through an electronic safety system. Another aspect that can be traced from the bridge is the position of the movable decks. Usually, PCCs have 8 to 12 decks, with 3 of them (the one at the ramp's level and the surrounding ones) being liftable to two or three different preset heights in order to fit the loading needs of larger vehicles like trucks or heavy machinery. Moreover, not every deck can withstand the same amount of weight, and generally the closer they are to the main ramp, the more resistant they tend to be. As a consequence, the main ramp needs to be able to support very similar loads as the tougher of the decks, while considering in the stress calculations the tilted condition of the ramp as well as the non-prolonged state of the weight that it has to support.

However, on feeders, the maximum capacity of the ramps ranges from a few metric tons to 100mt in some cases, while for oceanic car carriers it can go as high as 400mt. Another way of seizing how much weight a surface can withstand is through pressure, usually measured by kg/cm2. This is very helpful when loading specific types of heavy machinery because it allows knowing how much weight affects the sometimes few supporting points of these units. Also, before loading high and heavy machinery (H&H), vehicles or over dimensioned pieces on mafies (mobile loading platforms that facilitate the transportation of large items), the measurements of the ramp need to be taken in account, mainly the width (commonly ranging from 6 to 12 meters) and its angle in relation to the horizontal plane because notable changes of the gradient between the ramp and the main deck can cause units with low points between its rolling axis to be unable to be properly loaded/discharged (see Figure 4).

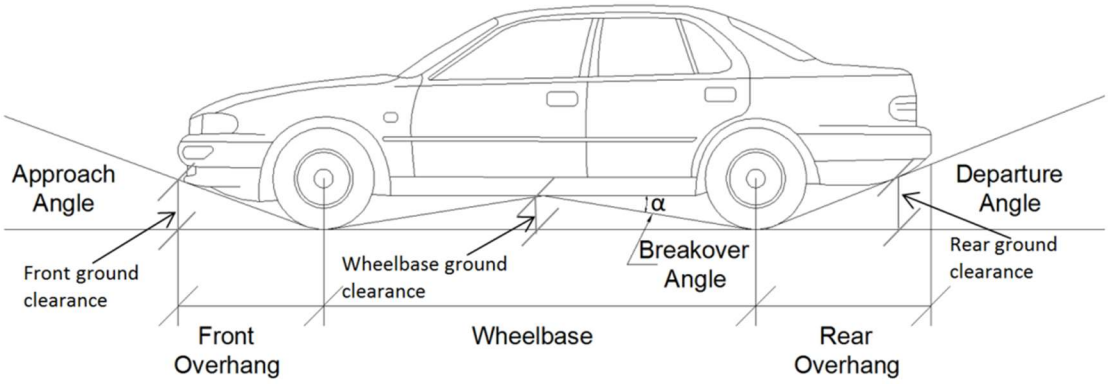

Figure 4. The importance of taking into account the floor clearance of a vehicle while operating on ramps.

After understanding how weight affects Ro-Ro ships, it's also key to manage the space accordingly. On PCCs, the dimensions of decks decrease as they get closer to the bottom of the vessel due to the shape of the hull so, the lower a deck is, the shorter and narrower it tends to be. The amount of space a deck has is simply measured by its length and width, as there are no pre-established tracks that subdivide those spaces and thus enclose the vehicles into grid-like schemes, so vehicles can be freely stowed at any point of the deck and in every direction, although a longitudinal stowage is always preferable as opposed to transversal stowage.

On Ro-Pax ships decks are delimited by tracks painted on the deck's floor designed for the sake of a more organized loading of trucks and particular cars. These tracks are measured by LIM (Lanes In Meters), which counts the lanes' length, times the number of lanes on each deck, times the amount of decks on the vessel, with the purpose of obtaining the available loading longitudinal space.

In any case, on either type of car carriers, the decks' lashing means share the same features: evenly distributed holes on the floor that serve as anchor points for the lashes, thereby allowing the securing of vehicles at any location all along decks. These holes are placed with a frequency enough to effectively stow a vehicle wherever it is supposed to, and have a size big enough to fit the lash hooks.

When speaking of lashing, an aspect to have in mind is that the responsibility to secure it. On ferries, it is common to find that the crew of the vessel is responsible for the lashing, while on PCCs the stowage personnel are the ones who usually take care of it, with the exception of some specific ports that don't provide this service. A car carrier's crew, however, mustn't be unaware of the loading and unloading operations, as the responsibility of all cargo issues usually relies on a bridge officer (typically the first officer), who is usually helped by several seamen while doing this task. Furthermore, the composition of

a car carrier's crew is similar to the ones on other types of ships, always comprising: the Master, three bridge officers and three engineer officers (with a fourth of both departments being optional), a bosun and variable number of deckhands.

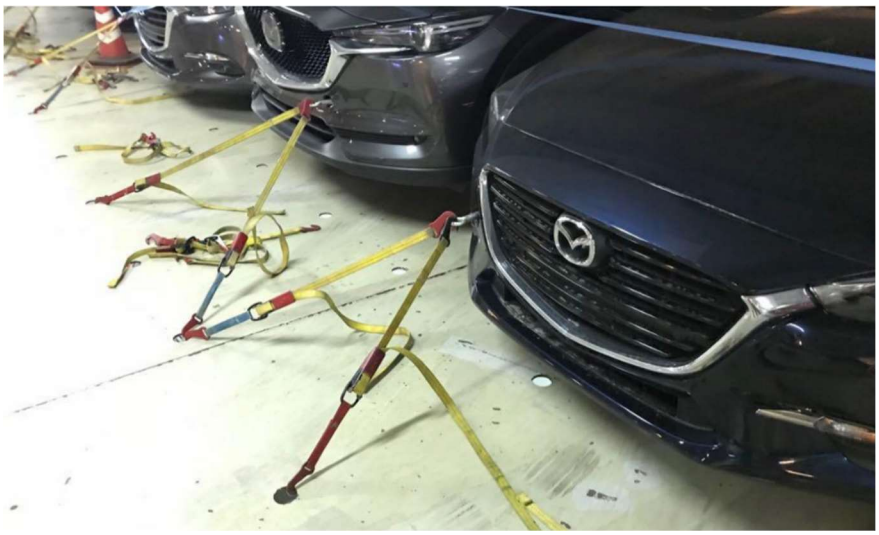

Figure 5. Lashing means on a car carrier's deck.

Moreover, following its navigational capabilities, car carriers have a rather average navigational speed, generally sailing at around 16 knots at eco speed, but being able to reach 20 knots if needed, e.g. when the sailing schedule is very tight. However, this case is not very common, as car carrier services are usually well-established and time-wise because of the already known transit times and the capability to calculate how many shifts a vessel will need at a determined port and thus how much time will it spend there. However, due to car carriers shape and seaworthiness, heavy weather conditions are the main cause for making PCCs sensible to delays.

Its shape also causes PCCs to be quite unagile, and it has a direct effect on their rate of turn, advance and tactical diameter, the three of them reaching high figures. In addition, because the maneuvering tends to be tricky, it's very common for car carriers to require tug assistance in order to berth, which is usually heavily conditioned by whether the vessel is fitted with a bow thruster, a key element for port maneuvers; if it doesn't, its absence would be replaced by an additional assistance tug, often of compulsory use.

Also, considering that rolled cargo is very sensitive to movement and can get damaged easily due to prolonged non-purely horizontal conditions, it is very important for car carriers to have effective draft and stability regulation systems. That's the reason why nowadays all Ro-Ro ships are built with automatic ballast tanks that constantly track and regulate the weights that cause the vessel's list, moving the vessel away from 0 degrees. This is very useful during loading operations, when the amount and position of the weights varies all the time. Thus, this helps to keep the drafts difference to the minimum during navigation (as opposed to other merchant ships, where the draft aft is usually greater for fuel efficiency reasons).

Another aspect to consider is the metacentric height, always higher in car carriers than in other types of ships as a consequence of a more elevated center of gravity. A higher GM magnifies the effects of listing, a dangerous feature on Ro-Ro vessels as previously discussed, so automatic ballast systems are of big help because they enable to quickly and reliably amend these situations. In addition, they also make

possible to precisely place the center of gravity wherever it is found to be more convenient safety-wise. But, as vehicles are not always loaded in uniform ways, both from the longitudinal and transversal axis' perspective, ballast compensation is usually an effective solution to non-symmetric stowage plans.

Finally, it is also important to mention a car carrier's lifespan, first starting with the planning and design, and then its posterior construction, which usually means an overall stay at the dry dock of around three years. Once the vessel is operative, it is expected to serve for at least twenty years; after this period, and depending on whether its operative capacities keep on maintaining the same quality and safety standards, the most likely scenario is that it become relegated to routes with less navigational impact, as in the case of oceanic PCCs, which in many occasions will end up operating as feeders.

2.2. The vehicle as the standard cargo unit

Apart from studying the nature of the vessel, while trying to explain the process of operating a car carrier, it's very important to comprehend the broad scope of characteristics that the loaded vehicles can have and in what ways these can affect the process of managing a car carrier's operative and each of the parties involved. In order to do so, every attribute that a vehicle can possess and that plays a relevant role, wellbeing operative or documentation wise, in customs issues or in tax paying, needs to be considered. That's why comprehending the nature of the vehicles that are being loaded is as key as understanding the way the vessel herself works, because during an operative the vessel is a constant and the cargo is an ever-changing variable.

2.2.1. The vehicle in the context of the car carrier

As cars and other rolled cargoes can cover such a wide range of shapes and measures, at the dawn of PCCs there was an attempt to standardize these variables into one value: the CEU, which was based on the first mass-produced commercial car to be sea shipped by car carriers, the 1966 Toyota Corolla. The motivation behind the standardization efforts was, as usually, to try to make the stowage plans and other sort of organizing duties easier and faster without sacrificing quality nor safety. Nevertheless, as the commercial automotive market evolved, a more and more wide spectrum of cars surfaced, which meant a challenge for shippers and ship builders. Hence, it became accepted that achieving high standardization levels was very complicated and so, car carriers began investing in versatility in order to be able to carry all kinds of rolled cargo.

Nowadays, approximate measurements are of little use in actual cargo operations, and they are only used as a guidance for a vessel's capacity. This is because it is crucial to have as much information available as possible for efficiency reasons, thus, keeping track of every unit involved in an operation. An essential piece of information is the Vehicle Identification Number (VIN), a unique code for every vehicle that contains data such as the model, when and where the unit was manufactured and a security check digit. The VIN is one of the most used pieces of information in car carrier operations, as it's useful for customs issues, terminal logistics, damage reports and every situation that requires tracing particular units. Because of the multiple aspects it is used in, when a vehicle is manufactured and ready to be shipped, a paper displaying the VIN is allocated on its windshield, so that this information is easily accessible throughout the shipping process.

Figure 6. Vehicles' locations where VIN plates are usually placed.

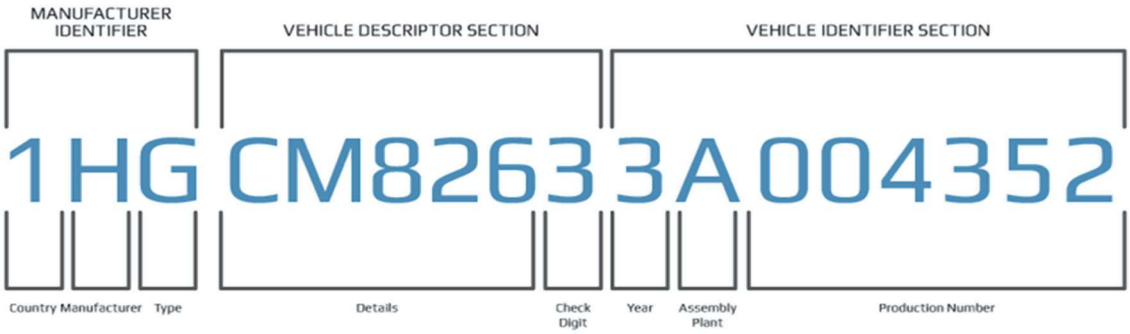

Figure 7. Purpose of the characters that compose a VIN.

Naturally, another key feature of a vehicle is its physical dimensions: the weight (in order to find out if the ramp and decks are able to withstand it and if so, how it affects the ship's stability) and its dimensions (so that the number of units to be fitted into a given space on a deck can be calculated). Clearly, these aspects are closely linked to the make and the model of the vehicle, but it has to be taken into consideration that they can have variations due to being fitted with different engines, electronics or whichever specific feature that may affect their weight or size.

The vehicles' physical characteristics aren't exclusively relevant for the operational aspect, but also for administrative matters such as the taxes they are subject to: in Barcelona, the rolled cargo, in the same way as the rest of the traffic of goods in the Port, comes along with a good's tax or T3; the difference for the T3 of vehicles is that the amount to be payed can be calculated with two different criteria: price per unit and price per ton. This way, the amount that applies to each car is somehow uniform. However, vehicles weighting more than 2.500 kg are automatically considered vans, so its T3 tax is higher. In the case of heavy machinery, there isn't an established price per unit, as it is hard to gather such varied units under a unique norm, and thus the tax is always charged in function of its weight. For this reason, it is crucial being conscious of the physical aspect of the handled vehicles in order to optimize all aspects during their transportation.

In this sense, it is notorious how the characteristics of vehicles have an impact not only on the physical space, but also on tax or customs issues. Because of this, a vehicle can be covered under a lot of documentation of diverse orientation: an invoice from a commercial point of view, a BL or other cargo documents, a customs document, etc. Even though these documents cover different fields, which will be explained later on, they all share an important reference that has implications on several fronts which is worth mentioning: the origin of vehicles. The origin of goods is defined as the location where the essential finishing of the product was carried out; it is key to be able to differentiate it from the concept of provenance, which refers to the port where goods arrive from, i.e. the exporting country.

2.2.2. The state of the car carrier business inside the automotive market

The origin and the provenance of vehicles is also a relevant theme to be analyzed, in order to obtain a bigger picture of the current state of the automotive market and its flows, which naturally has a direct influence over the car carrier business. In 2018, over 97 million vehicles where manufactured all over the world, representing an estimate revenue of 2.700 billion USD; from this, an approximate 22,8 million units were shipped by sea, translating into a revenue of 50-70 billion USD in regards to the car carrier market.

From all the cargo movements generated by these outstanding figures, over 70% of them gravitate around the three strongest automotive geographical areas: East Asia, Europe and North America (see Appendix I. The current state of state of the global automotive market in numbers). This is both the cause and the reason why the major car manufacturers hail from these spots, and as a consequence, the countries inside these areas also handle the biggest production and consumption volumes, even though a lot of their factories are outsourced.

Both in production and units sold, China has already led the global market for a decade, with very similar figures in both ends due to its high self-sufficiency levels; for this reason, China is not proportionally involved in the amount of trade that its size would suggest. However, the United States, which is ranked second, also on both selling and production, finds itself in a very different position: due to its manufacturing capacity being slowed down during the past decades in comparison to its competitors, and its steadily-growing population's consumption demand, around a third of the vehicles that are sold in the US are imported. Naturally, this causes an incoming trade flow, which mainly has its origin in Japan and South Korea. Both Asian countries are in an opposite state to the US, producing more than what their own countries demand, and consequently benefiting from shipping their vehicles overseas.

The other automotive giant, Europe, has a far more complex relationship with its trade flows: while the production levels of Germany and Spain, among smaller countries, surpass their sales, the United Kingdom, France and Italy have a manufacturing deficit. Still, the overall production output of the EU is positive, which results in an export flow towards foreign countries of the Union, with notable rising destinations being developing areas like Africa, the Middle East and South America. However, the bigger portion of Europe's car carrier trade is interior, boosted by the free circulation of goods, as well as the proximity of the in-between countries, the presence of interior waters and a strong system of intermodal transport infrastructures.

Apart from studying the movement of the trade flows and the reasons behind them, it is also worth examining the type of vehicles that constitute them. In this sense, the aspect that probably grabs the most attention is the overwhelming rise in sales of the Sport Utility Vehicles (SUV) during the decade of the 2010's. In 2010, the reigning type of car was the compact, with best-sellers such as the Volkswagen Golf, the Toyota Corolla and the Ford Focus, and the SUV market had a share of less than 20%, with a presence of 35 million units worldwide. However, nine years later, the SUV sales share has doubled, going to up to a staggering 36,4% of the sales around the globe in 2019, which means that over 200 million SUVs were on the road last year.

2.3. Parties involved in a car carrier operative

In the same way as with other types of vessels, the operation of a car carrier involves several parties in order to assure that all the necessities are covered, so that the ship can carry goods from one port to another. These parties are usually the same ones in all operations and it is crucial to understand what every of them procures about in order to fully comprehend what the operation of car carrier consists in.

2.3.1. Shipping company

Like most of the goods and resources, the building of a car carrier is first set by a need: what kind of vehicles that are on demand and what type of vehicles will the vessel carry; this can be precisely grasped if the loading ports are known through the factories that are around the area and the models that are produced there, and the discharge port and its conditions (weather, maximum draughts, maneuverability, characteristics of the docks, etc.).

Considering these variables, a car carrier will be built in a way that the previously stated needs can be matched. With this in mind, the shipping company, who knows what type of car Carries are needed in order to complete its fleet, will make a purchase order to a shipbuilder so as to craft a new vessel with particular characteristics.

However, the fact that a shipping company orders and buys a new ship doesn't mean that it will commercially operate it: it is very common that vessels get constantly chartered among different shipping lines. That's because, throughout a car carriers' lifespan, it may happen that it stops being suitable for the purpose that it was initially built for, maybe because the shape of the cargo changes or simply because the market niche it was conceived for doesn't exist anymore. Anyhow, once a shipping company purchases or charters a car carrier, it will have to make sure that they are following routes that are coherent in regards to the market fluxes of vehicles sales, in order to make sure that they can fill up their vessels with cargo.

For example, if a brand-new car model is assembled in Mexico there is a very high chance that a shipping company will take care of covering the service that links the country that exports the vehicles and one of the main global consumer regions i.e. Europe. For this reason, it is essential for a shipping line to have good commercial relations with car manufacturers, which represent the largest part of their income, so that their vessels can transport vehicles at its fullest potential.

When a shipping company has direct labor trade relations, the freight will be charged to the carrier of the goods, consisting of a determined amount for each unit. On the other hand, if the shipping line that operates the vessel doesn't have a direct relation with the customer/carrier, but it is a second shipping company who does, the first shipping line will rent the needed space on the vessel of the second one so that the customer/carrier can load its vehicles in that space.

This process can happen in multiple ways, and sometimes a lot of parties get involved in the freight of a single space, so it is very important for the company that operates the vessel to carry on with this process even if it means carrying other companies' cargo on their vessel, as it represents its main source for covering the expenses of chartering and maintaining its vessels. Still the relationship between shipping companies and car brands is bidirectional, as it is essential for the manufacturers to be able to

carry their products from the factory to the selling point, so basically this means that both sides need each other in order to conduct economically successful trades.

Once a shipping line has its routes already established and its vessels freighted to the carriers, it will be necessary to assure that it can operate on the ports in its schedule. In the first place, the shipping company will have to secure its presence in those ports: on some occasions, the biggest shipping companies establish offices of their own in key ports of their routes, but the most common way of being present in a port is through an agent. Agents are third party companies, physically set up in a port or in its surroundings, who represent the interests of the shipping line. Their duty is essentially to act on behalf of the shipping company and follow their instructions.

In the second place, if a shipping line wants to operate in a particular port, it will have to contact a terminal and hire it too, because obviously, through the terminal's installations is where the vehicles of the customers will actually be loaded and discharged. It is important for a shipping company to make sure that the terminal where it wants to operate t is capable of assuming the proposed volume of work, that there are enough logistic resources to operate efficiently, and also that the terminal is well communicated by road and/or by rail. Its rates of work, and all the operative conditionings should also be checked.

Once a shipping company gets to a point where it has available ships, cargo to fill them up and presence on its ports of interest, the remaining tasks of the operative process will be delegated to its agents and to the terminals.

2.3.2. Ship agency

As previously mentioned, the duty of the agent is to represent the interests of a shipping company in a particular port; this is so and not the other way round, that is, the shipping line representing itself at every port, because local agents have closer relationships with local carriers, know trustworthy customs agents, have direct contact with the Port Authority, possess the necessary local permits in order to consign ships, have a deeper knowledge of the particularities of the port facilities and its legislation, etc. On the other and, the shipping companies also choose to name agents because of the big logistic and economic handicap that would mean setting an office at each port they call.

In addition, the agent also works as the connecting point between almost every party that intervenes in a call in the port: between carriers, the shipping company that it represents, the shipping companies that have fleeted space on the vessel, the terminal where the operations will be carried out, the Port Authority that will supervise the call, the customs office that controls the fiscal matters, customs agents, surveyors, suppliers and anyone who somehow takes part in the vessel's processes.

In order to be able to carry on with all these duties, an agency needs a department that handles the documentation and the administrative work that derives from the operation, and an operations department that closely supervises the ship's call from start to end at first hand.

