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Impact of Container Reverse Logistics on the Maritime Sector: Economic and Environmental Factors

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Abstract

This paper investigates the growing problem of abandoned maritime containers and the lack of effective reverse logistics to manage them: *Background:* The research highlights the significant environmental impact and economic burdens caused by the imbalance of container inflow and outflow, which leads to the accumulation of containers in storage yards; *Methods:* The study used the Delphi Method, gathering insights from a panel of experts in container transport and maintenance. The goal was to identify key challenges and potential solutions for improving container reverse logistics in Portugal; *Results:* The results confirm the urgent need for efficient reverse logistics strategies to address the container imbalance. The experts reached over 60% consensus on the importance of developing logistics systems and improving communication between ports. Implementing these strategies would not only reduce economic costs but also significantly lower environmental pollution; *Conclusions:* The paper concludes that a strategic shift toward effective reverse logistics is essential for enhancing the sustainability and operational efficiency of the maritime transport sector.

Keywords: reverse logistics; environmental pollution; maritime transport; containers; Delphi method; Portuguese case

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1. Introduction

An overview of this study is covered in this section in order to provide the reader with information about the topic and the key issues at stake. This includes the problem description and the related objectives.

1.1. Background of the Study

Enhancing container terminal performance is vital for maritime logistics. Efficient terminals reduce delays, lower costs, and boost global trade competitiveness. Researchers and decision-makers focus on automation, digitalization, and sustainable practices to streamline operations. As shipping demands grow, optimizing terminal efficiency becomes essential for economic resilience and environmental responsibility [1].

The container reverse logistics (CRL), which aims to effectively and efficiently exchange containers, was essentially compromised by the lack of communication between agents and the lack of cooperation between all companies involved in the maritime logistics chain. Therefore, CRL is an essential process in the main modern logistics networks,

focused on the efficient management of the return of empty or, preferably, full or used containers to the point of origin or to certain locations specialized in their reuse, repair or adequate recycling [2].

This process not only optimizes various logistics operations, as its objectives are to reduce costs for companies and improve efficiency, but also minimizes the visual and environmental impact resulting from the excessive abandonment of containers [3]. However, the persistent imbalance between container inflows and outflows at the Port of Lisbon—and other Portuguese ports—creates a recurring issue of abandoned containers at terminals. This situation poses a considerable challenge for maritime transport companies, leading to operational inefficiencies, and logistical complications across the supply chain [4]. This challenge ends up resulting in additional costs and makes more optimized resource management difficult [5].

This process, which involves several stages, starts with the planning and coordination of return routes, so that they do not become more pejorative, but rather ecological and efficient, passing through the collection and transportation of containers, up to inspection, in order to be able to identify which of the various containers can or cannot be reused or if they are already at the end of their useful life cycle [6].

1.2. Motivation

Reverse logistics (RL) is a process increasingly used by numerous companies integrated throughout the logistics chain process, in order to present nuances of competitive advantage, compared to direct competitors. However, in the maritime sector and due to its complexity, to this day, CRL is considered a factor of competitive advantage, but in a certain way, difficult to implement. Due to the transformations carried out over the years, both in containers and in maritime transport organizations, the sector has achieved substantial improvements, due to the improvement of advanced technologies and the implementation of integrated container management and monitoring systems [7]. This makes it possible to obtain the location and carry out a more detailed analysis of the exchanges made for each container, regardless of the location [5,6].

After implementing this process properly, numerous benefits are expected, such as reducing costs by reusing and repurposing containers instead of purchasing new ones, promoting more sustainable business practices, contributing to reducing the environmental impact of this mode of transport, since empty containers are not transported, and improving resource management, allowing companies to maximize the useful life of containers [3–5].

However, as cooperation between companies is not always possible to implement this process, there are proportionally several challenges, such as the complexity of coordinating RL in a sector with poor information sharing and the increase in transport costs that can result from poor administrative management [3–5]. Furthermore, ensuring that shipping companies that containers will return or continue their journey in good condition is a task of some complexity and constant maintenance.

Every year, in the Port of Lisbon, as in other Portuguese ports, excess containers are a problem that can arise due to inefficient management of the CRL or fluctuations in demand and supply for this means of transport. This results in an increase in storage and maintenance costs and ends up making transport logistics more difficult, causing them to occupy spaces considered valuable to other companies and consequently deteriorate over time, resulting in the need for repair or replacement, which is more expensive.