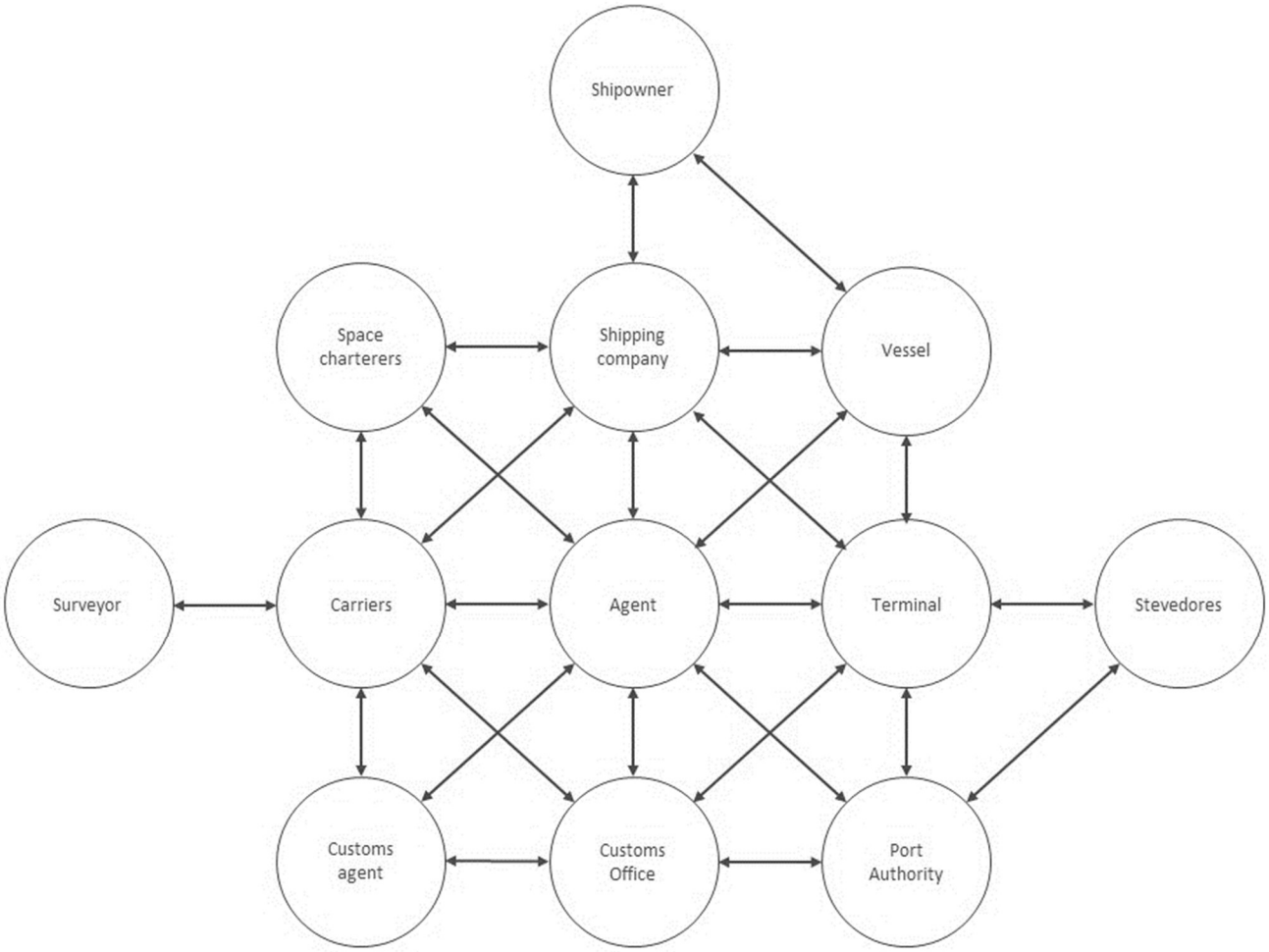

Figure 8. Correlation between the operators involved in a car carrier operative.

2.3.2.1. Administrative tasks of the ship agency

This segment of the agent's duties represents the work that has to cover all the documentation requirements for a vessel to be able to operate later on. Hereafter, a briefing of the documents that comprise these functions is showcased:

- **Connection between parties:** working as a focal element for all the parties involved in a car carrier operation constitutes one of the main functions of the agent; while the shipping company and the carriers negotiate the freights, the vehicles included in them enter the terminal under the agent's close supervision. The same happens after the loading operations, where the loading confirmation coming from the terminal will reach

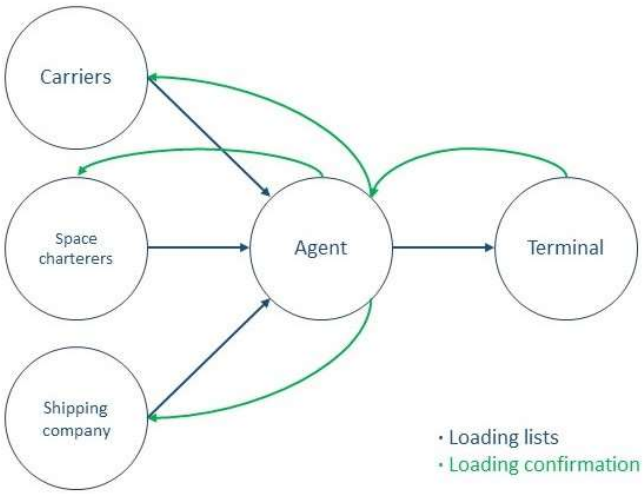

Figure 9. Loading lists transmission and the operators involved in it.

the carriers and the shipping company by passing through the agent's hands; this joining nature is also present on the rest of the documentary aspects, either on purely operational issues, or on invoicing and customs procedures.

- **Issuing cargo documents:** mainly referring to the Bill of Lading (see Appendix II. Bill of Lading form), which is probably the most important document in the whole shipping business as it serves as a contractual agreement between a shipper and a carrier for transporting the goods from one point to another. In the car carriers' case, the BLs can either be Oceanic Bills of Lading (OBL) or Waybills (WBL), depending on the requirements established by the parties involved.

As its name suggests, the OBLs are mostly used for long distance voyages that imply trans-oceanic navigation. Using OBLs implies that original BLs are issued and, consequently, the delivery of the goods at the destination requires the surrendering (presentation) of these documents. Apart from the original BLs, copies are always issued for the operators for documentary reasons without implications over the cargo.

On the other hand, the WBLs are used for feeder trades and don't have any actual implication over the possession of the goods, and are simply sent by e-mail as an acknowledgement of the shipment. In these cases, where there is no original documentation involved, the receiver of the goods will be able to pick them up once all the local costs are covered and it has the consent of both the terminal and the agent as a representative of the shipping company.

The BLs are usually issued as per a shipping company's form, but independently of it, a Bill of Lading will always include or imply the following information:

· Shipper: a shipper is the owner of the vehicles covered under the BL, or failing it, a company that manages the shipping on its behalf. In cases where the shipping company uses chartered space on another shipping company's vessel (also known as third party shipments), a second set of BLs for internal use is issued by the charterer's demand, displaying its agents at origin and destination as shipper and consignee respectively instead of the actual shipper and consignee.

· Consignee: a consignee is the company that takes care of the goods at the destination port. Depending on the shipper, the consignee will either be its branch office (for big automotive companies) or directly the purchaser of the vehicles (for modest shipments).

· Notify: this is a party that requires being advised of all the updates regarding the discharge of the units comprised in the BL; it usually coincides with the consignee or with its customs agent.

· Contractual clauses: these are the pre-agreed conditions that rule the shipment. On OBLs, these will be frequently displayed on the reverse of the paper, but on WBLs will simply not appear for confidentiality reasons, as in this case the BL would probably pass through the hands of more operators.

· Loading terms: equivalent to the Incoterms but not always matching in criteria or denomination, these delimit the transference of loading responsibilities and costs from the shipper to the carrier. Each shipping company and terminal uses its own nomenclature; for example, in Barcelona some of the most used terms are:

1. Free Alongside (FAS): the transference of responsibilities and costs happens at the point where the ramp touches the terminal. In a discharge, the carrier is responsibility-free as soon as

the vehicles land on the dock; in a loading, its accountability begins when the cars first hit the vessel's ramp.

2. Free In and Out Stowed (FIOS): only includes the sea freight, and the loading/discharge and lashing/unlashing costs are by the charterer's account. This type of loading terms is frequently used for casual shipments such as used cars and H&H machinery, because these usually require special lashing conditions (additional number of stevedores, mafies, cranes…) and the terminal will do a customized quotation for each case.

3. Last/First Point of Rest (LPR/FPR): the conditions are very similar to the FAS ones, only differing at the point of transference; in this occasion happening alongside the vessel i.e. at the dock before the loading or after the discharging. An extra step for this term is the Buffer, which prolongs the responsibility from alongside to the buffer (terminal storage installations under a roof, that serve as vehicle organization structures).

· Load and discharge ports: naturally, a BL needs to provide the information where the vehicles have been loaded and are supposed to be discharged.

· BL body: this is the central part of the BL, and its purpose is to give details about the cargo included in the BL such as the number of vehicles, its type or model and the total weight. Here, additional information can also be added referring to the cargo's conditions; some common clauses are: "freight as per agreement", "clean on board", "VIN numbers as per attached list", "used vehicles", etc.

- **Comply with customs obligations:** due to several reasons, from tax paying control to border security, every good that enters or leaves a country through its port terminals must be declared in front of both the Customs Office and the Port Authority. This duty usually relies on the agent of the vessel, who must issue a customs declaration, also known as cargo summary, before the ship's arrival and after her departure. In order to fulfill the above authorities' requirements, these declarations, which nearly always have a standardized form, must provide the following information:

· Declaration's code: a particular number for each declaration that provides information about the Customs Office where the cargo operation takes place (for example, in Barcelona, 0811 for the entry Office and 0812 for the export Office), a year and a security check digit, and the number of the call assigned by the Port Authority.

· Terminal: in a Customs Declaration, the figure of the terminal not only means where the operations carried out must be declared, but also the responsibilities that derive from it, which are divided into 3 concepts:

· Concession terminal: it represents the terminal in which the vessel berths. Commonly, private terminals operate at publicly granted berths for a determinate period of time.

· Stevedore: it is the terminal that actually operates the vessel, and thus the one in charge of hiring the stevedoring personnel.

· Customs allocation: each terminal also has a non-physical, customs warehouse status, that makes it subject to the Regulations of the Customs Authority. This aspect of the terminal's field of work comes along with the customs responsibilities and consequent implications.

Usually, a vessel is operated in the same terminal for each of the three aspects above, but in some occasions it may not be the case because of contractual agreements between the shipping companies, the charters, the carriers and the different terminals involved in the operation.

· Vessel's itinerary: the declaration must include the vessel's last and next port, as well as the entry country to the EU. This information is key for knowing which procedure must be used later on in the declaration.

· Vessel's condition: in cases where the vessel is in ballast condition or when it is not discharging/loading vehicles in the port where the customs declaration takes place, it must be declared, as other port's cargo is not to be declared.

· Parcels: constituting the body of the declaration, is where the information of the cargo is displayed. Each parcel usually contains a BL, and thus, it must contain its data, as well as additional aspects related to it:

· Loading port, transshipment port, discharge port and destination (if inlands).

· Anterior/posterior means of transport: to be declared on discharges and loadings respectively, this refers to whether the goods were previously transported or expected to be transported by road, by rail or by vessel. It serves as a mean for linking summaries and can also grant tax cuts for the vehicles transported by means promoted by the Administration, such as the rail.

· Type of goods: internationally regulated under the HS Harmonized System (HS) code, and more strictly controlled by the Integrated Tariff of the European Communities (TARIC) in the EU, it is a code that has the function of classifying all of the tradable goods. The HS code consists of eight digits, while the TARIC can have up to six additional numbers. The majority of utility vehicles are included in chapter 87, heading 03 (see Appendix III. HS Code headings classifying terrestrial vehicles, Chapter 87).

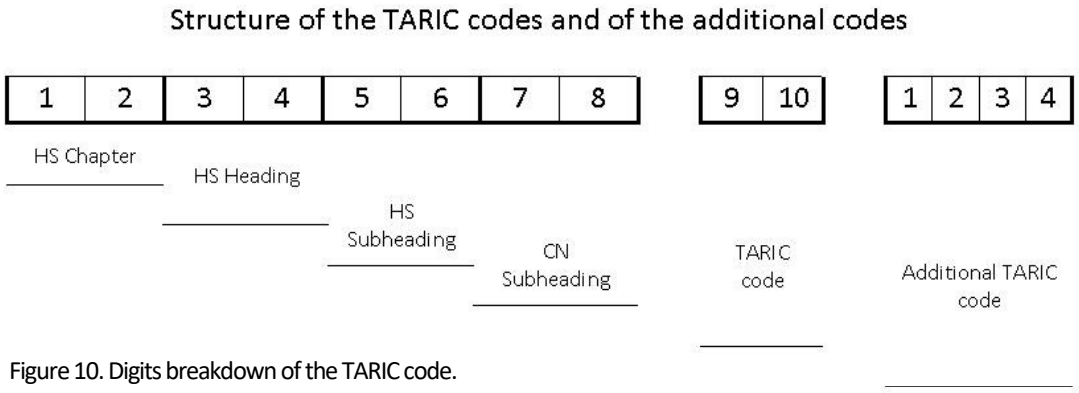

Figure 10. Digits breakdown of the TARIC code.

· Number of units and weight: along with the code above results in the tax tariff to be applied.

· Singe Administrative Document (SAD): it is the customs document attached to the BL, and it is a mean for the Customs Offices to have a control over the goods included in them, proving its origin, as well as persecuting tax fraud and smuggling. Currently, the unification standards for SAD typed are in a development process, so each country has its own models. However, among most of them there are equivalencies, especially in the EU, where the most frequently used ones are:

A. For non-EU goods (T1 goods): when cargo that possesses a non-community status inbound into the EU is declared in front of the Customs Authority through an Entry Summary Declaration (ENS) submission, an Electronic Data Interchange (EDI, see Appendix X. About the future of Electronic Data Interchange) message that gives information about the cargo's origin and itinerary. For exporting T1 goods, an Exit Summary Declaration (EXS) is issued instead.

B. For EU goods (T2 goods): most of the time, when T2 cargo moves between community ports, the T2L is the document that covers the goods customs-wise. When the destination country is outside the EU, the most common option is issuing an exportation SAD, represented by the EDI code 830.

NOMBRE DEL DOCUMENTO	CLAVE DOC.	CÓD. EDI	FORMATO NÚMERACIÓN (4)		TIPO LINEA (1)		S.A (2)
					REGULAR	NO REGU	
Documento de defensa	ID	190	UUXXXXXXXXXXX	A	SI	SI	1
DUA exportación sin MRN	222	222	UUXXXXXXXXXXX	A	SI	SI	1
Formulario 302 (OTAN)	302	302	TTXXXXXXXXXXX	A	SI	SI	1
Factura o conocimiento con expresión "T2L" visada o sin visar (valor inferior a 10000€)	380 BL	380 705	ESXXXXXXXXXXX ESPSLNNNN o ESEAPSNNNN	A	SI	SI	1
Factura con expresión ""T2LF – Mercancía sin declaración de expedición"	387	387			SI	S/	1
Documento transferencia regímenes aduaneros económicos	701	701	UUXXXXXXXXXXX	A	SI	SI	1
Transbordo automático	DSD	785	RRRRANNNNNNPPPPP	C	SI	SI	1
Tránsito	T1 T2 T2F	821 822 826	AACCXXXXXXXXXXXXD	C	SI	SI	1
T2L electrónico nacional	T2L	825	AACCXXXXXXXXXXXXD	C		SI	1
T2L de otro Estado miembro o visado por un operador autorizado	T2L	825	UUXXXXXXXXXXX ESPSLNNNNNNNN o ESEAPSNNNNNNNN	A		SI	1
T2LF electrónico nacional	T2LF	827	AACCXXXXXXXXXXXXD	C		SI	1
DUA Exportación	DUE	830	AACCXXXXXXXXXXXXD	C	SI	SI	1
Manifiesto visado aduana salida	MAN	833	AACCNNNNNNNNNNNNND UUXXXXXXXXXXX	C A		SI	C
TIR	TIR	952	TTXXNNNNNNNNN	C	SI	SI	1
ATA	ATA	955	TTXXXXXXXXXXX	A	SI	SI	1
Documento administrativo electrónico de II.EE. (e-AD)	AAD	AAD	AACCNNNNNNNNNNNNNNND	C	SI	SI	1
Mensaje "Declaración sumaria de salida (EXS)"	EXS	EXS	AACCXXXXXXXXXXXXD	C	SI	SI	1
Convenio JUSMG, A-9	A9	ZA9	TTXXXXXXXXXXX	A	SI	SI	1
Servicio Regular (1)	SR	ZSR	NNN	A	S		C

Figure 11. Types of SAD currently active in Spain.

2.3.2.2. Operational tasks

In parallel to the documental work, an effective operational management is needed so that vessels can enter the port, berth, complete the discharge and loading operations and finally leave port. This process begins with the arrival notice of a ship, when the shipping company informs the agent and the terminal that a particular vessel will call its port by sending approximate working prospects and the vessel's ETA. Once the agent acknowledges the receipt of the notice, it will be its duty to notify the Port Authority so that the said ship can enter the port.

For the access to be granted, some requirements need to be fulfilled; each port demands different conditions to be met, but generally it checks the liability of a vessel and its standards through "pre-arrival documentation", which is provided by the vessel to the Port Authority through the agent. These documents must include:

- Master's General Declaration: all general information of the vessel can be found here, such as its IMO number, the name of the Captain, the call sign, the flag of register, the vessel's dimensions or the classification society. Additionally, it declares, as in the following example, the Port operations that the vessel has planned and that it complies with all the necessary IMO certificates.

"The Master of the above-mentioned vessel also declares that all the Certificates and documents, have to be on board in compliance with SOLAS 74/78, MARPOL 73/78, Memorandum of Understanding for

Port State Control (MOU-PSC) and other compulsory Certificates and Documents according to the type of vessel, are in force and truly on board, and they will not expire, at least, until the date of arrival to the next port of call".

- Ship Pre-Arrival Security Information Form: all ships must provide it before entering an EU State Member Port in compliance with the SOLAS Regulation XI-2/9 and the article 6.1 of the regulation no.725/2004. This regulation states that, a part of the basic information of the vessel, a Chief Security Officer (CSO) must be nominated; he/she will remain available 24 hours a day in case of an emergency. In this document, the last 10 ports of call and t corresponding levels of security should also be declared.

- Annex II, declaration of residues: it is a compulsory notification model that needs to be presented before entering a port, which provides information about the waste carried on board, the discharged one in her last port of call, her storage capacity for each waste type and the amount expected to be generated during the vessel's stay in port. Specifically, it refers to the waste appearing in the following MARPOL Annexes:

  · Annex I (oil waste): sludge, bilge water and others.

  · Annex IV (sewage)

  · Annex V (garbage): plastic, food wastes, domestic waste, cooking oil, incinerator ashes, operational wastes…

- Crew list: it contains a relation of all crewmembers both at the entry and the departure of the Port, and it must include their rank, nationality, Seaman's Book and a series of personal data that allows the Port Authority and the security services to keep an accurate track of their identity.

- Health declaration: this document is provided for health issues, in which the Master of the vessel declares if any of the crewmembers suffers from a disease that can cause harm to the health state of the country the vessel calls at.

- Ship's Certificates: the requested Certificates vary from one Port to another, but some of the more common ones are the International Tonnage Certificate (ITC69) and the Civil Liability Certificate (CLC), referring to the vessel's bunker, which must be presented every year.

Once the Port Authority has been duly informed of all the above requirements, it is time to plan the operative side of the call, in coordination with the terminal and the shipping company. The more important aspects to set up are the berth (for car carriers, it is usually safe to assume that the vessel will berth starboard to the dock due to the locations of its ramps), the time of berthing and the duration of the operation.

However, the time in which a vessel proceeds to berth depends on several factors: the time it arrives to the anchorage/pilot station (End Of Sea Passage), if the berth is occupied/blocked by other vessels, the availability of pilotage, if the weather conditions allow maneuvering, the presence of higher priority vessels such as ferries, etc.

Regarding the duration of the cargo operations and the departure time of the vessel, it will depend on the number of vehicles to be loaded and the rates of work of the stevedores at a given terminal. Based on these factors, the agent, in accordance with its principal, will order the terminal to hire stevedoring gangs that can carry out the expected operations.

Once the berth is clear and confirmed and the gangs are arranged, the next step is taking care of the stowage plan (see Appendix V. Stowage plan example).

Naturally, it has to be realistic so that it can truly be translated from paper to vessel and it always has to emphasize both the time and economic efficiency (avoiding cargo shifting) while respecting the vessel's stability and safety requirements.

Because the stowage plan tries to be a schematic representation of the vessel and its cargo, its format doesn't leave much room for details or precision: it consists of an elevation view of all the decks from the perspective of the vessel's side. Then, each cargo is appointed with a color, and it gets painted on the decks based on the space it is expected to occupy. For the sake of distinguishing the cargo in function of its destination, a color is assigned to every port of loading/discharge; also, it must indicate the exact number of units and its model on top of the painted section, so the stowage plan can serve as an aid for the on-board agent.

Another crucial aspect of the stowage plan is the location and direction of the ramps, as they are the entry and exit point of the vehicles from decks. It is very important to always take this into account, so that no ramps get blocked by stowed cargo nor they get impeded by loading on top of the foldable ones over its allowed weight.

Additionally, the ramps strongly shape the loading plan because they dictate the order in which the vehicles are loaded; it is usually done in a circular way around the ramp so that the vehicles end up facing the ramp in order the enable a faster and easier discharge. The loading direction will be either clockwise or counterclockwise based on the side of the steering wheel of the vehicles to be loaded (continental or British) for maneuverability reasons.