However, in order to mitigate this problem, companies need to implement effective strategies in maritime and port management, including aspects such as demand and supply and the optimization of return routes [8]. So that there is no increase in visual environmental pollution (VEP) from containers in various storage areas and that an improvement is

possible. As has happened in past years, as was the case in large-scale events, such as the year Pope Francis came to Portugal [9].

There is a research gap regarding the containerized goods sector in maritime transport in Portugal. In particular, the scenario of abandoned containers at terminals in Portuguese port cities requires further study.

1.3. Research Question and Purpose of the Study

This research is part of the aforementioned theme and its main objective is to analyze the impact of the incorrect application of the CRL process in the maritime sector.

Likewise, if this process, applied in a less practical way, it could have a negative impact on the delays in entries and exits at Portuguese Ports. Taking into account the VEP resulting from the excess of abandoned containers.

Therefore, the following research question was developed to guide this study: What is the impact of CRL on the maritime sector in Portugal?

The relationship between the research topic and the associated consequences, economic and environmental factors, depends on numerous aspects, namely, cooperation between maritime companies and national ports.

This study has the general objective of understanding the existing problem in the maritime sector, related to CRL and the lack of correct implementation of this process throughout the logistics chain. That said, in order to analyze the problem in question in more detail, three specific study objectives were defined, namely:

i Identify the CRL problem in the maritime sector;
ii Understand the impact of the time lag between container entries and exits at Portuguese ports;
iii Analyze to what extent CRL influences economic and environmental factors.

The main contribution of this paper is to highlight the importance of implementing CRL in Portugal's maritime sector as a key strategy for reducing both economic and environmental costs.

1.4. Structure of the Manuscript

The remainder of this paper is structured as follows. Section 2 reviews the relevant literature for the study. Section 3 outlines the methodology. Section 4 details the proposed case study. Section 5 presents the case study results along with the discussion. Finally, Section 6 offers the concluding remarks.

2. Literature Review

The literature review will focus on reverse logistics, including container reverse logistics, the imbalance between container entry and exit at Portuguese ports, and environmental issues. Furthermore, the specific literature review for the questionnaire's development will be addressed in Section 4 to avoid duplication of content in the manuscript.

2.1. Reverse Logistics

Logistics consists of the process of planning, implementing and controlling the efficient and economical flow of raw materials, materials, finished products and goods, from their point of origin to the point of consumption, with the intention of meeting the needs of the end consumer [10]. In turn, RL includes the entire process mentioned above, but in the opposite direction. Starting with the intention of meeting consumer needs, through to the process of planning, implementing and controlling efficient and economical flow. The main purpose of this process is to recapture the initial value and properly dispose of certain goods, which can be reused or even repurposed, creating a second opportunity [11].

In the 1970s and after the energy crisis, some companies began to see this process as a long-term competitive strategy. This made it considered a competitive advantage, since most companies had not implemented the ability to deliver and recover the material used throughout the logistics chain [10].

The way companies began to react to environmental problems arising from the logistics chain allowed them to gradually implement this process as a factor in competitiveness. However, factors like this do not automatically result in innovations or immediate productivity rates, but they do allow companies to realize that successful changes are beneficial in the long term [12].

2.2. Container Reverse Logistics

Container Reverse Logistics (CRL) consists of a process of returning containers to their country of origin, preferably loaded with goods or continuing their journey to another destination, so that it is possible to extend the useful life cycle of the containers [2]. This process has as its main focus the adequate management of CRL, providing environmental and economic benefits throughout the entire process, which, when implemented, can result in several positive aspects, not only for companies, but for society in general [3].

Therefore, if this process is not applied correctly, we may be faced with an existing problem of abandonment by shipping companies and a lack of care, leading to an excess of containers in various parts of the country, resulting in excessive production of containers and visible VEP [4]. The container shipping chain is subdivided into two distinct categories, namely the full container supply chain and the empty container supply chain. However, the movement of containers ends up not being at all profitable for the maritime sector, when it comes to empty CRL, since what translates into profit for transport companies are the various contracts made with companies that need the same transport of containerized goods [5].

A container can be redistributed several times, which makes its reuse and redistribution a natural and economically viable recovery option. The recovery is therefore driven by economic reasons. Since the inherent function of containers is to move back and forth through the supply chain, they will need to be carefully checked and cleaned so that they can be safely redistributed later. Several stakeholders are involved in this process, such as shipping companies, agents, seaports and operators [6].

De Brito & Konings (2006) [6] examined numerous strategies for managing empty containers in the maritime sector, which emphasized approaches such as balancing trade with recovered products, using more appropriate containers, such as collapsible containers, and using information technologies to better systematize the use of stagnant containers or even share information about the containers available in each port. In relation to foldable containers, these have advantages, such as practicality because they are dismountable, due to flexibility and the reduction in VEP in spaces, such as port terminals [13].

2.3. Problems of Entry and Exit of Goods in Portuguese Ports

Over the years, maritime transport has become one of the most important and most widely used means of transport, thus simplifying trade between different countries around the world. However, this growth meant that all companies and organizations participating in this logistics chain also had to adapt and consequently suffered in numerous ways the pressure arising from this growth, as did port terminals [14].

A port terminal constitutes the entire surrounding space and activities related to containers, such as the space where they are deposited, whether temporarily or for a longer period of time, until they are transported to another means of transport, be it sea, road or rail, regardless of their final destination.

In addition to the growth of this sector, containers and container ships had to grow in a similar way, in order to achieve increased benefits from economies of scale and maintain constant transport prices for these goods.

Due to the growth of maritime routes, ports experienced several peaks in container traffic, suffered greater pressure on operational exchanges, and observed an increase in operational costs, an increase in the number of containers in circulation, and other disruptions due to the impasse in this sector [15,16].

Based on the UNCTAD [17] document, due to the changes observed in this sector over the last few years, there is a need for numerous freight forwarders, terminals and seaports to cooperate with each other. This way, it is possible to control all the negative factors of abundant growth and to prevent disoriented strategic control. This means that, since it is possible to verify, factors such as the growth in the size of container ships, traffic peaks, growing pressure on operators, the increase in container circulation, the increase in operating costs, and the intensification of container production, among others. These variables are key points that, in cooperation with all maritime organizations and companies, can be controlled and bring several benefits to the sector.

2.3.1. Port of Lisbon

The Port of Lisbon is one of Portugal's main seaports, strategically located on the north bank of the Tagus River, with numerous factors that make it a landmark and which have annually played a fundamental role in the country's economic and commercial development. Thus, this port ended up becoming a crucial multifunctional hub for maritime trade and encompassing several commercial activities, including the transportation of containerized goods [18].

However, despite being a success in terms of loading and unloading containers, which gives companies the opportunity to make an almost immediate connection with other means of transport (intermodal), such as rail and road transport, we can observe that the number of container entries and exits is unbalanced annually. This results in a problem at a logistical level, since the number of empty container entries is significantly higher than the number of exits, resulting in a growing surplus of empty containers, which end up being abandoned [19].

After a more detailed analysis of the literature and the figures presented, it was considered a daily problem, which ends up being visible in several Container Terminals, as happens annually, at the Bobadela Terminal, which receives an average of 100 thousand containers per year [20], coming from various ports, such as Lisbon and Sines and which end up being stagnant there, until they find another place where they can be relocated or the company that owns them needs one.

2.3.2. Port of Sines

In the mid-1970s, the Port of Sines began construction work and is still considered to this day as one of the reference ports in terms of the movement of containerized goods and deep-water ports [21].

Currently, the Port of Sines is considered among the 100 largest ports in the world, and has a tendency to continue growing due to the beneficial conditions it presents in this sector, namely, the natural conditions, such as deep waters, which allow it to receive numerous large ships, as happens several times, with the unloading of the Ship Tessa, one of the largest cargo ships, today and the easy accessibility to maritime transhipment [22].

Although the number of container ship unloadings is relatively similar to those that dock daily at the Ports of Lisbon and Leixões, when analyzing in more detail the amount of containerized cargo handled at the Port of Sines, it is possible to conclude that the number

is substantially higher. This is due to the high capacity to receive vessels of greater capacity daily and the space in the port terminal being substantially larger than that observed in other ports.

Despite all the beneficial conditions mentioned above, which the Port of Sines presents and currently receives on average 39.2% more containerized cargo, essentially due to the crisis in the Red Sea, not all of these factors can be considered positive for the study. Since, on the one hand, the ships end up passing through one of the largest Portuguese ports and thus giving shipowners the opportunity to carry out more commercial exchanges with Portugal. On the other hand, there is greater pressure on this port to have space considered valuable, so that it can receive the various containers that end up stagnating in Portugal and until they have the opportunity to resume their journey, we may be facing an undefined waiting time [23].