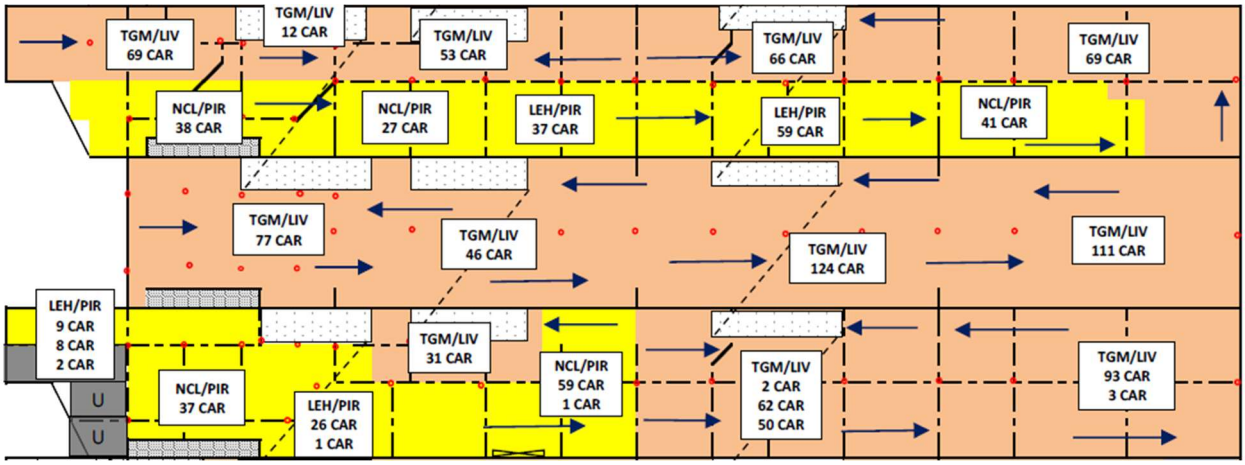

Figure 12. Loading sequence in a stowage plan.

The height of the decks is also something to consider: it must be known at all times, both on static and mobile decks, in order to know which vehicles can be loaded in a particular spot (leaving always a safety margin between the upper top of the vehicle and the roof of the deck, to be determined by the quality standards of the shipping company).

Also, when loading vehicles of bigger dimensions such as buses or heavy machinery it is especially important to acknowledge the height of the roof at the point of entry from the ramp and the overall at the whole deck to make sure these fit into the vessel as intended in the stowage plan. This type of

vehicles must be loaded onto the main deck, as close to the main ramp as possible, so that they have to travel the least distance when discharging them. The main reasons for this are that usually with heavy machinery, often loaded overseas, setbacks frequently emerge, such as vehicles without battery or other unexpected inconveniences that constrain the discharge by their own means. Also, at the entrance of the main deck the available height is at its highest, so it is where these vehicles fit better.

Depending on the working procedure of the shipping company, the responsibility of the stowage plan can belong either to the Chief Officer of the vessel, to the planner of the company or to the agent; in any case, a loading plan must always be checked by the terminal, by the shipping company, by the agent and by the ship, before implementing it.

While the loading operations are being executed, it is also the agent's responsibility to obtain the Port Authority's permission for the vessel to sail. Then, the Port Authority will verify that there is no security, safety, health, environmental or administrative reason for enforcing the vessel to stay in port after the loading operations.

Few hours before the operation start, the agent must be aware and ensure that vessel is ready for working, and if so, that the terminal has arranged the stevedoring gangs according to the vessel's operational needs. Once all of the above is covered, the operations will start, with the agent's presence in order the check that both the shipping company and the carriers' Technical Quality Standards (TQS) are being matched, which usually consist of the following points:

- Driving speed: both at the terminal and on the vessel's decks very restrictive speed limitations apply. It is the agent's responsibility to closely follow the drivers' behavior so that these limitations are not exceeded, usually ranging from 20km/h to 30 km/h at the terminal and inside the vessel.

- Safety: loading operations imply having vehicles moving at all times and in all directions, so it is particularly important to follow the set of safety guides in order to prevent accidents at the workplace. In addition to wearing the usual IPEs (helmet, reflective jacket and safety shoes) it must be watched out that there are not spare objects left on the ground on the deck such as lashes. Also, it must be avoided whenever possible standing still in zones where loading operations are being carried out, especially at low visibility spots such as behind bulkheads; instead, the delimited transiting zones, painted on the floor, must be used for walking around the vessel.

- Lashing: is one of the main quality requirements, as it is a key aspect in both ensuring the cargo's perfect conditions and a safe state of the holds while sailing. Especially, the total strength of the load restraining system has to be enough to withstand a forward force of no less than the total weight of the load to prevent moving it under severe braking, and half the weight of the load moving backwards and sideways. For accomplishing these requirements, each company has its own standards (see Appendix IV. Lashing standards example for a shipping company), but generally these involve: double lashes front and back of the vehicle for regular cars, additional lashes for heavier vehicles, stowed on ramps or during winter, lashing angles that work both horizontally and sideways and avoiding un-tensed or superposing lashes.

- Distance between vehicles: as well as an adequate lashing, in order to avoid damages on the cargo, a safety distance must be kept between cars. In general terms, the frontal distance must be no less than 30 centimeters, and 10 centimeters laterally with the wing mirrors deployed; in cases where the loaded

vehicles are of higher economic value, the distances must wider, which would be determined by the carrier.

- Attire: it is strictly prohibited wearing any accessory that may cause damage to the cargo. The stevedores, as well as the terminal's loading master, but also the vessel's crew and the agent must avoid wearing metal watches, wrists, rings, earrings, pendants, belts with metallic buckles, and any other object that may scratch the vehicles body.

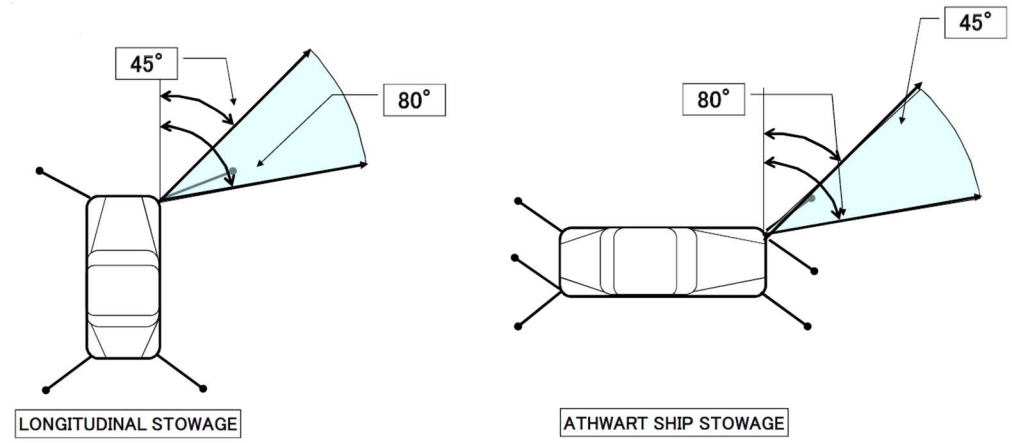

Figure 13. General standards for the lashing angles.

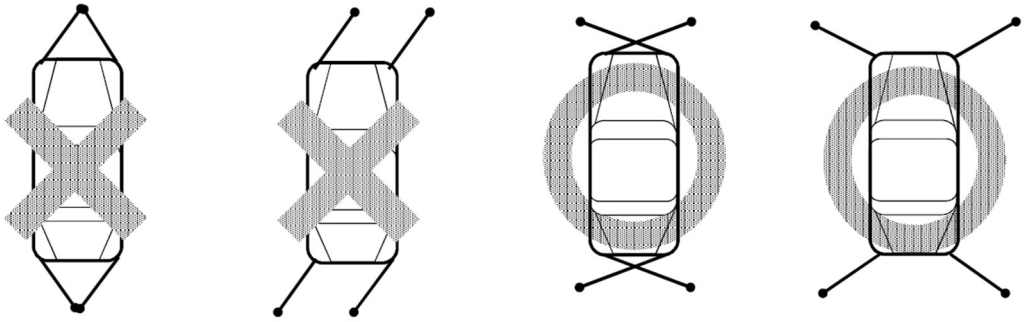

Figure 14. General standards for the direction and intersection of lashes.

Once all these requirements are met, and the loading operations are successfully completed, the agent must prepare a report regarding the stay of the vessel at port and the operations that have been held. This report usually comes in form of a Statement of Facts (SOF), a legal memo that consists of a detailed chronological description of the vessel's timings and movements such as: the pilot boarding time, the mooring, the loading and discharge operations, the amount of units involved in these operations and remarks concerning all of the above. Usually, both the agent and the vessel issue their own SOF.

Another essential item for understanding the way a car carrier operation functions is being able to calculate the expected port expenses, or in other words to draft a Proforma Disbursement Account (PDA). The PDA is elaborated by the agent so that the commercial operator of the vessel has an estimation of how much calling at a particular port and carrying out a certain operation would cost. The total amount on the PDA will mainly rely upon the vessel's Gross Tonnage and upon her stay in port, and it will have the following concepts:

- Light dues (T0): it refers to the cost of using the port marking installations such as beacons, buoys and lighthouses; it varies according to the GT of the vessel, and usually gets a discount for repeated calls at the port. At Barcelona, it is calculated by:

$$TO = GT * 0{,}035 * 0{,}57$$

Coefficients corresponding to merchant vessel's tariff; applicable only to the first three calls of the vessel.

- Berth tax/port dues (T1): represents the cost for occupying the berth, and it depends on the vessel's GT and on her stay at said berth. For example, Barcelona Port's T1 is calculated through the following formula:

$$T1 = BS * h * \frac{GT}{100}$$

"BS" being 1'43, reduced to 1'20 for SSS (Short Sea Shipping) services.

"h" being the hours spent at berth (minimum 3 and maximum 15 per 24 hours).

Additionally, for operations involving brand new vehicles, a 20% discount is applied to the tariff.

- Towage: is the cost regarding tug assistance while manoeuvring, and it depends on the GT of the vessel, the number of tugs used and the movements made (berthing/unberthing/shifting).
- Mooring: it is the price for mooring and unmooring the vessel, and it depends on the vessel's GT.
- Pilotage: corresponds to the cost of the service provided by the pilot and the control tower, and it also depends on the GT.
- MARPOL tax: it is the price to pay for disposing the MARPOL Annex I and V wastes, and it depends on the GT.

- Agency fee: it is the agreed commission between the shipping company and the agent for it to provide its services during a call.

2.3.3. Port terminal

Ro-Ro port terminals are dockside spaces granted by the local Port Authority where a logistic infrastructure is established in order to handle loading operations on car carriers. Thus, the main function of the terminal is to serve as a link between the production centers of the vehicles and the mean of transportation that has to bring them to their selling destination.

For this reason, the ease for the vehicles to flow both through and in and out of the terminal is key, and that's why an optimal communication facility is essential. A good example of this premise is the vehicle terminals at the Port of Barcelona, Autoterminal and Setram (see Appendix VI. Barcelona Port terminals, space distribution and structure) which have a high level of versatility thanks to the vehicles able to access the terminal and exported by various means:

- By road: it can either be realized using car carrier trucks for accomplishing longer distance shipments, or by driving the vehicles by its own means in briefer connections. In Barcelona, the road traffic represents a big part of the incoming flow intake due to the high volume it receives from the nearby Nissan factory; the cars and vans are driven from the factory to the logistic center, adjacent to the

terminal, and once a vehicle is booked and assigned to a vessel's voyage, it is transferred to the terminal ready to be loaded. This model is widely extended among the biggest terminals: Volkswagen in Bremerhaven, as well as Gefco (PSA Group: Peugeot, Citroën) and Nissan in Zeebrugge are some of the most prominent examples. The reason behind these external logistic areas and why the carriers wait until the very last moment for transferring the vehicles, is that the terminal frees an important amount of its storage capacity, and the manufacturers achieve a higher level of control over its stock.

- By rail: it also represents a high percentage of the entering volume to the terminals, as it is a model that successfully combines cost efficiency, reliability and safety. The train chain supply usually connects production centers that are allocated at mid to far distances from the port; it the case of Barcelona, two examples of this are the Volkswagen Group factory in Martorell, and the Mercedes-Benz factory in Germany. This way, the terminal works as a focal point for exporting vehicles with widely varied origins within the region.

- By sea: mostly transshipments from other vessels, in this case, the vehicles hail from transcontinental production spots, and are discharged on hub terminals, and then reloaded onto feeders that distribute them around the nearest ports. This model is again found at Barcelona terminals, where Mazda operates at Autoterminal by using it as a distribution center; in this case, vessels load to their maximum capacity at Japan and Mexico, where the factories are located, and progressively discharge the vehicles in hub ports like Barcelona or Antwerp, where they are transshipped to other European destinations.

However, by observing these different types of cargo movements from a border policy point of view, it can be clearly seen how they imply continuous entries and departures from the customs territories where the terminals are located, which makes up the main cause behind all of the customs rules. For this reason, all European port terminals are intended to work as customs warehouses, as ruled by the EU Regulation No. 952/2013 laying down the Union Customs Code, Chapter 3, Section 2. In this code, the responsibilities of the terminal as a customs warehouse are laid out through the Article 242, Responsibilities of the holder of the authorization or procedure:

1. The holder of the authorization and the holder of the procedure shall be responsible for the following:

(a) ensuring that goods under the customs warehousing procedure are not removed from customs supervision; and

(b) fulfilling the obligations arising from the storage of goods covered by the customs warehousing procedure.

2. By way of derogation from paragraph 1, where the authorisation concerns a public customs warehouse, it may provide that the responsibilities referred to in points (a) or (b) of paragraph 1 devolve exclusively upon the holder of the procedure.

3. The holder of the procedure shall be responsible for fulfilling the obligations arising from the placing of the goods under the customs warehousing procedure.

This change has obligated the terminals to directly gather all the necessary customs information, which demands a complex and exhausting crossing of data with both the Customs and the Port Authorities. This duty, traditionally relied on the agent of the ship but, because of this responsibility shift, terminals' interest in having full control over the customs status of the vehicles that get through its installations have substantially grown since the UCC (Appendix XI: Union Customs Code articles that define and

delimit the customs procedures that shall be applied onto Car Carrier's customs procedures.) was published in 2013. Although all of its contents, including the adoption of digitalized customs documentation, should have been applied to all terminals belonging to the EU as of May 2019, these weren't, and thus, the European Commission proposed an extension for this transitional period to 2025, which is yet to be approved.

Regarding the loading operations, as previously stated, the role of the terminal is to provide loading means for the vehicles brought by the carriers into the vessels of the shipping companies that call at the terminal's berths. However, the loading operations are not carried out by the terminal personnel per se, but by externally hired stevedores. The actual loading is performed by a gang of stevedores, which is commonly comprised by lashers and drivers on even proportions, and a head leading each team. When a gang is hired, it carries on with the loading and discharging operations for the shift it is designated to; usually, shifts comprise 6 hour set periods, meaning that there are 4 shifts in a day: 8-14h, 14-20h, 20-02h and 02-08h. Naturally, the night and early morning shifts imply an extra hiring cost, as well as it does working on weekends and holidays.

Being the stevedoring gang ready, it's the terminal's duty to prepare all the necessary logistics for ensuring a smooth operative. Before starting the first shift, the vehicles to be loaded on board, parked all along the terminal's esplanade and buffers, will be placed alongside the vessel in a distribution that fits the stowage plan as precisely as possible, which involves segregating cars by brand/model and by destination. Once the vessel is ready, and the shift begins, the stevedores will drive the vehicles into the holds of the vessel and lash them, and the opposite process will happen on a discharging operation.

In order to perform all of the operations in an efficient manner, the terminal has to choose among its available berths, the one closer to the location of the designated vehicles, so that fewer and faster movements are made. This task is mainly sorted out by the loading master, the main representative of the terminal during a vessel's loading operations. It is also his/her duty to closely check the compliance of the stowage plan, monitor the stevedore's driving, stowage and lashing, achieving and maintaining good loading rates, and ensuring a safe work environment.

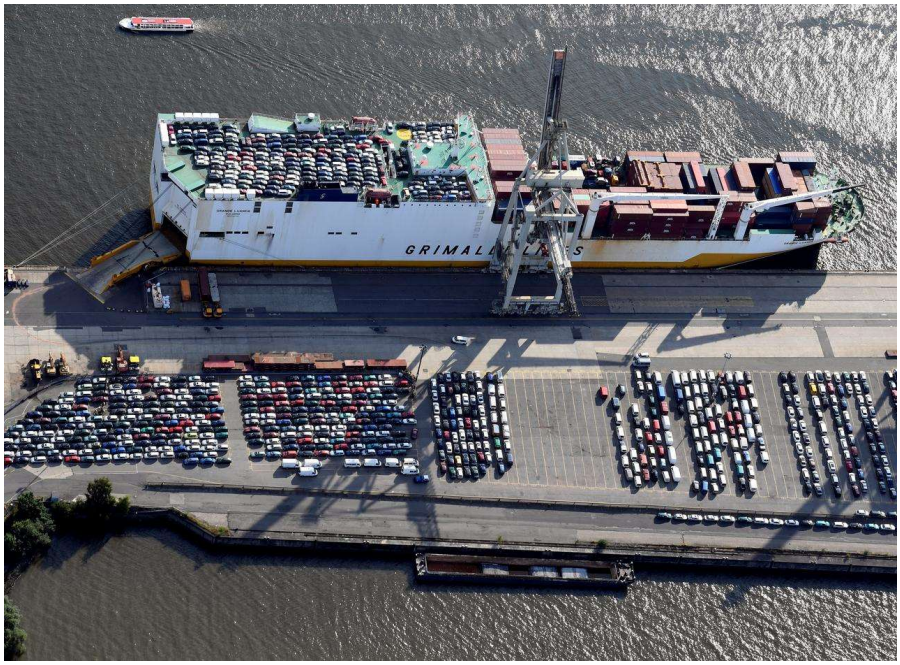

Figure 15. Vehicles disposed in the terminal's esplanade before being loaded.

When a loading operation involves more unconventional vehicles, from buses to a caterpillar, additional specialized personnel is employed for its safe stowage and lashing, frequently involving supplementary needs such as a wooden bed for the units to lay down at, and complex lashing systems that ensure that all the vehicle heavy weight is steadily stowed on the vessel's deck for a safe navigation. For performing these activities, terminals usually have heavy-load machinery, which mainly comprises mafies and gondola cranes. These are especially useful for loading non-rolled cargo e.g. containerized cargo, train wagons, helicopters…

The understanding of all these insights is essential for putting through another key aspect of the terminal's functioning: calculating the operational costs of a vessel's call. The act of estimating these expenses is always preceded by an agreement between the terminal, and every shipping company that operates it, whereby the cost for each movement and action involved in the cargo operations is set. This, first of all, refers to the cost per unit for loading and discharging, with the particularity that this concept is divided by segments that allow charging both the shipper and the receiver the corresponding prices, depending on their contractual loading terms. For example, the terminal's tariffs may differentiate the price for "loading from ramp to hold", "from LPR to vessel ramp" and "from buffer to LPR", allowing this way to fraction the operative expenses. In addition, different costs are usually specifically set for other movements like transshipments and cargo shiftings inside the vessel. Also, it must be taken into account whether the lashing/unlashing of the vehicles is included or not in these prices, which has to be clearly specified; in case it is not included, a price per unit is set too for doing so, sometimes even differentiating the type of lashes/slings to be used.

Another aspect to be considered is the working overtime, set by a percentage that grows cumulatively for night shifts, weekends and holidays, which is added on top of the above costs for each unit. Also, when the last booked shift is not enough for completing the loading operations, an extra working hour can be hired for finishing it, implying an additional cost too. The storage of vehicles at the terminal is also commonly considered in the agreement, usually giving a determinate number of free days, in which the vehicles don't generate any occupational demurrages, and from there and on, a price per vehicle and day is charged. Furthermore, for all these concepts, there are different costs depending on the type of vehicle: naturally, it is more expensive to operate with a H&H unit than with a regular car. Many other variables can also appear in these agreements: refueling vehicles, working on rain, vessel delays, using a forklift, hiring mechanics, and all types of particularities and penalizations that aim to cover every possible situation given during the cargo operations.

2.3.4. Port Authority

The Port Authority is an organism of public nature that rules over several aspects of port activities: from logistics, to cargo operations, customs, business development, administration, etc. However, in each country, the sphere of influence of Port Authorities may cover different areas and have diverse institutional structure and importance. Still, it is crucial to elaborate a picture of the shape shared by the majority of Port Authorities countries, in order to fully understand the functioning of a car carrier operation.

In the first place, it is the Port Authority's duty to manage the installation and maintenance of the port's maritime signaling and navigational aids and its surroundings. This is key for warranting an easy maneuvering and thus, making sure that vessels can call the port safely, which leads to another Port

Authority function: to organize and coordinate the port traffic, both maritime and terrestrial. In this aspect, the Port Authority is responsible for assigning berths to the vessels that call its port, in addition to facilitating the transit of cargo through its intermodal connections. As previously mentioned, these intermodal installations are linked to the vessels through terminals, which are also designated by the Port Authority through public tenders. Moreover, many other services are often granted to privately owned operators too: the towage, mooring services, bunker supplying, MARPOL residues disposal…

Another aspect regulated by the Port Authority is the designation of port tariffs, and the cost for any other commercial services it provides. The tax collecting of the goods that transit the port, closely links the Port Authority with the Customs Authority; this relationship, also implies that it is the Port Authority's duty to enforce the customs regulations, as it acts as a physical gate for the goods that enter and leave the country. The Port Authority must also have control over the compliance of the regulations that affect the admission, handling and storage of dangerous goods, as well as ensuring a safe work environment for potentially dangerous operations such as hot works and bunker supplies.