However, exchanges carried out with container depots at a national level, such as that observed at the Bobadela terminal, mean that this and other Portuguese ports do not present such a high level of environmental pollution, essentially due to the transhipment connections that exist throughout the country [22,24].

2.4. Visual Environmental Pollution

VEP caused by numerous containers is a growing problem in many urban and port areas, mainly due to their disorganized and random accumulation. This measure subsequently results in several containers being out of use or damaged by time, showing the population an uninteresting and aesthetically unpleasant landscape [25,26].

In addition to the accumulation of containers in various industrial zones near ports, this environmental pollution can negatively impact not only the population's interest in those areas, but also negatively affect tourism, reducing the value of potential land in the vicinity and generating a somewhat mistaken perception about the logistical and environmental management of the location [26,27].

The disorganization and excess of containers observed in repair and rest yards not only generate stress and a feeling of open-air landfill for the population, but also demonstrate that environmental authorities and shipping companies must act simultaneously. In order to implement an effective solution from the outset of the problem, which stems from the weak implementation of the CRL and is worsened by the deficient entry and exit of containers, for example, at the Port of Sines, it is essential to intervene in a strategic and coordinated manner.

Despite the problem, mentioned above, of the excess of open-air containers and their numerous relocations, particularly at the Bobadela Terminal, and despite the fact that in recent years the Loures City Council (CML) and multiple environmental groups have tried to develop strategies to resolve this problem [27], little or nothing has been achieved. Since the temporary measure of relocating containers from the Bobadela Terminal ended up becoming a measure taken as definitive [28]. The resettlement to other terminals, initially temporary, was, as mentioned in the previous chapter, only temporary, due to the visit of Pope Francis. However, these ended up being abandoned in numerous terminals spread throughout the Lisbon district and the Bobadela Terminal, after the Pope's visit [29] began storing new containers from various companies, further increasing the number of containers visible to the population.

This whole problem generates a wave of discomfort for some residents; however, the various companies that cooperate in this terminal strongly condemn the decisions taken and planned by the entities involved. Since they are one of the decisive points in negotiations between the various transport sectors and seaports, such as Sines, Lisbon, Leixões and Setúbal, which handle thousands of containers daily.

RL is defined in the literature as the process that aims to return consumer products to their origin, allowing for more appropriate reuse and/or disposal of materials. The CRL, in particular, has the main objective of extending the life cycle of containers, promoting their return, preferably loaded. Its efficient implementation generates economic and environmental benefits; on the contrary, poor implementation results in the abandonment and accumulation of containers, especially in urban and port areas, contributing to VAP.

Container redistribution requires cooperation between various actors such as shipping companies, port operators and logistics agents. Recommended strategies include the use of collapsible containers, balancing trade, and implementing information technologies for more effective resource management.

In Portuguese ports, the problem is evident. Although there is a well-developed intermodal infrastructure, there is a clear imbalance between the entry and exit of containers, which generates surpluses. VAP resulting from the disorganization of damaged or disused containers is a growing problem in several industrial and urban areas near ports. This situation devalues land, affects tourism, pollutes soil and nearby waters, and gives the population a negative perception of local environmental management [26].

In short, the ineffective application of the CRL in Portugal has direct implications for logistical efficiency, operational costs and environmental quality. The literature review suggests the urgent need for cooperation between companies, logistics operators, port authorities and public entities to implement sustainable strategies that ensure the adequate management and circulation of containers within the country. In addition, the literature review will also contribute further to the enrichment of the research methodology.

2.5. Literature Review for Case Study Questionnaire

The literature review for the case study is presented in Section 4, thus avoiding possible redundancy in this subsection.

3. Methodology

In this work, to make the study more complete and assertive, a mixed quantitative methodology will be used from an exploratory perspective. And it aims to explore the opinions of experts, build a possible consensus, predict possible trends and delimit critical factors on the topic under study [30]. Data will be collected at different times, supported by knowledge provided by experts and through a questionnaire conducted using the Delphi Method, which will later be applied on the Welphi online platform [30].

Taking this into consideration, and in order to reach a consensus on the objectives of the study, it was found that the Delphi Method was the most appropriate.

This method was chosen due to the possibility of understanding the knowledge of various experts in the area, as well as analyzing the possible change in opinion of these experts, when faced with the opinions and knowledge presented previously.