Additionally, the Port Authority must carry out marketing and commercial actions that place its port in a strategical position in order to generate a firm business development. In this sense, the Port Authority must also perform a statistical control over its traffic and issue periodical reports in regards to the state of its trade fluxes. For doing all these tasks, the Port Authority shall count on qualified personnel and updated technical systems, so it is also its responsibility to train its human actives and develop IT (Information Technologies) resources that enable adapting all operational procedures to the current ever-changing landscape. Last but not least, every Port Authority has the duty of making all efforts to reduce the environmental impact of its port through policies that firmly prioritize the prevention and reverting of the current global warming status.

3. Control Device Appliance

3.1. Introduction

This second part of the thesis is a creative exercise that tries to find concretion in the margin of improvement that exists in the processes involved in a car carrier's operations. The result of this aim is a device/application that has been given the name of "Control Device Appliance".

The idea for this tool, CDA from now on, comes from a personal admiration towards standardization systems; standardization is a not so obvious concept that is frequently overlooked, but the truth is that it contributes immensely into organizing our society and improves our everyday work in a very effective way.

At cities or inside homes, if one stops to examine with a bit of detail how objects work, it is easy to discover that very few of them are the way they are by chance, and by realizing this, simple yet fundamental conclusions can be drawn: if the outlets were each of a different size, then the electric devices wouldn't be able to be plugged because they wouldn't fit. If standard sizes for the clothing and shoes hadn't been established in the past, mass production wouldn't be possible and then filling up the wardrobe would be less affordable. If paper sheets' size wasn't universalized to the DIN A-4, then letters wouldn't fit inside envelopes and they would wrinkle inside bucks, and printers would have a hard time doing their job, etc. Basically, it goes like this for most everyday objects, but this doesn't only apply to seemingly plain things, but also to non-tangible standardization systems that shape our lives even more, like all the physical magnitudes, the money and the language among many other standardization systems, without which, society wouldn't be as remotely developed as it is.

However, in the maritime transportation of vehicles, standardization is less present than in other industrial and logistics fields, even though this business generates a notable enough amount of wealth in order to put some more thought on it. This translates into inefficiency, errors and a safety compromise, so that the question of "how can this be improved?" arises.

Thus, the objective of the CDA is to pave the way in the direction of improving the efficiency through the automation and standardization of systems; this is why the concept of the CDA is inspired by two remarkable design successes of the 20th century: the barcode and anti-theft systems. On the one hand, the barcode, arguably the most brilliant standardization system of our time, bases its functioning on identifying and transmitting data from a product through an encryption system that may contain a lot information in an apparently simple scheme. On the other hand, the anti-theft devices used on many stores and malls, provide physical presence through a small device that communicates with a static base placed in the working environment where it is supposed to operate, and then it replies with information about the state of the object that the device is attached to.

If the functionalities of these two technologies are blended, the result is a device that has the tools for implementing a notable degree of standardization into the maritime transportation of vehicles. The potential of this idea grows deeper the more it is developed, however, the actual production and implementation of this device would suppose a project beyond the expectations of this work, so only the theoretical side of the application will be explored from now on.

3.2. Potential applications

The potential applications of the CDA are its cornerstone, but the functionalities that it could actually bring to the table would depend on two factors. The first one is the level of implementation, because the more the CDA would be deployed in car carrier operations, the more functions would be unlocked, and new possibilities would open due to the automation of the procedures involved. The second factor that would dictate the level of usability that the CDA would have is the device per se, because the system would only be able to bring its potential to life as long as it would a have a technology adequate enough to back it up. Anyhow, even if the used technology was to reach the goals of the device, it would also have to comply with some kind of reasonable budget while being environmentally friendly, or otherwise, the mass production of the device wouldn't be possible and the project would be severely limited.

In any case, even if the degree of implementation was high and the production challenges were accomplished, the possibilities of the CDA can only actually be accurately known after its use in actual cargo operations, as both new challenges and not initially considered applications would most likely emerge. All this being said, it is sure worth doing the exercise of studying the potential of this project, which has been dissected into five fields of application.

3.2.1. Vessel-cargo communication, stowage, draft and stability aid

The aim of the device is to connect the vessel with the cargo it carries, so instead of acting as two completely separate entities, they would operate as a smart whole unit. Once the vessel would be able to transmit and receive data within the vehicles loaded inside her decks, then it would possible to know exactly and instantly, the state of each car, such as its location or any other piece of information that the CDA was able to provide. This would be possible by placing receptors in the vessel's holds, that would communicate with the stowed vehicles through the CDAs for exchanging useful data.

This way, for example, only by introducing the vehicles weight into the CDA, this information would be sent to the vessel and, along with the weight and location of the rest of the cargo, it would enable to precisely calculate the effect of the cargo on the vessel. Thus, this would translate into a completely new level of automation on stability calculations, being able to do so even before the cargo was actually loaded by simulating the whole system with the data given by the CDA.

Moreover, if this draft and stability calculation procedure was linked with the ballast system, it could automatically regulate itself to a degree of precision where, with the loading of each vehicle, the vessel could reach an optimal and immediately updated stability state.

Similar functions could also be potentially applied onto a wide variety of aspects present on the vessel: from fuel consumption calculations to a perfect assessment of the decks space usage towards stowage planning. In this sense, the automatic generation of stowage plans could be carried out in order to optimize the vessel's space more effectively, improving both stability, and loading and discharging speed, by introducing the dimensions of the vehicles, rates of maneuvering, steering wheel type, etc. into the CDA, as opposed to the current system used with stowage plans, which is based on painting decks and rough estimations that don't unveil their degree of precision until the actual loading operation takes place, where there is little or no room for improvisation.

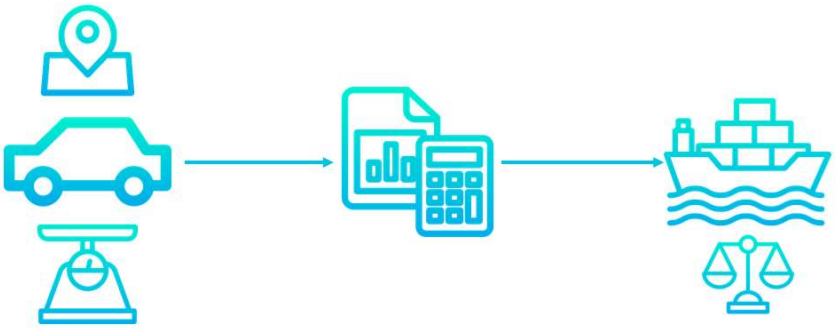

Figure 16. Vessel-cargo communication and stowage aid.

Using today's method, creates obvious planning inconveniences, and often, it means not loading vehicles that should go on board, because the stowage plan was found unrealistic at the very last moment during cargo operations. On the other hand, with the implementation of the CDA, the planning capabilities of the operators would make a huge leap in its reach, as it would allow to faithfully translate into the vessel what was previously embodied on paper.

3.2.2. Terminal support and its future automation

After breaking down the idea of connecting the vessel with its cargo, the next logical step is doing the same between the vehicles and the terminal. In a similar way as it works inside the vessel, the functioning of the CDA at the terminal would be based on the data transmission from the car's CDAs to the terminal's receptors, and vice versa.

By implementing the CDA in this field, it would enable an effective tracking of all sorts of variables: from automatically locating the vehicles inside the terminal, to registering the date and conditions of entry and departure to the terminal (e.g. which would be able to instantly calculate the demurrage costs), provide safety and security alerts when needed, check the fuel consumption levels of the cars and advise the ones that require refueling, or even notify the temperature of vehicles directly exposed to the sun, just to mention some potential applications.

Being able to have a control this deep over the vehicles present at the terminal would enable using new planning methodologies in a similar way as with the innovative vessel's stowage plan system, providing additional efficiency and an overall more satisfactory service for customers.

Still, deepening into the potential use of the CDA in terminals would open the door for taking this aid system a step further: it would be a most fitting option for the actual transition to fully automated terminals. The absolute control over the units that the CDA would provide, represents the perfect partner for the current trend of developing self-driving technologies in commercial vehicles. With both systems complementing each other, the future of the rolled cargo terminals would likely be nearer, which is something that has been in the works since the 1990's for container terminals but has had a shier approach on vehicle terminals. Also, with the tools that the CDA system would be able to offer, its usage on the handling of electric vehicles, another growing trend, would be as suitable as for the already mentioned scenarios for the same reasons.

This way, in a landscape where the CDA was implemented in this direction, the possibility of carrying out entirely automated loading operations could be posed. Moreover, not only this appliance would provide useful tools for executing autonomous operations, but perhaps most importantly, it would contribute to providing adaptability to the operators, in order to make them capable of effectively reacting to the changes that the future landscape of the business may bring. Another key aspect that comes along with both automated operations and providing adaptability for the future is the possibility to embrace all these changes into the most environmentally friendly possible manner. This would be possible thanks to the energy saving that would represent optimizing the operations, as well as the increased capability of handling non-fuel dependent vehicles.

Figure 17. The CDA as a support in terminal operations.

3.2.3. Documentation handling and customs control

The input of information into the CDA database could also have a huge impact on documentary tasks. First of all, it would facilitate an automation upgrade for the handling of loading lists; with the assignment of the vehicles to be loaded onto the vessel on the CDA platform, it would enable all the concerned parties to access and share its data, instantly and through a unified format.

This would translate into the actual definitive implementation of the EDI (see Appendix IX. Union Customs Code articles referencing the usage of electronic systems for exchanging information.) load lists transmission, which has been aimed at for years now, by both Customs and Port Authorities. It would also mean that the shipping company and the destination ports of the cargo would be able to know precisely and with a lot of anticipation, through live updates, the loading forecast, the state of the operation and automatically receive loading confirmations (the vessel would detect the loaded vehicles thanks to the vessel-cargo communication).

In second place, this feature would create a chance to potentially save a notable amount of work regarding documentation handling, such as BL issuing. This would be especially useful in the car carrier trade market, as most of the lines conduct regular shipping services and as such, the documentation and its format roughly varies from one voyage to another due to the similarity of each shipment. A possibility, for example, would consist in uploading the BL template onto the CDA platform by the

shipping company and then, the shipper/carrier would add the amount of units booked with its specifications. Finally, the receiver/consignee and the shipping company would confirm their compliance with the BL. This way, the BLs, and other cargo documents as well, would be not only automatically generated with the information provided by the CDAs, but also safely supervised by all the operators involved in the shipment.

A similar process could be applied to the customs documentary formalities; it would only take the customs agent, with the agents and Customs Authorities supervision, to upload the data onto the template of the required customs document on the CDA platform and then, the document would be issued. In addition, if the CDA would also have the current customs status of each vehicle incorporated on its database (provided by automatic status changes during the operations such as "at the terminal/loaded/on board/discharged"). This way, it would be possible to fully and reliably automate the whole customs declaration process. Moreover, this ease of data flow and its clean organization inside an on-line platform, would represent a very important step towards the actual implementation of the Union Customs Code (see Appendix VII. Union Customs Code, aim and implementation terms).

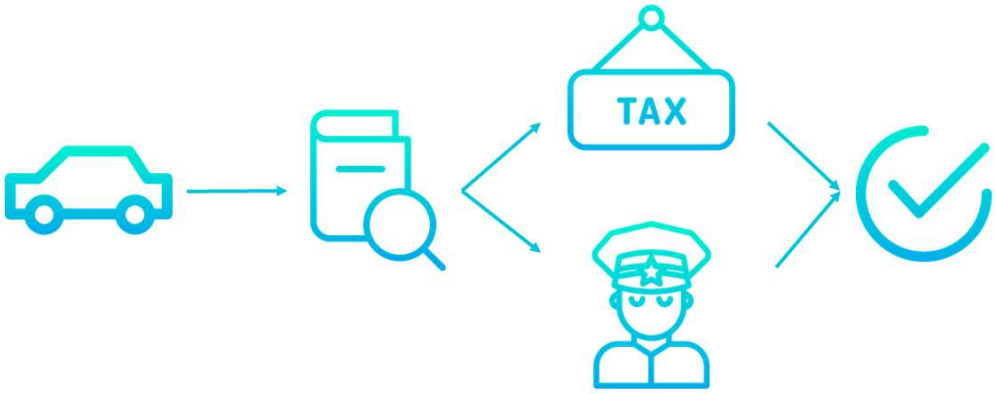

Figure 18. Customs procedures automation.

Another example of the potential reduction of administrative tasks can be found on the calculation and invoicing of port taxes. By knowing the status of a vehicle (loaded/not loaded), its weight (embed on the CDA) and the operator that will take care of the cargo charges (provided by the agent), then all of the invoicing related to the vehicles involved in the operative would be easily generated. Thus, only by uploading a few variables to the CDA system, would allow to consistently take care of the majority of the accounting side of the car carriers business, as it would be capable to control the whole process: from the mentioned invoice calculation to payment claims, and even putting together PDAs.

3.2.4. Quality control

Another field where the introduction of the CDA could have a positive impact is the quality control and surveying of the vehicles, as it currently lacks aids of this kind. With the connection of the CDA to the electronics of the vehicles, the functional status of the car could be accessed at all times: speed, fuel remaining, wheel's pressure, safety and security alerts, etc.

This way, it would be much easier to find out the origin of damages and breakdowns, and thus effectively assign the reparation costs to the actual responsible; it would also allow to discover possible hot spots for incidents along the logistic chain, and therefore take actions in order to prevent damages to the cargo. In contraposition, in the current system, where a vehicle suffers some kind of mishap, it

can be very hard to actually find out where and when it was caused, and thus the resulting costs often end up being shared by parties that are not responsible for the damage.

In this sense, it would represent a very useful tool for the shipping companies and its agents, as it would allow to precisely and remotely control a lot of the variables that conform the quality standards of the shippers. It would even allow to automatically issue reports of each operation with the gathered data from the CDAs, which would also facilitate the evaluation of the performance of the operators in charge of handling the cargo, like stevedores.

Figure 19. Automatic verification for quality surveys.

In addition, the CDA could serve the cargo surveyor's purpose, as it would help them to report damages with ease by assigning reports directly to the device of the vehicle in situ during the operation; It would only take the surveyor to scan the desired CDA, and attach a report to the profile of the vehicle into the system, in order to register an incident. This would be specially fitting for reporting damages that cannot be automatically detected by the CDA, such as grates and dents.

3.2.5. Software simplification

During the few past years, a big part of the information related to the operation of car carriers has been electronically transmitted between the involved parties. Obviously, this represents a step forward, efficiency-wise, in comparison to the way it worked in the 20th century, where the extensive use of paper both slowed down all documentary processes and supposed an ecological abuse.

However, since the implementation of PCs and the e-mail two decades ago, very small to no progress has been made towards the performance optimization that could be achieved with today's technological advancements; instead, at the beginning of its application, informatics were implemented in the shipping business in no different way than it was done in any other sector, and since then, barely any changes have been made, and the current inefficient system has been granted with surprising conformity from the operators, even though, for them, this means losing money, time and resources.

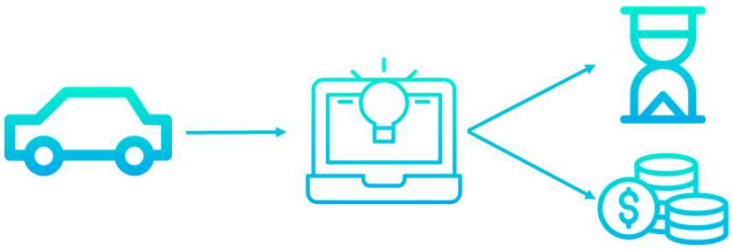

Figure 20. Advantages of unifying operating systems.

In order to understand the clutter present in the current sharing and handling of data in some sectors of the shipping business, having a look into all the different software and platforms needed for carrying out a single car carrier operation in Barcelona results revelatory:

- Email: this is the main channel of communication and the one that makes possible reaching almost everyone, as every operator has this tool, from vessels to the Port Authorities. The email is used for transmitting all kinds of information, but a big part of it, like the loading lists and loading confirmations, have an intrinsic format that barely varies between voyages, and thus, these could be easily automated if executed through a unified path.

Usually, the data sent by email has to be translated from other formats or platforms, such as datasheets, paper documentation or any other piece that contains the information gathered from operations; this, however, implies that in order to transfer this data to the e-mail it has to be modified or even re-elaborated so that it can be adapted to a text message. Even after this, it is possible that the receivers won't get the information in an optimal format (i.e. some vessels have limited data access), or that it has to be re-elaborated to new receivers, update the data again, and many other obstacles that are usually found and that don't allow to effectively transmit the desired data in a single clear piece of information.

- Port Authority platform (*Portic, Portel*): this is the channel between the Port, the terminals and the agents, and it is generally used for managing aspects of the Port calls, such as berthing, waste disposal, or the customs declarations.

Often, a lot of these functions are redundant as they are done for a second time through e-mail or other platforms. In addition, many parties involved in the operations, like surveyors or suppliers, who are interested in having access to the information contained in this platform, can't enter the platform, which implies that they request the information that has already been uploaded to the system, via e-mail to other operators. Not to mention, that these platforms are often privately owned by corporations, outsiders of the maritime business, that only seek economic profits from it, putting aside the adequate functioning of these applications.

- Customs Authority platform (*sede electronica, Agencia Tributaria*): it is the official channel for the transmission of customs declarations and other related communications involving the State's Administration. However, these are made most of the time in first instance through the Port Authority's platform.

In cases that require inquiries regarding actions previously made, such as customs declarations amendments, then this platform serves as the primary communication channel, but its operation is neither clear nor agile, and the interface is not intuitive nor designed for the specific purpose that it should be aimed to. The flawed nature of this system may be attributed to the varying interest from the Public Administration, as it doesn't directly benefit economically from an efficient functioning of the platform, neither has to hold accountability for its results to a superior organism.

- Shipping company platforms: most the bigger shipping companies have already tried to create unified focused platforms, but these are obviously not shared among competitors, and so, they are only useful for connecting the agents that work for the same shipping company. In case an agency represents several shipping companies, it will need to use as many systems as customers it has. In addition, it is

common that the shipping companies require the transmission of information by duplicate, as they also demand it via e-mail, and as a consequence, the implementation of these systems loses all meaning.

- Operator's platforms of internal usage: agents, as well as terminals, surveyors, carriers and the Port Authorities have their own internal systems that are used for managing their data. This software is sometimes prepared for communicating with some of the previously mentioned platforms, but because they are developed by smaller entities, their quality is usually inconsistent. It is also very common, that each operator uses more than one of these applications, each for a different purpose, i.e. a platform for issues concerning operations and another one for accountability purposes.

It seems clear then, that there exists both a lack of coordination between parties and an excess of tools; counting the number of different parties involved in each port of the world and the number of platforms every one of them uses, the amount of existing applications developed for the same purpose must be of the order of thousands, when in reality the information they try to convey is very similar.

The implementation of a unique system would allow substituting all these platforms by one of higher quality, where all the parties involved would have easy access to what they actually need, and provide for others with the same ease. The development of this platform would mean a one-time work, focused on delivering a system adapted to the needs of the sector, with the goal of enabling the automation to reach every corner of the car carrier operation process, and one that would break language and time zone barriers. In conclusion, it would mean efficiency.

3.3. Implementation

After going over the potential that a system like the CDA has, the next step that comes along in the examination process of this idea, is the viability for translating it from a concept to a reality. This section serves as an outline of all the necessary steps for carrying on with actual production of the device, its functioning and its implementation.

3.3.1. The CDA

In order for the posed system to have the highest possible chance of success, it would be indispensable that the physical device of the CDA would be capable of accomplishing the majority of the previously exposed applications. Thus, the goal would be to produce a unit that could connect with the vehicle, gather its information and transmit it to the receptors, in order to have a constant broadcasting, both inwards and outwards, of the system. Therefore, a key aspect of the device would be its connectivity.

In addition, the CDA would have to be sturdy enough to resist the brusque conditions of the loading operations, and also to be able to withstand the harsh nature of its natural working environment, sea-side; obviously, all these performance conditions would have to match the economic viability of the production, so the idea of the device being reusable would have to be seriously considered. Thus, the second aspect to define about the CDA would be its physical structure; however, by anticipating it's functioning, it's easy to realize that the implementation would require of a flexible device, when speaking of the connectivity to the vehicle, as it would be very different to attach and link the CDA to a new car as opposed to doing so on a used one, or to a bulldozer, for example. For this reason, the existence of two versions of the CDA is suggested in order to obtain the needed adaptability for the device to be able to operate with the maximum number of vehicles possible.

The first version would be the CDA of absolute implementation, and it would represent the mainly used model in an ideal scenario, and the one that when introduced, would aspire to achieve all of the raised goals. In order to do so, it would have to be capable of storing the information extracted from the vehicles through a direct physical connection to the vehicle's electronic system; not only that, it should be able to save the data inputs from the involved parties and transmit them to the CDA software.

In a landscape where most of the operators were up for collaborating with the implementation of the CDA, the manufacturer of the vehicle would be the one to attach the device onto the car's system, ideally in a non-visible spot inside the glove compartment set or in the hood. This way, the CDA would be able to obtain data directly from the vehicle at any given moment: from its speed to the fuel remaining, in addition to offering the possibility of having factory data and specifications introduced by a source as reliable as the car makers.

In case of not counting on with the manufacturers' cooperation, then the CDA would have to be connected at some point between the vehicle's departure from the factory and its entry at the terminal, most likely through an external visible connection, but still inside the car for preserving the device better; this connection type would presumably be USB due to its data transmission capacity, as well as its universality. Following this premise, the device would be able to access almost the totality of the needed data, but on the other side, it would imply the inconvenience of connecting the CDA manually once the vehicles were already out of the production chain, and by it being done by a third party, it

would mean an extra expense. Anyhow, in both situations, the vehicle would provide the CDA with power for its functioning, an elemental aspect on its success aspirations.

Either way, even if it seems that the CDA would need a power source in order to carry on with its functions, it wouldn't necessarily be that way: it would count on with the help of the Radio Frequency Identification (RFID) technology. RFID uses electromagnetic fields for automatically identifying and keeping track of objects thanks to tags (emitters/receptors) attached to them, and interestingly enough, RFID systems don't necessarily require a constant electrical supply in order to operate.

The application of the RFID technology would provide a solution in regards to the communication capability of the CDA, but there is an inconvenient: because RFID systems may not use electrical power, they don't have connecting means for obtaining the information from the vehicle. Because of this juncture, the proposition is that the CDA with the RFID technology integrated in it, would communicate with a base attached to the vehicle's interior (see Figure 21, component g). This way, the emitter connected to the car's electronics would transmit the data to the CDA located on the exterior of the vehicle (component c).

By re-arranging the system in this manner, the CDA would be granted with a range improvement and a wider capacity for storing information, and it would also allow thinking of a design simplification of the physical format; in the same as the anti-theft detectors on department stores, an external carcass would be used for covering and protecting the internal device by making the whole piece robust. For externally attaching the CDA to the vehicle, a magnet (components b and j) would be incorporated to the base of the device; this way, it would have the steadiness and the stability needed for keeping still on the car's body during the operations and the harsh conditions that these may entail. However, in order to avoid damaging its own vehicle and the adjacent ones, both the magnet and the device would be covered with a rubber coating (components d and l) in order to soften its surface.

Additionally, reshaping the system by using an external CDA would bring the already mentioned functioning flexibility, as it would enable using the device on all types of vehicles that otherwise wouldn't admit an easy connection of the internal RFID transmitter to its electronic system, such as heavy machinery or used cars. In these cases, on the one hand, the CDA wouldn't be able obtain some of the data directly from the vehicle, so it would have to be introduced manually, but on the other side, it would also allow implementing the system to a broader specter of automobile types.

At this point of the design approach, the CDA would be capable of compiling information from the vehicles and transmit it, but there are still several pieces of the system to be put together. The CDA, in order to performs most of its potential applications, would require, apart from the posed emitter attached to the vehicles, figuring out a second device in charge of receiving and handling this data. The answer to the counterpart of the CDA emitter, would be found in the CDA receivers, a series of devices placed all along the vessel's decks and terminals that would work as links between the vehicle's CDA and the external online network.

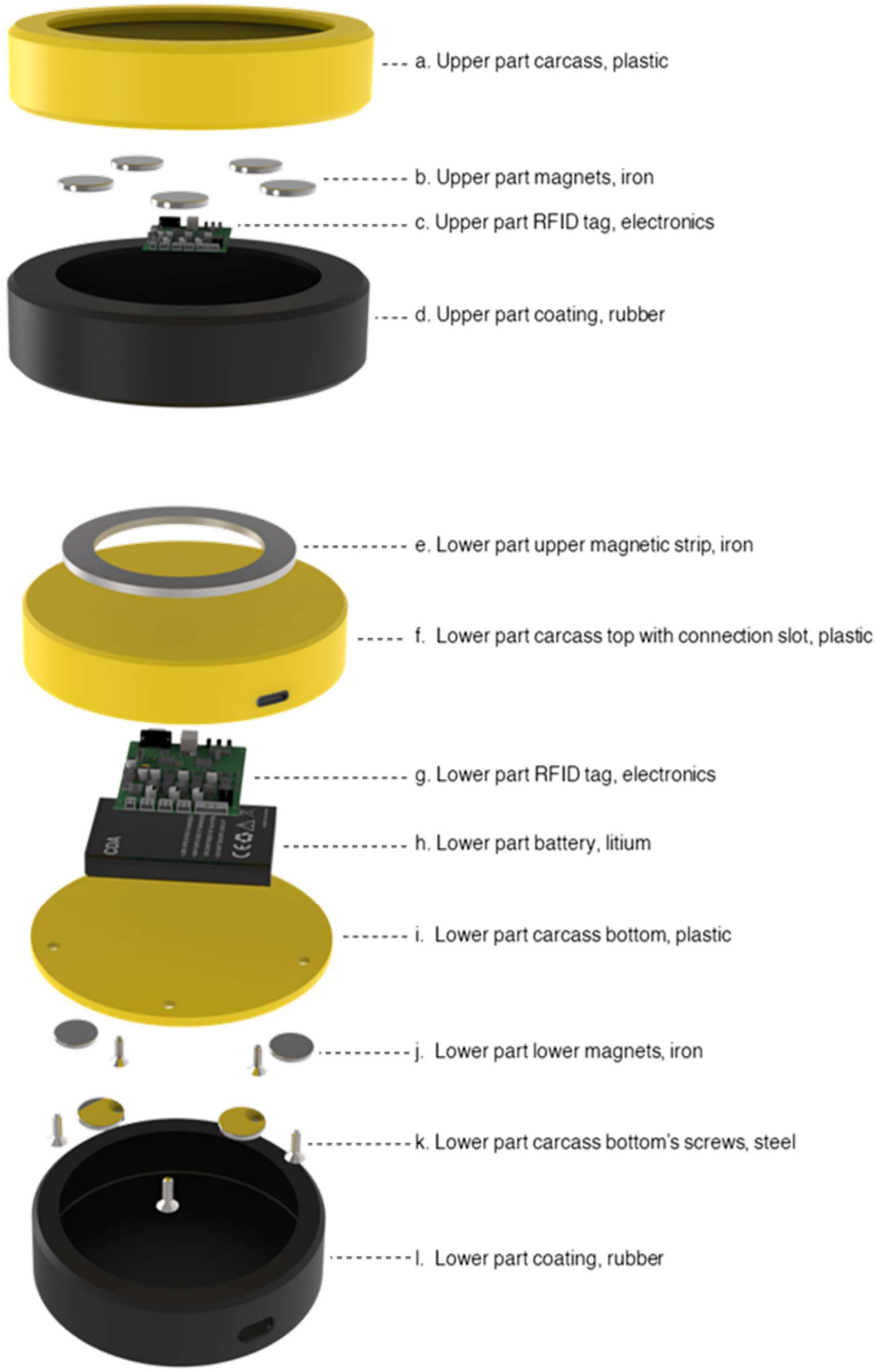

Figure 21. Model of the CDA, deconstructed.

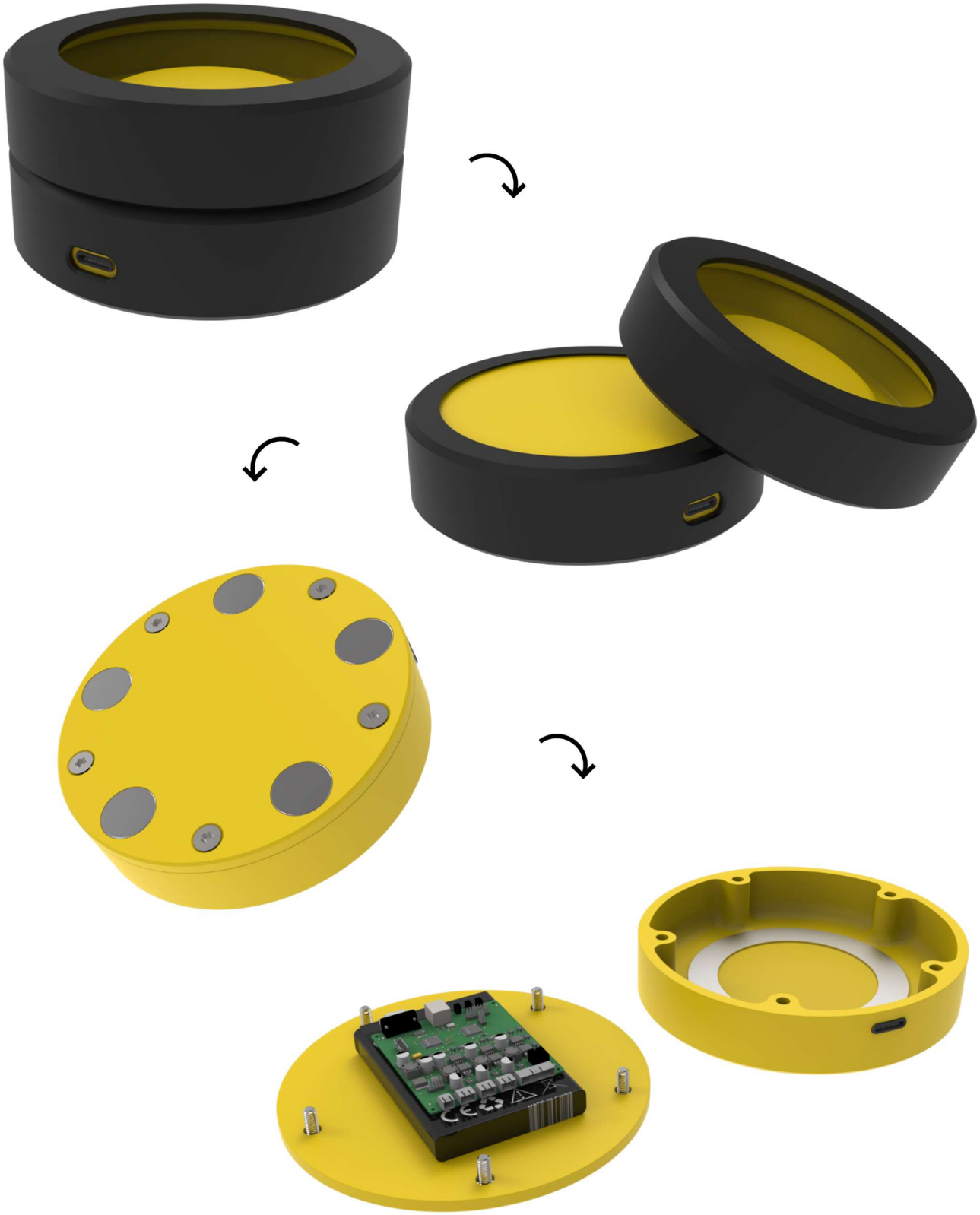

Figure 22. Unfolding and interior design of the CDA.

3.3.2. The CDAR

The CDA receptors, CDAR from now on, would play an essential role in the working process of the system as they would be the nexus between all of the data generators: both the CDAs and the operators that use the platform. For this reason, the key to the success of the CDARs would reside on its connectivity.

When analyzing the two sides that the CDAR is supposed to connect, the design approach runs into the challenge of making a device capable of communicating with the CDAs, which means short distance information transmission and direct range incidence, while being able to connect with the public domain internet network, which demands a wider range of connectivity features.

Clearly, the solution to this challenge would require the CDA to use two different information transmission technologies in the same device: the first one, for connecting the CDA with the CDAR, would use the already mentioned RFID; and for connecting the CDAR with the online platform database, it would simply use the vessel's and the terminal's internet network. Once again, two new challenges arise: one would consist in translating the data received from the RFID into signals that can be treated for its online use, while the other challenge would be providing the CDAR with a power source so that it could carry on with all of its tasks.

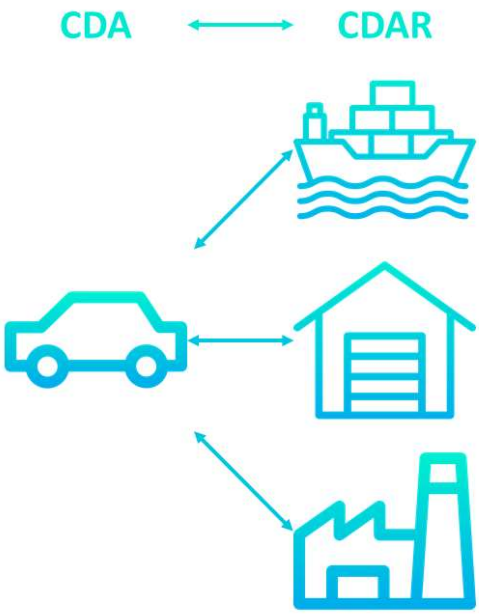

Figure 23 Interconnection between the CDA and the CDAR.

For the first issue, the answer can be found inside the majority of RFID systems, as they usually require an online support in order to ensure the functionality of the process they interfere in, so in this case it would only be necessary to adapt this already existing technology, present on the CDA, in order to be able to work with the specific data of car carriers. In the second case, the more seemingly practical solution would reside in connecting the CDARs to either the vessel's or the terminal's power source depending on where they would be placed. This way, the signal repeaters would have access to a constant and reliable electricity supply that would allow them to achieve optimal levels of speed and quality in regards to the transmission of data.

Overall, the CDAR's design would require higher levels of complexity and, therefore, these would end up being more expensive than the CDA. However, they would be expected to last for years at the vessel whom it would be installed at, in contraposition to the flowing nature of the CDA. To summarize, the CDARs would be installed and left in its desired location, to interact with the CDAs, that would come and go from the CDAR's range as the vehicles were loaded and discharged.

3.3.3. The CDAP

Once the CDA's design would successfully cover the tracking and transmission of the vehicle's information through its physical formats, then a software platform would be required in order to effectively handle this complex flow of data.

This support, with the name of Control Device Appliance Platform, has the goal of bundling all the data, so that the operators, from agents to terminals and shipping companies, could use it as a tool for upgrading their efficiency. Also, the CDAP aims at being a multidirectional tool, which means that the platform would be supposed not only to extract information from the CDARs, but also to allow adding tags and details to these device's profiles on the CDAP, in situ of the operations through the operators' inputs.

For this reason, when formulating the functioning procedure of the CDAP, the first thing to do would have to be analyzing which information the device ought to compile. In the first instance, the CPAD would receive data transmitted from the CDARs, wellbeing initially introduced by the manufacturer, such as the VIN, car model or the weight, or the ones generated by the tracking during the operations such as the stowage location of the vehicle, its driving speed or emergency alerts. On the other side, the system would have to include all the information that the involved parties would consider; in this sense, the number of possibilities expand exponentially, as the CDAP would serve as the communicating channel between everyone concerned, each of them with different functions and interests. As a guidance for comprehending the varied range of fields where the platform would able to act at, three examples are pointed out:

- By adding a tab into the CDAP, displaying the loading state of the vehicle such as "entered terminal / ready to load / loading / on board and stowed / discharging / arrived at destination", it would allow to automatically trigger all kinds of actions, from customs declarations to loading confirmations. In this case, the agent would radically optimize its update and report functions to the shipping company, the Port Authorities, carriers, etc., while doing so through a unique, reliable and convenient communication channel.

- If besides incorporating the loading status of the vehicles, the shipping company and the carriers were to add its loading terms, the dimension of the CDAP would expand its form operative-only, to an administrative/finance tool, too. In this case, the act of cross-checking the loading status and the loading terms would instantly enable delimiting where the responsibilities and risks begin and end for every side of the transportation process, which would also allow to immediately activate payment procedures and its consequent claims, or to effectively attribute the cargo damages to the corresponding party, among other administrative applications.

- In regards to customs formalities, the loading status of a vehicle in the CDAP would obviously be key for its automation, but not only this, it could also serve as a tool for expanding the operators' knowledge

of the matter, and as a safer way to issue the customs declarations by acting as a more direct and effective communicating line between declarants and the Customs Authorities. Thus, having the Customs' Office and the legislating Authorities' cooperation, the CDAP would be directly fed with high quality information by the own sources that regulate these types of procedures, which would be extremely useful for successfully executing all actions with customs/fiscal incidence; this way, its users would have an easy access to a procedure guide and regulations database that would provide both self-confidence and trustworthiness to their work, translating into lower amount of errors in these procedures. In addition to ensuring the correctness of the procedures, involving the legislative organisms into the CDAP would also mean the birth of a practical and reliable tool for finding out about other countries/ports' legislation, as well as increasing the global comprehension of the different customs models that may be involved in any given trade.

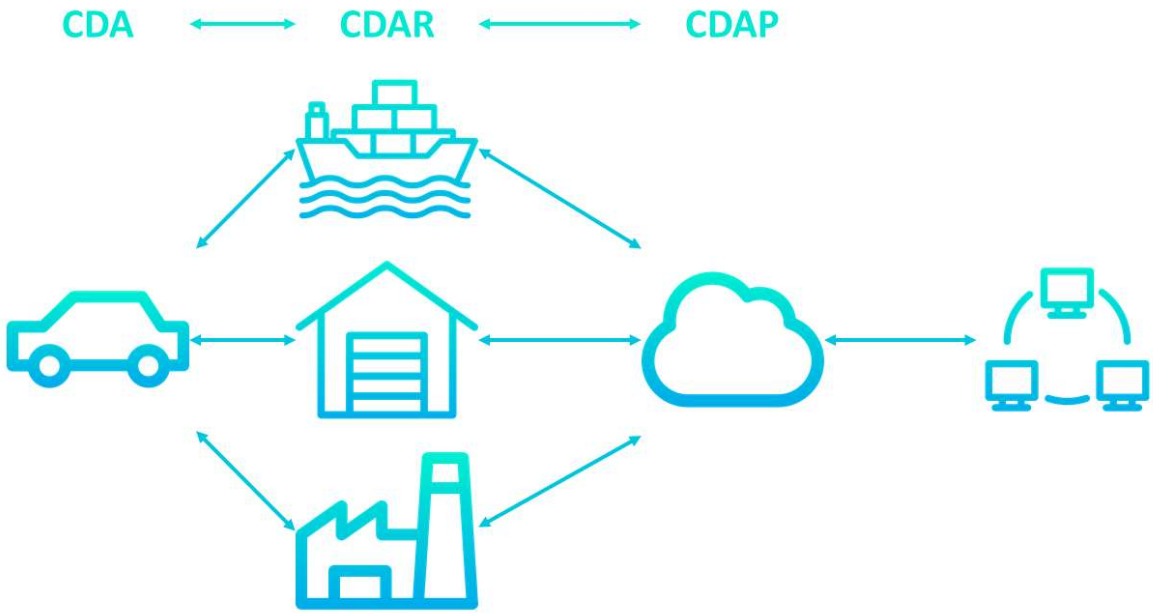

Figure 24. The CDAP as a link between the cargo and the operators.

Like this, every time a new variable was introduced into the CDAP, it would link with the rest of the already existing data, which would multiply the amount of applications that the system could provide. For this to be possible, it would be essential for the software to accompany in quality the rest of the CDA project.

First of all, an agile and intuitive interface would have to be designed so that it could match the goal of handling and displaying the maximum amount of information possible, while doing it in a very organized way. In order to allow doing the desired tasks as quick as possible, it would be proper to optimize the number of clicks and screens to pass through while executing a task, which is a common hassle in most current platforms that drags the operational agility.

Following an easy-going interface would be just as important as to pay special attention into crafting a well-thought information-organizing system, as data would the most precious good in the whole process. Thus, the basis of the data sorting would reside in the diverse units capable of containing information related to the vehicles, like vessel's hold or a BL, each possessing a distinct nature, but all of them encapsulated under a unique displaying form and interconnected between them, where the basic

unit would be the vehicle, combining with other basic units to form more complex structures, just like a honeycomb does.

Hence, the interface could be structured so that tabs would showcase different layers of depth of a car carrier's operation and its diverse types of units, encapsulating each other, sort of like a Russian doll, so data could be displayed in both practical and aesthetical ways: a tab for a showing a single vehicle, another one for a hold, for a whole vessel, a terminal, or even for laying out not tangible spaces like a customs warehouse or Office, a customs document, a BL, etc.

Meanwhile, apart from providing an efficient service, the system would also have to keep the privacy of both the data and its operators as a cornerstone. This would be ensured by regulating the access to each site of the platform through a net of permissions that would restrict the operators' admission. The management of the access permissions to the platform would ideally be in charge of the EU, through the application of electronic signatures. These electronic signatures could be linked to the administrative profiles of the operators categorized as Authorized Economic Operator (AEO) or Economic Operators Registration and Identification number (EORI).

By doing this, each party would only have access to a determined selection of the previously mentioned layers, according to which information would be needed to perform their particular operational tasks. The access to each piece of data would be regulated by the uploader of said data, which would commonly be the owner of the cargo.

3.4. Potential assessment of the CDA's implementation

In the second part of this project, a specific proposal for breaking ground in the field of the car carrier business has been posed. However, every developing process reaches a point where, in order to move forward, it must demonstrate whether it is capable of crystalizing into a solid project, or else, remain in the trunk of good ideas and eventually fade away. Therefore, the goal of these conclusions is to try to evaluate the likeliness of translating the CDA into reality.

An initial premise for feeling optimistic about the success of this project, relies on the instinct that anticipates a notable evolution in the working processes present in the car carrier's sector, which would easily require a specialized tool for moving along with it. These upcoming changes are very likely to happen rather sooner than later, as the proliferation of regulatory frameworks revolving around the Union Customs Code suggest. All going well, the majority of these pronouncements will come into effect during the following decade, which may point several developing efforts towards the making of a tool that helps smoothen this transition, either doing so in a similar shape to the CDA's or by embracing a completely different concept.