Therefore, and given that the method concentrates the opinion of several experts in the area in question, a more appropriate choice is necessary, encompassing members with comprehensive knowledge, in order to develop, explain and, if possible, reach a possible consensus among all participants [31].

3.1. Delphi Method

The Delphi Method consists of a descriptive-exploratory study, focusing on investigations and specialized articles related to the topic being developed in the study [32].

This methodology ends up being considered more economical, simple and reliable, since it allows the development of new studies based on past phenomena, directly/indirectly related to the research question, so that a better understanding and

more guided and structured decision-making are possible due to the guidance given by experts in the area, involved throughout the process [33]. This method's main objective is to reach a possible consensus among an uncertain number of individuals specialized in the specific area, so that it is possible to obtain controlled feedback from the numerous opinions, portraying important data and possible personal experiences, which may be strictly important for the development of the research question [34,35].

Initially, this method was developed so that it was possible to eliminate the weaknesses of other methods traditionally used, such as in meetings with experts in the fields. However, it turned out to be a more reliable method, due to the main purpose of obtaining consensus among a group of individuals of a heterogeneous nature, through several related questions, with the diverse capabilities and knowledge presented by the experts [36].

3.2. Characteristics of the Delphi Method

The Delphi Method was developed as a systematic and interactive prediction method, with the intention of being used as a structured and more assertive research tool in numerous branches of research, using the opinion of several experts in the area in question [37].

During the rounds, the experts share their opinions on the problem under study individually and without any visual or physical contact, without feeling that the other members involved are in any way prejudicing or even condemning their true opinion [37].

This process continues until the experts reach a possible level of consensus among all, in relation to the topic presented. The main reason for the increasingly frequent use of this method is due, in particular, to the fact that the collective collection of responses from a group tends to be more effective compared to individual responses. Namely, because the theory suggests that even the most qualified and informed expert may have a more retrograde view or even consider their options better in relation to the topic and not be the most accurate compared to the individual/collective opinion and subsequently analyzed opinion of other members [31].

Subsequently, it will be mentioned how the selection of the experts in question was carried out, as well as the development of the Delphi questionnaire to address the research question and the platform used to analyze the data obtained.

3.3. Implementation Process

The steps applied in the case study, in the maritime sector and/or related to containerized goods, will be described below.

Considering [32], the implementation of the Delphi Method is developed in several stages, which in summary, are presented as follows:

- Selection of the experts involved;
- Development of the questionnaire;
- Initial contact in an informal manner for future collaboration;
- Sending an invitation to experts to participate in the study;
- Distribution of the first phase of the questionnaire;
- Collection of responses obtained in the first phase;
- Statistical/descriptive analysis of the responses collected;
- Restructuring and resending the questionnaire with feedback;
- Collection of responses collected in the second phase;
- Comparative analysis of the responses of both phases;
- Evaluation of a possible continuation to subsequent phases.

With this in mind, during the development of the above steps, a necessary level of preparation and high rigor are required throughout the process, so that it can be documented and recorded and later published as a case study.

3.4. Welphi Platform

Prior to distributing the survey, experts are informed via email and a Word document, which explains in detail the topic of the study, the methodology used, and the platform used. On this platform, the user is allowed to divide the questionnaire into different dimensions. The study dimensions scheme for the questionnaire is duly detailed in Figure 1.

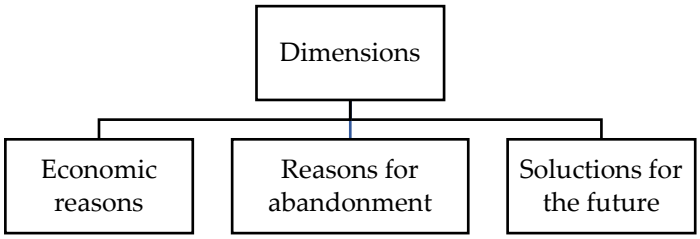

Figure 1. Dimensions of the questionnaire.

The platform allows the user to set up a round system, so that it is possible to anonymously compare the numerous opinions of experts with their peers, thus encouraging a possible group consensus, without there being any personal interactions. Welphi also supports comparisons of different opinions, whether online, participatory and interactive [30].

Regarding anonymity, this aspect encourages participants to share their opinions without external judgment, giving them the opportunity to adjust opinions given in previous rounds compared to the feedback provided, promoting possible consensus.

This tool can be accessed as the best option for the specialist, either through a link provided in the initial email or by resending it, in order to reduce possible conflicts between interested parties. By completing this questionnaire, it is possible to collect the opinions of countless individuals spread across any part of the country/world, since from a link it is possible to respond to it and even resend reminders, so that there are no dropouts.

4. Case Study

The case study is on the Portuguese maritime sector, applying to players of container goods operations. Furthermore, a specific literature review for Delphi survey is presented.

4.1. Characterization of the Business Sector

The companies selected for the case study have a strong presence in the sector, due to the services they provide in cargo transportation, logistics and port operations.

Multinational maritime transport companies stand out, namely Maersk and MSC, which are global leaders in the sector, with a presence in the main Portuguese ports. At the national level, companies such as Logislink, Medway and Klog Logistics Solutions provide a range of integrated logistics services, including sea, rail and road transport, as well as warehousing and customs clearance. In the port sector, it was possible to obtain contributions from entities such as the Ports of Lisbon and Sines, responsible for managing maritime infrastructure. Furthermore, in terms of operators, it was possible to collaborate with companies such as Contemar, Tagustainer and Terminal da Bobadela, which ensure the movement and storage of containers. Companies such as Boluda, Sealine, AGILIMA, Geocargo, Atlantic Cargo, Futurcargo, GTT and LogísticaModerna offer maritime support services, freight forwarding and logistics operations, contributing to the efficiency and integration of the logistics chain and the sector in Portugal.

For reasons of confidentiality, other characteristics of the companies and experts linked to them could not be mentioned.

4.2. Selection of Experts

In the first phase, the initial decision is to choose which individuals are most suitable and have knowledge in the area, as well as whether they will be interested in sharing information for the study in progress in the future. In this case, there is an initial contact with the predefined group, through emails and/or informal forum messages, asking if there is an interest in future collaboration.

Therefore, and with a strongly defined contact base, participants are informed that they will later receive a questionnaire by email, with the aim of possibly reaching a consensus on the research question.

The individuals chosen to participate in the study are related to the maritime sector and/or have a business area interconnected with containerized cargo, so that it is possible to have a diversified perspective. This diversity of participants enriches the study, reducing the possible influence of a single opinion, arising from the vision of a single company or organization in the maritime sector.

According to Okoli & Pawlowski (2004) [38], it is necessary to carefully select all experts/participants, since they need to have a certain degree of knowledge and experience in the area in question, interest in participating and sharing ideals, have the capacity due to the inquiry process having two or more phases and present effective communication skills.

4.3. Questionnaire Development

In order to define which considerations to include in the questionnaire, those that best suited the study were selected from among numerous statements from the literature review and several semi-structured interviews and subsequently, it was possible to combine those that best fit the maritime sector with the support of experts. In order to avoid potential dropouts in the middle of the questionnaire and to obtain easy answers from the experts, the Delphi questionnaire was composed of three dimensions as presented in Table 1, as well as the sources that were used as a basis.

Table 1. Dimensions and sources.

Questionnaire Dimensions	Sources
Economic reasons	(Ismatullaev et al., 2023) [39], (Morais, M. & Morais, G., 2022) [40], and (Merdivenci et al., 2023) [41]
Reasons for abandonment	(Ismatullaev et al., 2023) [39] and (Kroon & Vrijens, 1995) [3]
Solutions for the future	(Kroon & Vrijens, 1995) [3], (Morais, M. & Morais, G., 2022) [40], and (Schwarzer, 2013) [42]

In addition to the dimensions presented, experts were given the opportunity to express their own opinion on the research question, with the presentation of a "Comments" box, as they have a different and more detailed perspective on the subject, compared to the literature review.

The scale for measuring the opinion given by experts, used in the study, was the Likert scale consisting of five levels of opinion, which measures qualitatively and allows for a more simplified analysis. Since the objective was to simplify the analysis, the following levels of analysis were presented in the survey: "Totally Disagree", "Disagree", "Neither Disagree nor Agree", "Agree" and "Totally Agree".

The number of contacts in the Delphi Method works by rounds and there is no exact number of them, being determined later, by the person responsible for the study and according to the results obtained in each round. Normally, this method is conducted in just

two or three rounds (the last one when justifiable), with only one round being considered, which is not very conclusive [43].