Moreover, the point of working on an efficiency-boosting technology of this kind, apart from providing adaptability for the future, is also meant to add value to the logistical chain it is implemented into. Hopefully, this would incentive the vehicle manufacturers to find reason in keeping their production locally based, instead of continuing with the past decades' trend of relocating its factories onto cheaper countries. While moving the production spots to developing areas is rather profitable for the makers, outsourcing supposes a higher environmental impact, derived from the transportation of the vehicles to their selling points. So, if the added value that the implementation of a system like the CDA would provide could create a chance for shifting towards a more ethical business model, it definitely would be worth trying.

Another bright glance for making the CDA a reality, is the fact that, the technologies used already exist. Mashing up systems that are effectively implemented on other fields, like the RFID and the EDI, would imply a reduction of the developing efforts and costs, so in a way, the CDA not being a completely original concept, would most likely work in its favor. Still, both its development and later production would require a significant economic investment.

Obviously, in order to put together the necessary funds for the actual development of the project, the investors, whether private operators or public organisms, would have to find either a monetary return, or an operational improvement big enough for the investment to be worthwhile.

Having in mind the dimensions of a car carrier operative, and the nature of the CDA, which would require a device per vehicle, plus the installation of CDARs in vessels and terminals, then the extension of the investment would have to cover the production of thousands of devices per vessel, for dozens or even hundreds of car carriers. In a scenario in where the production cost for each device would be as low as 5€, even then, the amount of money needed for implementing the system globally, would presumably have seven zeroes. Nevertheless, putting the cost of the CDA into the context of the entire transportation and logistics process of a vehicle, it would only imply a mild economic effort, as it would represent a very small percentage of the expenses of the whole chain.

While the whole implementation process would require meeting very high stakes, the size of the market is proportionally broad, so a joint venture of several strong operators, could make its financing viable. In order to sound out the interest of the different parties that would benefit from the CDA, and therefore invest in it, the proposition would have to be preceded by a market analysis in order to assess the possibilities of making enough operators come together, once again requiring additional funds.

4. Conclusion

In this final segment, the purpose is to bring together all the propositions conveyed in this work in order to draw as many useful conclusions as possible. For this case, the focus will be on evaluating the state in which the project is found and to try to define its following steps.

The first subject of analysis is the technical achievement of the system's design. Although some operational aspects are yet to be detailed or tested, such as the actual viability of the suggested technologies for accomplishing all the functions of the CDA, the assessment in this area is positive in general terms: the overall functioning of the system seems to be cohesive and doesn't present any evident design void, at least prior to its testing in a real vessel operation.

Hence, the presented structure is considered to be enough for the system to work, and thus to be optimistic about its implementation. However, while the CDA could notably improve the efficiency in many tasks when implemented, this same advantage could also bring uncertainty to the sector. Like in many other industries these days, the potential loss of jobs due to the automation of tasks is a very present concern. In this case, this concern is very much applicable, but it is also true that for the most part in these situations, the jobs that were initially thought to be lost, are ultimately reshaped in order to fit into the updated working landscape.

Furthermore, the application of the UCC is also a source of a certain confusion, as well as a key element for understanding the potential success of a tool like the CDA: the deadlines for its entry into force keep being pushed back, some Customs Offices doesn't seem to be ready for effectively embracing it, and its commands may shift the relevance of some operators. For example, under the context of the UCC, some of the current customs obligations on the agents' hands are expected to be transferred to terminals, which could weaken their position of the firsts. Because the implementation of the UCC can change the way in which the operators are interconnected, their willingness to bet on new systems before the upcoming environment is unveiled can be compromised.

For this reason, making most of the operators come together into trusting this project could be the major obstacle to overcome. However, the way that CDA is designed could facilitate progressively implementing it, which would shrink the dimension of the challenge. For example, if a shipping company started using the CDA for its operations, then it could propitiate that terminals and other operators whom had witnessed its functioning, would find it helpful and gradually adopt the system into their working procedures.

Nevertheless, while some operators, like terminals and shipping companies, could benefit in several ways by embracing the CDA, other organisms might not find the same motivation in adopting a system of this kind. This could potentially be the case for some Customs Offices, whom traditionally require a longer period of time for adapting to new scenarios. Also, due to the sanctioning nature of these organisms, they constantly seek economic gains by penalizing the operators' mistakes along the administrative process, but the paperwork simplification that would come along with the CDA would likely weaken the effects of their collecting mechanism, and therefore potentially make them take a stand against its implementation.

On the other hand, the entry into force of UCC will make all Customs Offices in the EU to reconsider their situation, and the CDA, being designed to converge with the requirements of this legislative frame, could be a very useful tool for helping the Administration make this transition.

By taking all the mentioned considerations into account, seems clear then, that the biggest handicap that this project faces is the gathering of consensus, which can only be tackled by defining a clear strategy. For this reason, the general evaluation of this essay into trying to estimate the actual viability of the CDA, concludes in that it would only have a chance of success if two conditions were met.

The first indispensable condition would be to take this project as far as possible without having any economic support. This means that the author of this work would have to develop his idea to the last detail, especially in the technical aspect, in order to be able to craft a prototype that would enable patenting the system, which would be essential in order to confidently promote it. Then, the second step would consist in, with the device in hand, knocking the doors of as many relevant operators as possible, which in case of generating supports, could lure others into adopting the system.

From a prelaminar standpoint, the only bodies that would be able generate such gravity, while granting a chance for welcoming innovative initiatives, would be three different ones: a leading car maker (as they are present all along the logistic process), a leading shipping company (as they are the central piece of the logistic chain, and the one that could probably obtain the biggest improvement) and the European Union (due to its support programs for funding innovative projects, and as a complement to their customs flagship, the UCC).

With these expectations marking the chances for a further development of the project, the idea exposed in this work can only move forward if, either the author or any other reader that finds interest in joining the project, decides to gather the energy, dedication and ambition, to take the necessary steps mentioned above and make the CDA a reality.

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Appendix I. The current state of state of the global automotive market in numbers

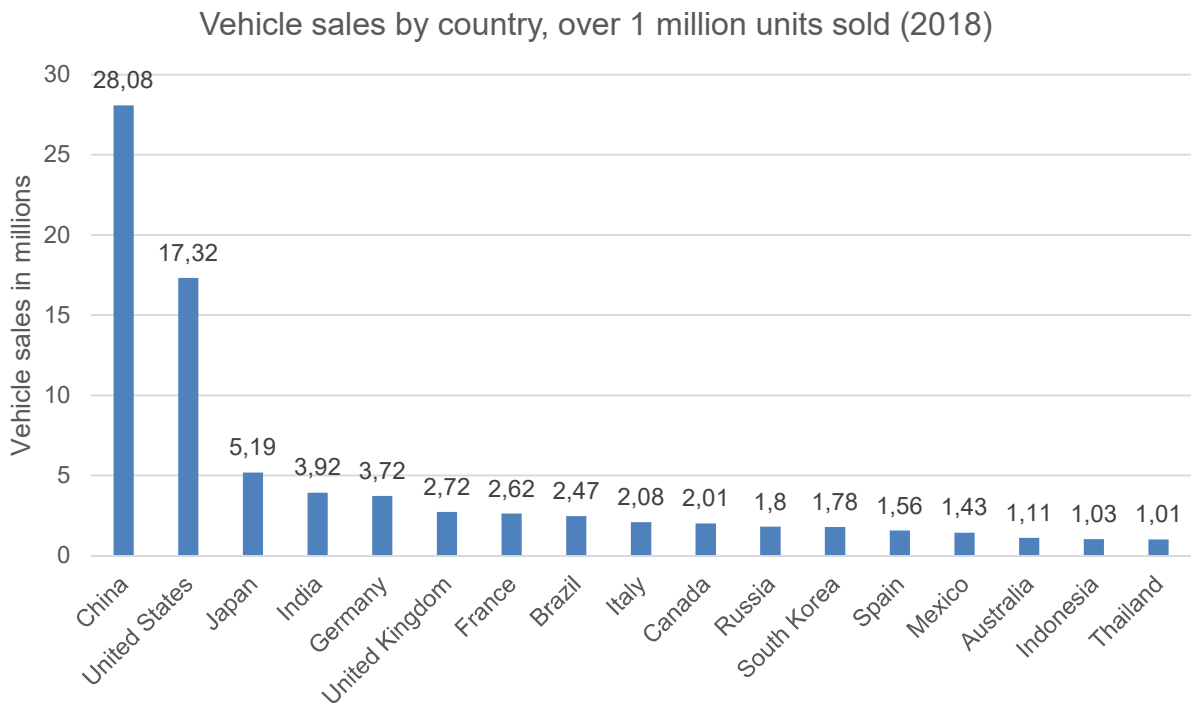

Figure 25. Vehicle sales by country, over 1 million units sold (2018)

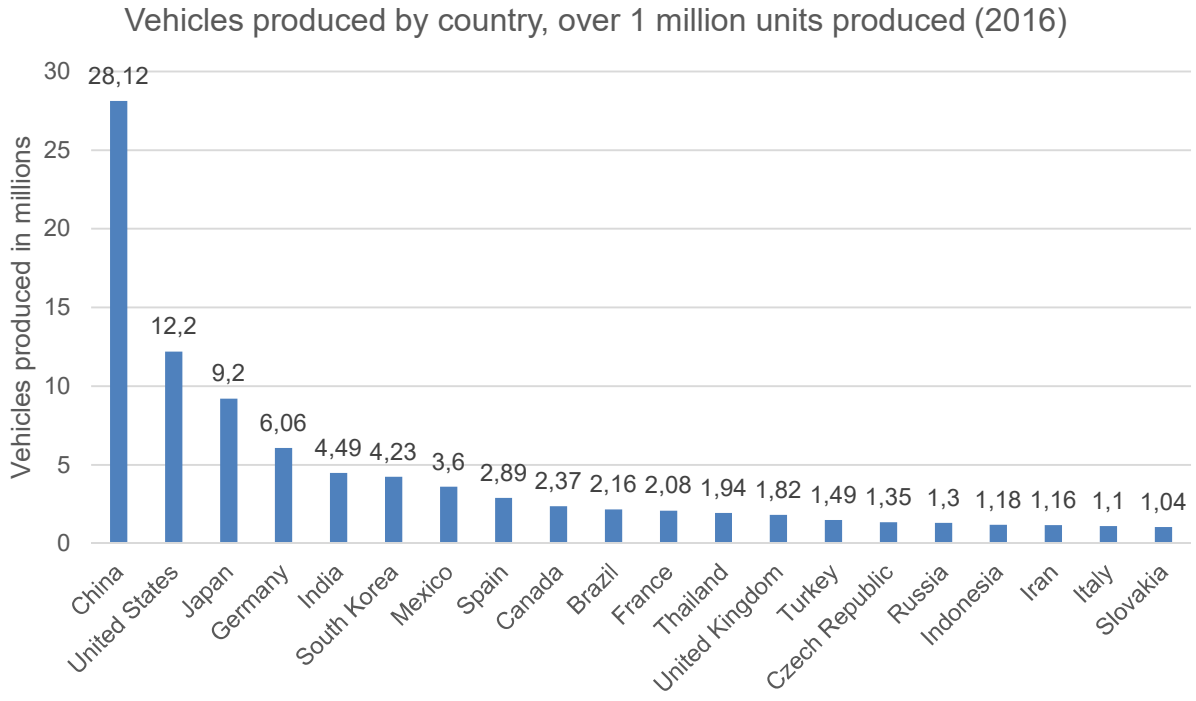

Figure 26. Vehicles produced by country, over 1 million units produced (2016)

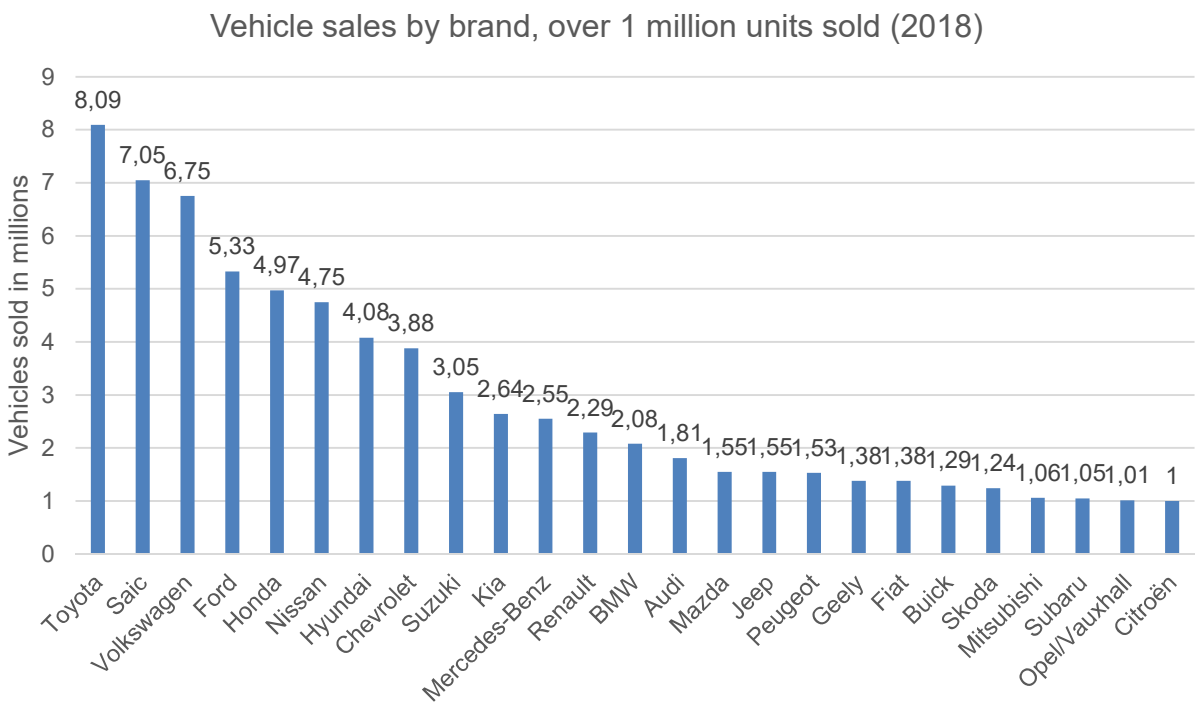

Figure 27. Vehicle sales by brand, over 1 million units sold (2018)

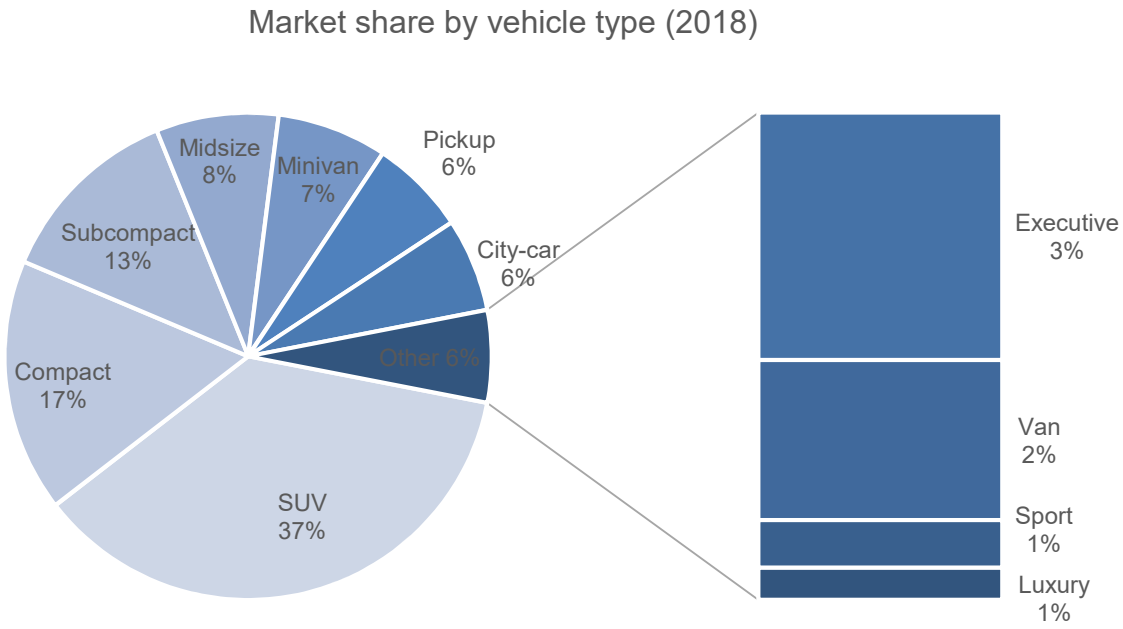

Figure 28. Market share by vehicle type (2018)

Appendix II. Bill of Lading form

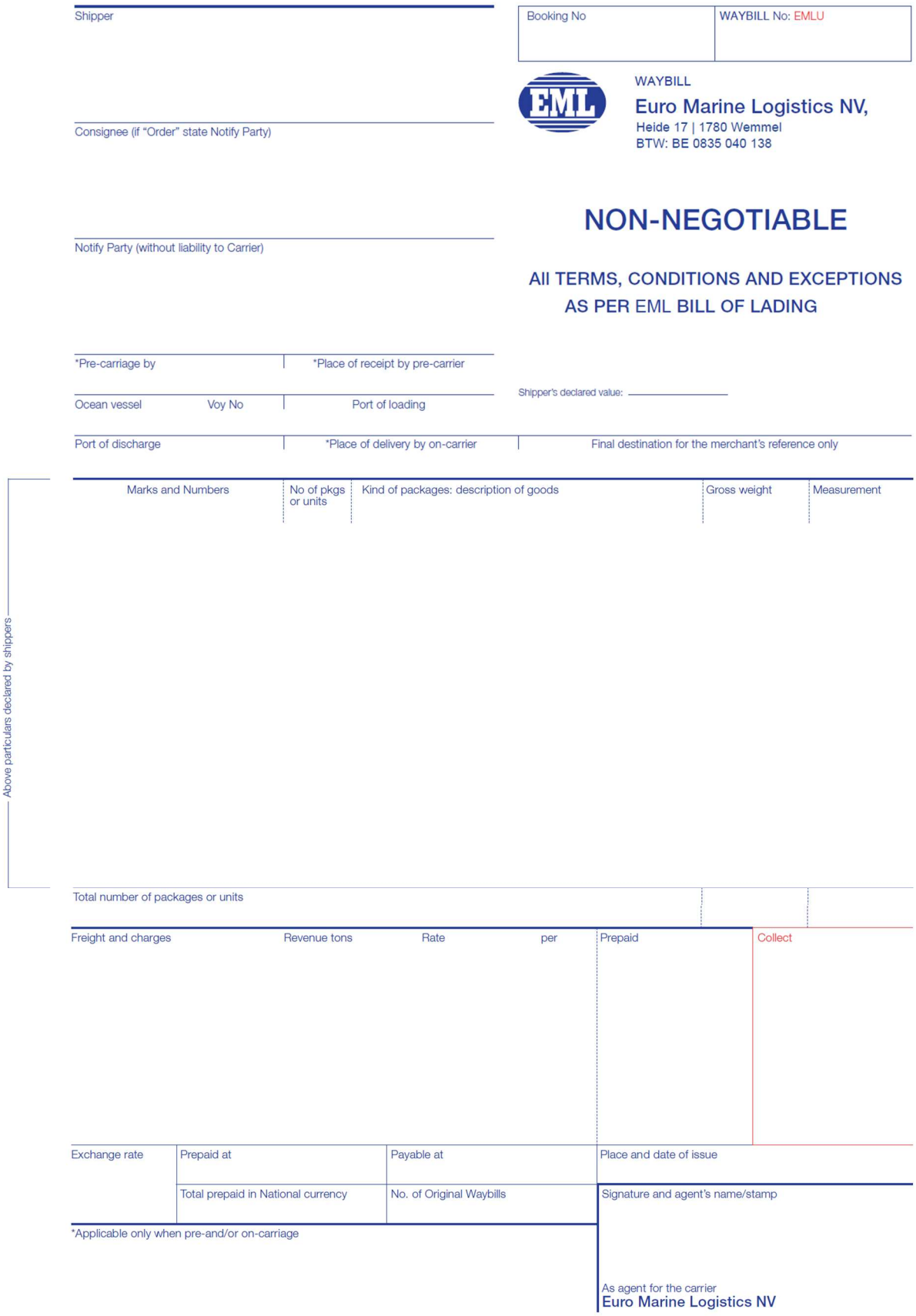

Figure 30. Euro Marine Logistics BL form

Appendix III. HS Code headings classifying terrestrial vehicles, Chapter 87

87.01 Tractors (other than tractors of heading 87.09).

8701.10 - Pedestrian controlled tractors

8701.20 - Road tractors for semi-trailers

8701.30 - Track-laying tractors

8701.90 - Other

87.02 Motor vehicles for the transport of ten or more persons, including the driver.

8702.10 - With compression-ignition internal combustion piston engine (diesel or semi-diesel)

8702.90 - Other

87.03 Motor cars and other motor vehicles principally designed for the transport of persons (other than those of heading 87.02), including station wagons and racing cars.