Based on the literature and previously conducted studies, it was established that only two rounds would be carried out in order to reduce the dropout rate, ensuring that experts do not feel tired and to reduce the bias in the responses obtained.

The three dimensions mentioned above are each subdivided into eight or nine statements, so that experts have several alternatives and can choose the one they think is most appropriate, in order to obtain a possible consensus among all.

In the first dimension, "Economic reasons" in the containerized goods transportation sector, as we can see in Table 2, it is subdivided into nine statements, which will be presented to the experts and which were collected, throughout a literature search, in several articles, related to the maritime sector and even to other companies/organizations, which are related to containers. The statements "Discrepancy between demand/supply", "Pandemics/Wars that influence the sector's undulations", "Heavy dependence on material imports", "Lack of international logistics systems", "Annual growth of commercial transactions in the maritime sector", "Reverse logistics compensates companies monetarily", "Sending empty containers can be economically unviable", "Monetary impact of visual environmental pollution" and "Production has a lower cost, compared to recovering a container", were the statements obtained in several articles related to the topic.

Table 2. Statements of the first dimension.

Dimension	Statements	Sources
Economic reasons	Discrepancy between supply/demand	(Ismatullaev, et al., 2023) [39]
	Pandemics/Wars that influence sector fluctuations	(Kroon & Vrijens, 1995) [3]
	Strong dependence on material imports	(Junqueira et al., 2019) [14]
	Lack of international logistics systems	(Junqueira et al., 2019) [14]
	Annual growth of commercial transactions in the maritime sector	(Ismatullaev, et al., 2023; Junqueira et al., 2019) [14,39]
	Reverse logistics is financially beneficial to companies	(Morais, M & Morais, G., 2022) [40]
	Sending empty containers can be economically unfeasible	(Bozeda, & Fialho, 2016) [44]
	Monetary impact of visual environmental pollution	(Morais, M & Morais, G., 2022) [40]
	Production costs are lower compared to the recovery of a container	(Morais, M & Morais, G., 2022) [40]

In the second dimension, "Reasons for abandonment" containers (Table 3), it was necessary to understand, in addition to the economic reasons, what were the material reasons that influenced the companies related to the sector, to disperse several containers across different terminals and seaports. As in Table 2, the statements presented to the experts were taken from various articles related to the problem, such as, "High cost of reshipping a container, whether empty or full", "Reverse logistics not implemented in the sector", "Lack of cooperation between companies", "Lack of planning and coordination in ports", "High level of maintenance in the life cycle of a container", "The main function of terminals is to accumulate several containers", "Lack of planning in the reception and dispatch of containers" and "The life cycle of a container is very long".

Table 3. Statements of the second dimension.

Dimension	Statements	Sources
Reasons for abandonment	High cost of returning a container, whether empty or full	(Ismatullaev et al., 2023) [39]
	Reverse logistics not implemented in the sector	(Natalino & Florian, 2022; Kroon & Vrijens, 1995) [3,45]
	Lack of cooperation between companies	(Junqueira et al., 2019; Kroon & Vrijens, 1995) [3,14]
	Lack of planning and coordination in ports	(Ismatullaev et al., 2023) [39]
	High maintenance level throughout a container's lifecycle	(Kroon & Vrijens, 1995) [3]
	The main function of terminals is to accumulate various containers	(Ismatullaev et al., 2023) [39]
	Lack of planning in the reception and dispatch of containers	(Ismatullaev et al., 2023) [39]
	A container's lifecycle is very long	(Al-Khatib et al., 2021; Milaneze et al., 2012) [46,47]

In the third dimension "Solutions for the future" (Table 4), statements were taken from the literature review that could be possible options to solve the research problem and that would not only solve the excess of containers, but could also be reliable options for companies in the sector. That said, the selected statements were, "Creation of sustainable temporary commercial spaces", "Implementation of a regulatory system for the sector at a global level", "Reduction of the index of visual environmental pollution through the adoption of reverse logistics of containers", "Adoption of strict measures on the dispersion of containerized waste", "Implementation of distribution and collection fees for containers worldwide", "Implementation of logistics systems that promote communication between ports", "Evolution of the model architecture" and "Adoption of a minimum number of uses until the abandonment of containers".

Table 4. Statements of the 3rd dimension.