8703.10 - Vehicles specially designed for travelling on snow; golf cars and similar vehicles - Other vehicles, with spark-ignition internal combustion reciprocating piston engine:

8703.21 - Of a cylinder capacity not exceeding 1,000 cc

8703.22 - Of a cylinder capacity exceeding 1,000 cc but not exceeding 1,500 cc

8703.23 - Of a cylinder capacity exceeding 1,500 cc but not exceeding 3,000 cc

8703.24 - Of a cylinder capacity exceeding 3,000 cc - Other vehicles, with compression-ignition internal combustion piston engine (diesel or semi-diesel) :

8703.31 - Of a cylinder capacity not exceeding 1,500 cc

8703.32 - Of a cylinder capacity exceeding 1,500 cc but not exceeding 2,500 cc

8703.33 -- Of a cylinder capacity exceeding 2,500 cc

8703.90 - Other

87.04 Motor vehicles for the transport of goods.

8704.10 - Dumpers designed for off-highway use - Other, with compression-ignition internal combustion piston engine (diesel or semi-diesel):

8704.21 -- Gross vehicle weight not exceeding 5 tonnes

8704.22 -- Gross vehicle weight exceeding 5 tonnes but not exceeding 20 tonnes

8704.23 -- Gross vehicle weight exceeding 20 tonnes - Other, with spark-ignition internal combustion piston engine:

8704.31 -- Gross vehicle weight not exceeding 5 tonnes

8704.32 -- Gross vehicle weight exceeding 5 tonnes8704.90 - Other

87.05 Special purpose motor vehicles, other than those principally designed for the transport of persons or goods (for example, breakdown lorries, crane lorries, fire fighting vehicles, concrete-mixer lorries, road sweeper lorries, spraying lorries, mobile workshops, mobile radiological units).

8705.10 - Crane lorries

8705.20 - Mobile drilling derricks

8705.30 - Fire fighting vehicles

8705.40 - Concrete-mixer lorries

8705.90 - Other

87.06 Chassis fitted with engines, for the motor vehicles of headings 87.01 to 87.05.

87.07 Bodies (including cabs), for the motor vehicles of headings 87.01 to 87.05.

8707.10 - For the vehicles of heading 87.03

8707.90 - Other

87.08 Parts and accessories of the motor vehicles of headings 87.01 to 87.05.

8708.10 - Bumpers and parts thereof - Other parts and accessories of bodies (including cabs):

8708.21 -- Safety seat belts

8708.29 -- Other

8708.30 - Brakes and servo-brakes; parts thereof

8708.40 - Gear boxes and parts thereof

8708.50 - Drive-axles with differential, whether or not provided with other transmission components, and non-driving axles; parts thereof

8708.70 - Road wheels and parts and accessories thereof

8708.80 - Suspension systems and parts thereof (including shock absorbers) - Other parts and accessories:

8708.91 -- Radiators and parts thereof

8708.92 -- Silencers (mufflers) and exhaust pipes; parts thereof

8708.93 -- Clutches and parts thereof

8708.94 -- Steering wheels, steering columns and steering boxes; parts thereof

8708.95 -- Safety airbags with inflater system; parts thereof

8708.99 -- Other

87.09 Works trucks, self-propelled, not fitted with lifting or handling equipment, of the type used in factories, warehouses, dock areas or airports for short distance transport of goods; tractors of the type used on railway station platforms; parts of the foregoing vehicles:

8709.11 -- Electrical

8709.19 -- Other

8709.90 - Parts

87.10 Tanks and other armored fighting vehicles, motorized, whether or not fitted with weapons, and parts of such vehicles.

87.11 Motorcycles (including mopeds) and cycles fitted with an auxiliary motor, with or without side-cars; side-cars.

8711.10 - With reciprocating internal combustion piston engine of a cylinder capacity not exceeding 50 cc

8711.20 - With reciprocating internal combustion piston engine of a cylinder capacity exceeding 50 cc but not exceeding 250 cc

8711.30 - With reciprocating internal combustion piston engine of a cylinder capacity exceeding 250 cc but not exceeding 500 cc

8711.40 - With reciprocating internal combustion piston engine of a cylinder capacity exceeding 500 cc but not exceeding 800 cc

8711.50 - With reciprocating internal combustion piston engine of a cylinder capacity exceeding 800 cc

8711.90 - Other

87.12 Bicycles and other cycles (including delivery tricycles), not motorized.

87.13 Carriages for disabled persons, whether or not motorized or otherwise mechanically propelled.

8713.10 - Not mechanically propelled

8713.90 - Other

87.14 Parts and accessories of vehicles of headings 87.11 to 87.13. Of motorcycles (including mopeds):

8714.11 - Saddles

8714.19 - Other

8714.20 - Of carriages for disabled persons

8714.91 - Frames and forks, and parts thereof

8714.92 - Wheel rims and spokes

8714.93 - Hubs, other than coaster braking hubs and hub brakes, and free-wheel sprocket-wheels

8714.94 - Brakes, including coaster braking hubs and hub brakes, and parts thereof

8714.95 - Saddles

8714.96 - Pedals and crank-gear, and parts thereof

8714.99 - Other

87.15 Baby carriages and parts thereof.

87.16 Trailers and semi-trailers; other vehicles, not mechanically propelled; parts thereof.

8716.10 - Trailers and semi-trailers of the caravan type, for housing or camping

8716.20 - Self-loading or self-unloading trailers and semi-trailers for agricultural purposes

8716.31 - Tanker trailers and tanker semi-trailers

8716.39 - Other

8716.40 - Other trailers and semi-trailers

8716.80 - Other vehicles

8716.90 – Parts

Appendix IV. Lashing standards example for a shipping company

Stow direction	Type of lashing / Vehicle weight		1.4ton or less	Over 1.4ton 2.1ton or less	Over 2.1ton 2.8ton or less	Over 2.8ton 3.1ton or less	Over 3.1ton 3.5ton or less	Over 3.5ton 4.2ton or less	Over 4.2ton 8.0ton or less	Over 8.0ton 12.0ton or less	Over 12.0ton 16.0ton or less	Over 16.0ton 20.0ton or less
Longitudinal Stow	SWL 600kg Lashing belts	B.L 2000kg Lashing belt	4		6		8		N/A	N/A	N/A	N/A
	SWL 1,500kg Heavy Lashing belts	B.L 6000kg Heavy Lashing belt	4					6	8	10	12	14
	SWL 2,600kg Chain & Turn buckle	B.L 8000kg Chain & Turn buckle	4							6	8	10
	SWL 5,300kg Chain & Turn buckle	B.L 16000kg Chain & Turn buckle	4									6
Athwart ship Stow	SWL 600kg Lashing belts	B.L 2000kg Lashing belt	6		8		10	N/A	N/A			
	SWL 1,500kg Lashing belts	B.L 6000kg Lashing belt	6					8	10			
	SWL 2,600kg Chain & Turn buckle	B.L 8000kg Lashing belt	6									
	SWL 5,300kg Chain & Turn buckle	B.L 16000kg Lashing belt	6									
ON THE SLOPE WAY			IN ADDITION TO THE ABOVE, ONE EXTRA LASHING IS REQUIRED ON UPPER SIDE.			STOWING ON THE SLOPE WAY IS NOT ALLOWED						

Stow direction	Type of lashing /		25ton or less	30ton or less	35ton or less	40ton or less	45ton or less	50ton or less	55ton or less	60ton or less	70ton or less	80ton or less
Longitudinal Stow	SWL 1,500kg Heavy Lashing belts	B.L 6000kg Heavy Lashing belt	20	24	28	32	N/A	N/A	N/A	N/A	N/A	N/A
	SWL 2,600kg Chain & Turn buckle	B.L 8000kg Chain & Turn buckle	12	14	16	18	20	24	26	28	32	36
	SWL 5,300kg Chain & Turn buckle	B.L 16000kg Chain & Turn buckle	6	8		10		12		14	16	18

If the cargo weight is over 80.0ton, the type and required number of lashings should be considered on a case by case basis.

Regardless of the lashing recommendations shown in the table above, to determine the number and kind of lashing materials to be used, the following items should be checked and considered in advance.

Particularly for cargo weighing over 2.8 tons, the required number of lashing should be determined in accordance with the method described in the "Evaluation of forces acting on cargo units".

The securing of cargo with wire ropes and other lashing materials should be considered.

Items to be checked and/or considered

1. Type of cargo
   Buses, trucks, trailers, bulldozers, excavators, etc.
2. Type of driving device
   Tire, caterpillar, steel roller, etc.
3. Size, Gross weight, Axle load, and Center of gravity of the cargo
4. Number and strength of securing points on the cargo
5. Lashing restrictions due to the nature of the cargo
6. Usage of materials to prevent possible damage to cargo and hull
   Example:
   * To prevent paint scratches: Rubber mats, Waste clothes, Strap belts. Etc.
   * To prevent damage to vessel and/or increasing friction: Ply wood, Thick board, Used haweser, etc.
7. Season, intended navigation route, and sea/weather condition forecasts
8. Where high profile vehicles are to be loaded, special consideration should be given to tipping force/movement.

Figure 31. Detailed guideline for lashing

Appendix V. Stowage plan example

POD		LEH		ZEE		SHS		NCL		AMS		TGM		BCN		LIV		PIR		DRC		BOR		Total	
		units	mt	units	mt	units	mt	units	mt	units	mt	units	mt	units	mt	units	mt	units	mt	units	mt	units	mt	units	mt
Derince	DRC																								
Borusan	BOR																								0
Barcelona	BCN																								
Sagunto	SAG																								
Tanger Med	TGM																								
Le Havre	LEH															55	90	142	160	14	28			211	278
Zeebrugge/Hanze	ZEE																	1	22					1	22
Newcastle	NCL															320	501	203	331	761	1240			1284	2072
Sheerness	SHS																								
Pireus	PIR																								
Tanger Med2	TGM2															1503	3086							1503	3086
Barcelona2	BCN2															150	259	1	2	39	59			190	320
Livorno2	LIV2																								
Total																2028	3936	347	515	814	1327			3189	5778,5

Figure 32. Stowage plan example

Appendix VI. Barcelona Port terminals, space distribution and structure

Both Barcelona rolled multipurpose terminals, Autoterminal and Setram, are located in 30 Dàrsena Sud and 31 Dàrsena Interior. The total available berthing longitude of these docks is 1671 meters, with a maximum draft of 12 meters and 4 stipulated ro-ro berths (each of these ranging from 200 to 275 meters).

Autoterminal has granted area of 29,2 hectares, with 4 buffers that increase its storage surface in 377.975 additional square meters. The capacity of the terminal is 48.481 vehicles, 21.500 of them corresponding to uncovered spots and the 26.981 to covered ones. The terminal also has a vehicle personalization center, a washing tunnel and a dewaxing installation.

The Setram terminal occupies a granted area of 9,4 hectares and has 1 buffer, which allows it to expand its storage capacity in 81.845 square meters (4.934 vehicles). Setram also includes in its installations part of a second buffer, that it shares with Autoterminal and raises its covered capacity in 88.700 square meters. Including both buffers, the total storage capacity of the terminal is close to 15.000 vehicles, 9.000 corresponding to covered spots.

Figure 33. Aerial view of Barcelona main rolled cargo terminals

Appendix VII. Union Customs Code, aim and implementation terms

The UCC legal package entered into force on 1 May 2016, repealing and replacing the previous framework for customs legislation, contained in the Community Customs Code (Council Regulation (EEC) No 2913/92) and the Code's implementing provisions (Commission Regulation (EEC) No 2454/93) and recasting the Modernized Customs Code (Regulation (EC) No 450/2008) so as to align EU customs legislation with the requirements of the Lisbon Treaty.

The UCC has simplicity, service and speed as its key objectives. Its aim is to:

- Offer greater legal certainty and uniformity to businesses and increase clarity for customs officials throughout the EU
- Complete the shift to a paperless and fully electronic customs environment
- Reinforce swifter customs procedures for compliant and trustworthy economic operators (AEO)
- Enhance the competitiveness of European businesses and thereby advance the main goals of the EU strategy for growth and jobs.
- Protect the flow of goods transiting or moving in and out of the EU
- Safeguard the financial and economic interests of the EU and of the Member States, as well as the safety and security of EU citizens.
- It clarifies rules, such as those on release of goods for free circulation and on special procedures.
- It contains most of the EU customs legislation in one package and provides precise rules of application.
- It defines data requirements for customs, pre-arrival and pre-departure declarations, notifications, applications and decisions in an integrated way. The EU Customs Data Model has been designed, in line with international standards like the World Customs Organization (WCO) data model, to assist national customs authorities in adapting the data requirements to their systems.
- All of this is designed to contribute to a harmonized implementation of customs rules and procedures across the EU.

The design of the UCC has taken into account to a large extent the daily needs and existing practices of trade. For instance, it allows the use of electronic transport manifests for customs purposes and the moving of goods under temporary storage without lodging a transit declaration and it envisages new forms to extinguish a customs debt. It introduces modern concepts, such as centralized clearance, and offers more uniformity to business, by providing uniform and harmonized rules on guarantees, for example.

It also reduces the administrative burden on compliant and trustworthy economic operators (AEOs) by allowing a number of simplifications of customs procedures, and of the use of guarantees, and by allowing self-assessment of customs debts under certain conditions.

The UCC strives for further automation of all exchange and storage of information through additional IT systems that integrate the new processes and legal requirements, such as common and shared services to customs and harmonized interfaces and EU portals for trade.

While the substantive provisions of the UCC entered into force on 1 May 2016 a transition period is necessary before full implementation can be achieved. This is primarily due to the fact that there is a

need to develop new IT systems or upgrade existing ones in order to fully implement the legal requirements.

This transition period currently lasts until 31 December 2020 at the latest, but the Commission has recently proposed that the transitional period be extended to 2025 for a small number of customs formalities managed by electronic systems that may not be fully completed until 2025.

The detailed rules regarding the transitional period are contained in a Transitional Delegated Act and in the UCC Work Programme. Their practical application is addressed in several guidance documents produced in collaboration with Member State and Trade representatives. These rules will ensure a smooth transition from the existing customs legislative regime to the new UCC rules on a gradual basis between 1 May 2016 and 31 December 2025.

Appendix VIII. Customs concepts defined in the Union Customs Code that are relevant in Car Carrier customs procedures.

Article 5

Definitions

For the purposes of the Code, the following definitions shall apply:

(1) "customs authorities" means the customs administrations of the Member States responsible for applying the customs legislation and any other authorities empowered under national law to apply certain customs legislation;

(2) "customs legislation" means the body of legislation made up of all of the following:

(a) the Code and the provisions supplementing or implementing it adopted at Union or national level;

(b) the Common Customs Tariff;

(c) the legislation setting up a Union system of reliefs from customs duty;

(d) international agreements containing customs provisions, insofar as they are applicable in the Union;

(3) "customs controls" means specific acts performed by the customs authorities in order to ensure compliance with the customs legislation and other legislation governing the entry, exit, transit, movement, storage and end-use of goods moved between the customs territory of the Union and countries or territories outside that territory, and the presence and movement within the customs territory of the Union of non-Union goods and goods placed under the end-use procedure;

(4) "person" means a natural person, a legal person, and any association of persons which is not a legal person but which is recognized under Union or national law as having the capacity to perform legal acts;

(5) "economic operator" means a person who, in the course of his or her business, is involved in activities covered by the customs legislation;

(6) "customs representative" means any person appointed by another person to carry out the acts and formalities required under the customs legislation in his or her dealings with customs authorities;

(7) "risk" means the likelihood and the impact of an event occurring, with regard to the entry, exit, transit, movement or end-use of goods moved between the customs territory of the Union and countries or territories outside that territory and to the presence within the customs territory of the Union of non-Union goods, which would:

(a) prevent the correct application of Union or national measures;

(b) compromise the financial interests of the Union and its Member States; or

(c) pose a threat to the security and safety of the Union and its residents, to human, animal or plant health, to the environment or to consumers;

(8) "customs formalities" means all the operations which must be carried out by a person and by the customs authorities in order to comply with the customs legislation;

(9) "entry summary declaration" means the act whereby a person informs the customs authorities, in the prescribed form and manner and within a specific time-limit, that goods are to be brought into the customs territory of the Union;

(10) "exit summary declaration" means the act whereby a person informs the customs authorities, in the prescribed form and manner and within a specific time-limit, that goods are to be taken out of the customs territory of the Union;

(11) "temporary storage declaration" means the act whereby a person indicates, in the prescribed form and manner, that goods are in temporary storage;

(12) "customs declaration" means the act whereby a person indicates, in the prescribed form and manner, a wish to place goods under a given customs procedure, with an indication, where appropriate, of any specific arrangements to be applied;

(13) "re-export declaration" means the act whereby a person indicates, in the prescribed form and manner, a wish to take non-Union goods, with the exception of those under the free zone procedure or in temporary storage, out of the customs territory of the Union;

(14) "re-export notification" means the act whereby a person indicates, in the prescribed form and manner, a wish to take non-Union goods which are under the free zone procedure or in temporary storage out of the customs territory of the Union;

(15) "declarant" means the person lodging a customs declaration, a temporary storage declaration, an entry summary declaration, an exit summary declaration, a re- export declaration or a re-export notification in his or her own name or the person in whose name such a declaration or notification is lodged;

(16) "customs procedure" means any of the following procedures under which goods may be placed in accordance with the Code:

(a) release for free circulation;

(b) special procedures;

(c) export;

(17) 'temporary storage' means the situation of non-Union goods temporarily stored under customs supervision in the period between their presentation to customs and their placing under a customs procedure or re-export;

(…)

(22) "customs status" means the status of goods as Union or non-Union goods;

(23) "Union goods" means goods which fall into any of the following categories:

(a) goods wholly obtained in the customs territory of the Union and not incorporating goods imported from countries or territories outside the customs territory of the Union;

(b) goods brought into the customs territory of the Union from countries or territories outside that territory and released for free circulation;

(c) goods obtained or produced in the customs territory of the Union, either solely from goods referred to in point (b) or from goods referred to in points (a) and (b);

(24) "non-Union goods" means goods other than those referred to in point 23 or which have lost their customs status as Union goods;

(25) "risk management" means the systematic identification of risk, including through random checks, and the implementation of all measures necessary for limiting exposure to risk;

(26) "release of goods" means the act whereby the customs authorities make goods available for the purposes specified for the customs procedure under which they are placed;

(27) "customs supervision" means action taken in general by the customs authorities with a view to ensuring that customs legislation and, where appropriate, other provisions applicable to goods subject to such action are observed;

(…)

Appendix IX. Union Customs Code articles referencing the usage of electronic systems for exchanging information.

Article 6

Means for the exchange and storage of information and common data requirements

1. All exchanges of information, such as declarations, applications or decisions, between customs authorities and between economic operators and customs authorities, and the storage of such information, as required under the customs legislation, shall be made using electronic data-processing techniques.

2. Common data requirements shall be drawn up for the purpose of the exchange and storage of information referred to in paragraph 1.

3. Means for the exchange and storage of information, other than the electronic data-processing techniques referred to in paragraph 1, may be used as follows:

(a) on a permanent basis where duly justified by the type of traffic or where the use of electronic data-processing techniques is not appropriate for the customs formalities concerned;

(b) on a temporary basis, in the event of a temporary failure of the computerized system of the customs authorities or of the economic operators.

(…)

Article 16

Electronic systems

1. Member States shall cooperate with the Commission to develop, maintain and employ electronic systems for the exchange of information between customs authorities and with the Commission and for the storage of such information, in accordance with the Code.

2. Member States to which a derogation has been granted in accordance with Article 6(4) shall not be required to develop, maintain and employ within the scope of that derogation the electronic systems referred to in paragraph 1 of this Article.

Article 278

Transitional measures

Means for the exchange and storage of information, other than the electronic data-processing techniques referred to in Article 6(1), may be used on a transitional basis, until 31 December 2020 at the latest, where the electronic systems which are necessary for the application of the provisions of the Code are not yet operational.

Article 280

Appendix IX. Union Customs Code articles referencing the usage of electronic systems for exchanging information.

Work programme

1. In order to support the development of the electronic systems referred to in Article 278 and govern the setting up of transitional periods, the Commission shall, by 1 May 2014, draw up a work programme relating to the development and deployment of the electronic systems referred to in Article 16(1).

2. The work programme referred to in paragraph 1 shall have the following priorities:

(a) the harmonized exchange of information on the basis of internationally accepted data models and message formats;

(b) the reengineering of customs and customs related processes in view of enhancing their efficiency, effectiveness and uniform application and reducing compliance costs; and

(c) the offering to economic operators of a wide range of electronic customs services, enabling them to interact in the same way with the customs authorities of any Member State.

3. The work programme referred to in paragraph 1 shall be updated regularly.

Appendix X. About the future of Electronic Data Interchange

(extract from IBM's Electronic data interchange (EDI): A standardized, automated method to communicate business information electronically).

Electronic data interchange (EDI) is the intercompany communication of business documents in a standard format. With EDI, the information moves directly from a computer application in one organization to an application in another. EDI standards, which specify what information goes where in an EDI document or message, eliminate the need to manually rekey information so that it can be accepted. This automated capability enables information to be shared rapidly, instead of the hours, days or weeks required with paper documents or other methods.

Businesses use EDI to integrate and share a range of document types — from purchase orders to invoices to requests for quotations to loan applications and more. In most instances, these organizations are trading partners that exchange goods and services frequently as part of their supply chains and business-to-business (B2B) networks. All EDI transactions are defined by EDI message standards. It is important to have good governance processes for data quality. When information is missing or in the wrong place, the EDI document might not be processed correctly.

(…)

In general, EDI transmissions can be broken down into two basic types:

Point-to-point or direct connections. Two computers or systems connect with no intermediary over the internet, generally with secure protocols.

Value-added network (VAN). A third-party network manages data transmission, generally with a mail boxing paradigm.

EDI internet transmission protocols include Secure File Transfer Protocol (SFTP), Applicability Statement 2 or AS2, an HTTPS-based protocol, Simple Object Access Protocol (SOAP) and others. EDI data is made up of data elements such as sender ID and receiver ID. EDI document flow or message flow describes the movement of EDI messages to various inbound and outbound addresses and departments to execute a business process or transaction.

The world as we know it runs on and depends on EDI, a global, foundational B2B technology. It has gained mainstream adoption throughout businesses worldwide as the preferred means to exchange documents in the B2B transaction process.

As an automation technology, EDI delivers core business benefits:

Saves time and money. Automates a process previously manually executed with paper documents.

Improves efficiency and productivity. More business documents are shared and processed in less time.

Reduces errors. EDI's rigid standardization helps ensure that information and data is correctly formatted before it enters business processes or applications.

Improves traceability and reporting. Electronic documents can be integrated with a range of IT systems to support data collection, visibility and analysis.

Supports positive customer experiences. Enables efficient transaction execution and prompt, reliable product and service delivery.

EDI is important to both large and small businesses. For large organizations, EDI enables standards to be instituted across trading partners to consistently achieve benefits. For smaller organizations, adherence to EDI offers greater integration with larger firms that have big budgets and strong influence.

(…)

For some enterprises, EDI can be difficult to implement. One reason is the need to keep pace with shifting government regulations, standards and updates. It is also inherently complex, as it needs to accommodate the complexities of global business needs. For example, each trading partner in a B2B network can present unique requirements. Even though two partners may agree on which EDI document to use, each can have unique formatting requirements that need to be supported. These factors, and others, have led many organizations to outsource their EDI.

Whether kept in-house or outsourced, there are some basic conditions, capabilities and resources needed to implement EDI effectively. In addition to obvious factors like agreement on document types, secure transmission methods, and requisite hardware and software, an effective EDI implementation should consider:

- Translation or mapping software. Takes fields such as names, addresses, currency amounts, part numbers and quantities, and maps them from business application formats into standardized documents and vice versa.
- Batch enveloping or deenveloping capabilities. Supports large EDI message batches to enable senders and receivers to wrap and unwrap transactions which can then be grouped from or split to several divisions or areas of a trading partner's business.
- Message routing mechanisms. Required once a message is deenveloped to sort messages for different groups and deliver them to the appropriate targets. Message transformation may also be required to get the message into the correct format for its destination.
- Trading partner agreements (TPA). Clarifies terms and conditions, establishes standards for business documents and defines communications and business protocols between trading partners.

Consider this scenario. Today, a chargeback related to a damaged shipment is triggered using an EDI 214 document - a Transportation Carrier Shipment Status Message. The material in the shipment is unusable or unsaleable. Disputes will most likely arise based on the chargeback. But in future supply chains, EDI will be the core document exchange capability to support innovations like the Internet of Things (IoT), blockchain and artificial intelligence (AI). Future EDI will use:

- IoT sensors. Incorporated into the shipment's packaging and tied to periodic EDI 214 messages to improve package condition visibility in near real time.

- Blockchain technology. Underpinning EDI information flows for shipments can offer a shared version of the truth to help quickly resolve and even avoid chargeback disputes.
- AI agent. Monitors all relevant events and information connected to the shipment, and can identify a non-compliant event, determine if a reshipment is required, analyze the most efficient source of replacement, initiate a new shipment and an authorized return.

Appendix XI: Union Customs Code articles that define and delimit the customs procedures that shall be applied onto Car Carrier's customs procedures.

Customs representative

1. Any person may appoint a customs representative.

Such representation may be either direct, in which case the customs representative shall act in the name of and on behalf of another person, or indirect, in which case the customs representative shall act in his or her own name but on behalf of another person.

2. A customs representative shall be established within the customs territory of the Union.

Except where otherwise provided, that requirement shall be waived where the customs representative acts on behalf of persons who are not required to be established within the customs territory of the Union.

3. Member States may determine, in accordance with Union law, the conditions under which a customs representative may provide services in the Member State where he or she is established. However, without prejudice to the application of less stringent criteria by the Member State concerned, a customs representative who complies with the criteria laid down in points (a) to (d) of Article 39 shall be entitled to provide such services in a Member State other than the one where he or she is established.

4. Member States may apply the conditions determined in accordance with the first sentence of paragraph 3 to customs representatives not established within the customs territory of the Union.

Article 46

Risk management and customs controls

1. The customs authorities may carry out any customs controls they deem necessary.

Customs controls may in particular consist of examining goods, taking samples, verifying the accuracy and completeness of the information given in a declaration or notification and the existence, authenticity, accuracy and validity of documents, examining the accounts of economic operators and other records, inspecting means of transport, inspecting luggage and other goods carried by or on persons and carrying out official enquiries and other similar acts.

2. Customs controls, other than random checks, shall primarily be based on risk analysis using electronic data- processing techniques, with the purpose of identifying and evaluating the risks and developing the necessary counter- measures, on the basis of criteria developed at national, Union and, where available, international level.

3. Customs controls shall be performed within a common risk management framework, based upon the exchange of risk information and risk analysis results between customs administrations and establishing common risk criteria and standards, control measures and priority control areas.

Controls based upon such information and criteria shall be carried out without prejudice to other controls carried out in accordance with paragraph 1 or with other provisions in force.

4. Customs authorities shall undertake risk management to differentiate between the levels of risk associated with goods subject to customs control or supervision and to determine whether the goods will be subject to specific customs controls, and if so, where.

The risk management shall include activities such as collecting data and information, analyzing and assessing risk, prescribing and taking action and regularly monitoring and reviewing that process and its outcomes, based on international, Union and national sources and strategies.

5. Customs authorities shall exchange risk information and risk analysis results where:

(a) the risks are assessed by a customs authority as being significant and requiring customs control and the results of the control establish that the event triggering the risks has occurred; or

(b) the control results do not establish that the event triggering the risks has occurred, but the customs authority concerned considers the threat to present a high risk elsewhere in the Union.

6. For the establishment of the common risk criteria and standards, the control measures and the priority control areas referred to in paragraph 3, account shall be taken of all of the following:

(a) the proportionality to the risk;

(b) the urgency of the necessary application of the controls;

(c) the probable impact on trade flow, on individual Member States and on control resources.

7. The common risk criteria and standards referred to in paragraph 3 shall include all of the following:

(a) a description of the risks;

(b) the factors or indicators of risk to be used to select goods or economic operators for customs control;

(c) the nature of customs controls to be undertaken by the customs authorities; (d) the duration of the application of the customs controls referred to in point (c).

8. Priority control areas shall cover particular customs procedures, types of goods, traffic routes, modes of transport or economic operators which are subject to increased levels of risk analysis and customs controls during a certain period, without prejudice to other controls usually carried out by the customs authorities.

Article 57

Tariff classification of goods

1. For the application of the Common Customs Tariff, tariff classification of goods shall consist in the determination of one of the subheadings or further subdivisions of the Combined Nomenclature under which those goods are to be classified.

2. For the application of non-tariff measures, tariff classification of goods shall consist in the determination of one of the subheadings or further subdivisions of the Combined Nomenclature, or of any other nomenclature which is established by Union provisions and which is wholly or partly based on the Combined Nomenclature or which provides for further subdivisions to it, under which those goods are to be classified.

3. The subheading or further subdivision determined in accordance with paragraphs 1 and 2 shall be used for the purpose of applying the measures linked to that subheading.

4. The Commission may adopt measures to determine the tariff classification of goods in accordance with paragraphs 1 and 2.

Article 60

Acquisition of origin

1. Goods wholly obtained in a single country or territory shall be regarded as having their origin in that country or territory.

2. Goods the production of which involves more than one country or territory shall be deemed to originate in the country or territory where they underwent their last, substantial, economically-justified processing or working, in an undertaking equipped for that purpose, resulting in the manufacture of a new product or representing an important stage of manufacture.

Article 61

Proof of origin

1. Where an origin has been indicated in the customs declaration pursuant to the customs legislation, the customs authorities may require the declarant to prove the origin of the goods.

2. Where proof of origin of goods is provided pursuant to the customs legislation or other Union legislation governing specific fields, the customs authorities may, in the event of reasonable doubt,

require any additional evidence needed in order to ensure that the indication of origin complies with the rules laid down by the relevant Union legislation.

3. Where the exigencies of trade so require, a document proving origin may be issued in the Union in accordance with the rules of origin in force in the country or territory of destination or any other method identifying the country where the goods were wholly obtained or underwent their last substantial transformation.

Article 127

Lodging of an entry summary declaration

1.Goods brought into the customs territory of the Union shall be covered by an entry summary declaration.

2. The obligation referred to in paragraph 1 shall be waived:

(a) for means of transport and the goods carried thereon only passing through the territorial waters or the airspace of the customs territory of the Union without a stop within that territory; and

(b) in other cases, where duly justified by the type of goods or traffic, or where required by international agreements.

3. The entry summary declaration shall be lodged at the customs office of first entry within a specific time-limit, before the goods are brought into the customs territory of the Union.

Customs authorities may allow the entry summary declaration to be lodged at another customs office, provided that the latter immediately communicates or makes available electronically the necessary particulars to the customs office of first entry.

4. The entry summary declaration shall be lodged by the carrier.

Notwithstanding the obligations of the carrier, the entry summary declaration may be lodged instead by one of the following persons:

(a) the importer or consignee or other person in whose name or on whose behalf the carrier acts;

(b) any person who is able to present the goods in question or have them presented at the customs office of entry.

5. The entry summary declaration shall contain the particulars necessary for risk analysis for security and safety purposes.

6. In specific cases, where all the particulars referred to in paragraph 5 cannot be obtained from the persons referred to in paragraph 4, other persons holding those particulars and the appropriate rights to provide them may be required to provide those particulars.

7. Customs authorities may accept that commercial, port or transport information systems are used for the lodging of an entry summary declaration provided such systems contain the necessary particulars for such declaration and those particulars are available within a specific time-limit, before the goods are brought into the customs territory of the Union.

8. Customs authorities may accept, instead of the lodging of the entry summary declaration, the lodging of a notification and access to the particulars of an entry summary declaration in the economic operator's computer system.

Article 133

Notification of arrival of a sea-going vessel or of an aircraft

1. The operator of a sea-going vessel or of an aircraft entering the customs territory of the Union shall notify the arrival to the customs office of first entry upon arrival of the means of transport.

Where information on arrival of a sea-going vessel or of an aircraft is available to the customs authorities they may waive the notification referred to in the first subparagraph.

2. Customs authorities may accept that port or airport systems or other available methods of information be used to notify the arrival of the means of transport.

Article 139

Presentation of goods to customs

1. Goods brought into the customs territory of the Union shall be presented to customs immediately upon their arrival at the designated customs office or any other place designated or approved by the customs authorities or in the free zone by one of the following persons:

(a) the person who brought the goods into the customs territory of the Union;

(b) the person in whose name or on whose behalf the person who brought the goods into that territory acts;

(c) the person who assumed responsibility for carriage of the goods after they were brought into the customs territory of the Union.

2. Goods which are brought into the customs territory of the Union by sea or air and which remain on board the same means of transport for carriage, shall be presented to customs only at the port or airport where they are unloaded or transshipped. However, goods brought into the customs territory of the Union which are unloaded and reloaded onto the same means of transport during its voyage in order to enable the unloading or loading of other goods, shall not be presented to customs at that port or airport.

3. Notwithstanding the obligations of the person described in paragraph 1, presentation of the goods may be effected instead by one of the following persons:

(a) any person who immediately places the goods under a customs procedure;

(b) the holder of an authorization for the operation of storage facilities or any person who carries out an activity in a free zone.

4. The person presenting the goods shall make a reference to the entry summary declaration or, in the cases referred to in Article 130, the customs declaration or temporary storage declaration which has been lodged in respect of the goods, except where the obligation to lodge an entry summary declaration is waived.

5. Where non-Union goods presented to customs are not covered by an entry summary declaration, and except where the obligation to lodge such declaration is waived, one of the persons referred to in Article 127(4) shall, without prejudice to Article 127(6), lodge immediately such declaration or shall instead lodge a customs declaration or temporary storage declaration.

6. Paragraph 1 shall not preclude application of special rules with respect to goods transported within frontier zones or in pipelines and wires as well as for traffic of negligible economic importance such as letters, postcards and printed matter and their electronic equivalents held on other media or to goods carried by travelers, provided that customs supervision and customs control possibilities are not thereby jeopardized.

7. Goods presented to customs shall not be removed from the place where they have been presented without the permission of the customs authorities.

Article 144

Goods in temporary storage

Non-Union goods shall be in temporary storage from the moment they are presented to customs.

Article 145

Temporary storage declaration

1. Non-Union goods presented to customs shall be covered by a temporary storage declaration containing all the particulars necessary for the application of the provisions governing temporary storage.

2. Documents related to goods in temporary storage shall be provided to the customs authorities where Union legislation so requires or where necessary for customs controls.

3. The temporary storage declaration shall be lodged by one of the persons referred to in Article 139(1) or (2) at the latest at the time of the presentation of the goods to customs.

Article 147

Conditions and responsibilities for the temporary storage of goods

1. Goods in temporary storage shall be stored only in temporary storage facilities in accordance with Article 148 or, where justified, in other places designated or approved by the customs authorities.

2. Without prejudice to Article 134(2), goods in temporary storage shall be subject only to such forms of handling as are designed to ensure their preservation in an unaltered state without modifying their appearance or technical characteristics.

3. The holder of the authorization referred to in Article 148 or the person storing the goods in the cases where the goods are stored in other places designated or approved by the customs authorities, shall be responsible for all of the following:

(a) ensuring that goods in temporary storage are not removed from customs supervision;

(b) fulfilling the obligations arising from the storage of goods in temporary storage.

4. Where, for any reason, goods cannot be maintained in temporary storage, the customs authorities shall without delay take all measures necessary to regularize the situation of the goods in accordance with Articles 197, 198 and 199.

Article 149

End of temporary storage

Non-Union goods in temporary storage shall be placed under a customs procedure or re-exported within 90 days.

Article 153

Presumption of customs status of Union goods

1. All goods in the customs territory of the Union shall be presumed to have the customs status of Union goods, unless it is established that they are not Union goods.

2. In specific cases, where the presumption laid down in paragraph 1 does not apply, the customs status of Union goods shall need to be proven.

3. In specific cases, goods wholly obtained in the customs territory of the Union do not have the customs status of Union goods if they are obtained from goods in temporary storage or placed under the external transit procedure, a storage procedure, the temporary admission procedure or the inward processing procedure.

Article 154

Loss of customs status of Union goods

Union goods shall become non-Union goods in the following cases:

(a) where they are taken out of the customs territory of the Union, insofar as the rules on internal transit do not apply;

(b) where they have been placed under the external transit procedure, a storage procedure or the inward processing procedure, insofar as the customs legislation so allows;

(c) where they have been placed under the end-use procedure and are either subsequently abandoned to the State, or are destroyed and waste remains;

(d) where the declaration for release for free circulation is invalidated after release of the goods.

Article 155

Union goods leaving the customs territory of the Union temporarily

1.In the cases referred to in points (b) to (f) of Article 227(2), goods shall keep their customs status as Union goods only if that status is established under certain conditions and by means laid down in the customs legislation.

2. In specific cases, Union goods may move, without being subject to a customs procedure, from one point to another within the customs territory of the Union and temporarily out of that territory without alteration of their customs status.

Article 162

Content of a standard customs declaration

Standard customs declarations shall contain all the particulars necessary for application of the provisions governing the customs procedure for which the goods are declared.

Article 163

Supporting documents

1. The supporting documents required for the application of the provisions governing the customs procedure for which the goods are declared shall be in the declarant's possession and at the disposal of the customs authorities at the time when the customs declaration is lodged.

2. Supporting documents shall be provided to the customs authorities where Union legislation so requires or where necessary for customs controls.

3. In specific cases, economic operators may draw up the supporting documents provided they are authorized to do so by the customs authorities.

Article 201

Scope and effect (*Release for free circulation)*

1. Non-Union goods intended to be put on the Union market or intended for private use or consumption within the customs territory of the Union shall be placed under release for free circulation.

2. Release for free circulation shall entail the following:

(a) the collection of any import duty due;

(b) the collection, as appropriate, of other charges, as provided for under relevant provisions in force relating to the collection of those charges;

(c) the application of commercial policy measures and prohibitions and restrictions insofar as they do not have to be applied at an earlier stage; and

(d) completion of the other formalities laid down in respect of the import of the goods.

3. Release for free circulation shall confer on non-Union goods the customs status of Union goods.

Article 240

Storage in customs warehouses

1. Under the customs warehousing procedure non-Union goods may be stored in premises or any other location authorized for that procedure by the customs authorities and under customs supervision ('customs warehouses').

2. Customs warehouses may be available for use by any person for the customs warehousing of goods ('public customs warehouse'), or for the storage of goods by the holder of an authorization for customs warehousing ('private customs warehouse').

3. Goods placed under the customs warehousing procedure may be temporarily removed from the customs warehouse. Such removal shall, except in case of force majeure, be authorized in advance by the customs authorities.

Article 242

Responsibilities of the holder of the authorisation or procedure

1. The holder of the authorisation and the holder of the procedure shall be responsible for the following:

(a) ensuring that goods under the customs warehousing procedure are not removed from customs supervision; and

(b) fulfilling the obligations arising from the storage of goods covered by the customs warehousing procedure.

2. By way of derogation from paragraph 1, where the authorisation concerns a public customs warehouse, it may provide that the responsibilities referred to in points (a) or (b) of paragraph 1 devolve exclusively upon the holder of the procedure.

3. The holder of the procedure shall be responsible for fulfilling the obligations arising from the placing of the goods under the customs warehousing procedure.

Article 243

Designation of free zones

1. Member States may designate parts of the customs territory of the Union as free zones.

For each free zone the Member State shall determine the area covered and define the entry and exit points.

2. Member States shall communicate to the Commission information on their free zones which are in operation.

3. Free zones shall be enclosed.

The perimeter and the entry and exit points of the area of free zones shall be subject to customs supervision.

4. Persons, goods and means of transport entering or leaving free zones may be subject to customs controls.

Article 249

Customs status

Where goods are taken out of a free zone into another part of the customs territory of the Union or placed under a customs procedure, they shall be regarded as non-Union goods unless their customs status as Union goods has been proven.

However, for the purposes of applying export duty and export licences or export control measures laid down under the common agricultural or commercial policies, such goods shall be regarded as Union goods, unless it is established that they do not have the customs status of Union goods.

Article 263

Lodging a pre-departure declaration

1. Goods to be taken out of the customs territory of the Union shall be covered by a pre-departure declaration to be lodged at the competent customs office within a specific time-limit before the goods are taken out of the customs territory of the Union.

2. The obligation referred to in paragraph 1 shall be waived:

(a) for means of transport and the goods carried thereon only passing through the territorial waters or the airspace of the customs territory of the Union without a stop within that territory; or

(b) in other specific cases, where duly justified by the type of goods or traffic or where required by international agreements.

3. The pre-departure declaration shall take the form of one of the following:

(a) a customs declaration, where the goods to be taken out of the customs territory of the Union are placed under a customs procedure for which such declaration is required;

(b) a re-export declaration, in accordance with Article 270;

(c) an exit summary declaration, in accordance with Article 271.

4. The pre-departure declaration shall contain the particulars necessary for risk analysis for security and safety purposes.

Article 267

Customs supervision and formalities on exit

1. Goods to be taken out of the customs territory of the Union shall be subject to customs supervision and may be subject to customs controls. Where appropriate, the customs authorities may determine the route to be used, and the time- limit to be respected when goods are to be taken out of the customs territory of the Union.

2. Goods to be taken out of the customs territory of the Union shall be presented to customs on exit by one of the following persons:

(a) the person who takes the goods out of the customs territory of the Union;

(b) the person in whose name or on whose behalf the person who takes the goods out of the customs territory of the Union acts;

(c) the person who assumes responsibility for the carriage of the goods prior to their exit from the customs territory of the Union.

3. Goods to be taken out of the customs territory of the Union shall be subject, as appropriate, to the following:

(a) the repayment or remission of import duty;

(b) the payment of export refunds;

(c) the collection of export duty;

(d) the formalities required under provisions in force with regard to other charges;

(e) the application of prohibitions and restrictions justified on grounds of, inter alia, public morality, public policy or public security, the protection of the health and life of humans, animals or plants, the protection of the environment, the protection of national treasures possessing artistic, historic or archaeological value and the protection of industrial or commercial property, including controls against drug precursors, goods infringing certain intellectual property rights and cash, as well as the implementation of fishery conservation and management measures and of commercial policy measures.

4. Release for exit shall be granted by the customs authorities on condition that the goods in question will be taken out of the customs territory of the Union in the same condition as when:

(a) the customs or re-export declaration was accepted; or

(b) the exit summary declaration was lodged.

Article 271

Lodging an exit summary declaration

1.Where goods are to be taken out of the customs territory of the Union and a customs declaration or a re-export declaration is not lodged as pre-departure declaration, an exit summary declaration shall be lodged at the customs office of exit.

Customs authorities may allow the exit summary declaration to be lodged at another customs office, provided that the latter immediately communicates or makes available electronically the necessary particulars to the customs office of exit.

2. The exit summary declaration shall be lodged by the carrier.

Notwithstanding the obligations of the carrier, the exit summary declaration may be lodged instead by one of the following persons:

(a) the exporter or consignor or other person in whose name or on whose behalf the carrier acts;

(b) any person who is able to present the goods in question or have them presented at the customs office of exit.

3. Customs authorities may accept that commercial, port or transport information systems may be used to lodge an exit summary declaration, provided that they contain the necessary particulars for such declaration and that these particulars are available within a specific time-limit, before the goods are taken out of the customs territory of the Union.

4. Customs authorities may accept, instead of the lodging of the exit summary declaration, the lodging of a notification and access to the particulars of an exit summary declaration in the economic operator's computer system.