Dimension	Statements	Sources
Solutions for the future	Creation of temporary commercial spaces	(Al-Khatib et al., 2021; Sun et al., 2017) [46,48]
	Implementation of a regulatory system for the sector at a global level	(Kroon & Vrijens, 1995) [3]
	Reduction in visual environmental pollution through the adoption of reverse logistics for containers	(Morais, M. & Morais, G., 2022) [40]
	Adoption of strict measures regarding the dispersion of waste in containers	(Kroon & Vrijens, 1995; Scarsi, 2016) [3,49]
	Implementation of global container distribution and collection fees	(Morais, M. & Morais, G., 2022) [40]
	Implementation of logistic systems that promote communication between ports	(Kroon & Vrijens, 1995) [3]
	Evolution of modular architecture	(Morais, M. & Morais, G., 2022; Bozeda & Fialho, 2016; Radwan, 2015) [40,44,50]
	Adoption of a minimum number of uses before container abandonment	(Al-Khatib et al., 2021) [46]

4.4. Initial Contact with Experts and Invitation to Participate in the Study

The initial contact with the experts was made informally via email and messages. Subsequently, a second moment occurred where the experts received an email with a brief explanation about the study in question and in order to request information about colleagues who might be interested in participating. During this time, there were emails in which it was not possible to obtain a response from the experts; however, it was always

possible to include not only companies in the maritime sector, but also companies that are linked to the containerized goods and model architecture sector.

Subsequently, and with all the data from the interested experts agreed upon, the participants received an invitation sent by email from the Welphi platform, with information on how to start the research.

5. Results and Discussion

Data collection was conducted through a questionnaire supported by the Welphi platform, a tool that manages and implements the Delphi Method in a more organized manner. The results will also be presented and discussed.

5.1. Sociodemographic Data

Data collection, as previously mentioned, was carried out using the Welphi tool. This allowed the experts to compare their responses with the previous round, as well as with what the rest of the experts thought would be most appropriate depending on the dimensions presented. This method meant that, despite constant feedback, the experts were not influenced by external means and by other parties involved, as could happen if it were a questionnaire requiring personal contact.

The qualitative scale presented to the experts ranged from "Totally Disagree" to "Totally Agree", with a total of 5 levels of possible response.

In the first phase, the emails of 51 experts were submitted to the platform, and 40 valid responses were obtained, totaling 78%.

Based on a sociodemographic question, it was also possible to identify the gender, age and years of experience of the specialists involved, as can be seen in Figures 2 and 3.

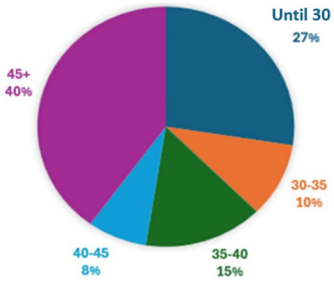

Figure 2. Specialists age's distribution.

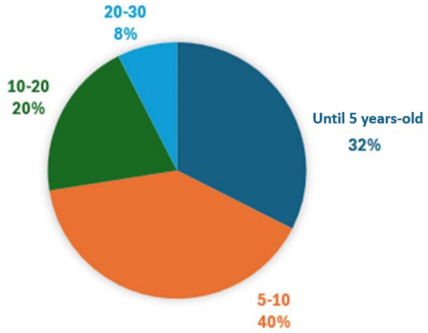

Figure 3. Specialists' Years of Experience Distribution.

Therefore, the percentage referring to the Female and Male genders was around 45% and 55%, respectively, which resulted in a dispersed and balanced survey for the two genders presented. Regarding the distribution of ages and years of experience, presented in Figures 2 and 3, an age limit between 22 and 59 years was possible, with a higher percentage of responses (40%) being obtained among specialists over 45 years old. The distribution of

years of experience was calculated based on values between 3 and 30 years, with a higher percentage at the level of 5 to 10 years of experience, with a 40% response rate.

In the second round, 100% of the questionnaires sent were answered, with 40 out of 40 respondents being perfect. Only fully completed responses obtained in the first round were considered accepted to proceed to the second phase of the research.

5.2. Delphi Survey: Round 1

In this first round, which took place from 10 to 17 March 2025, the responses of 40 of the 51 selected experts, who answered the questionnaire completely, were considered. From the participants included in the analysis of the responses, it was possible to bring together experts from various areas, namely, port terminal employees, logistics carriers, containerized goods shipping companies and companies related to model recovery. Because it was possible to diversify the research across several areas, it was possible to provide experts with a broader view of the responses given and a better understanding of the results.

Table 5 presents a summary of the statements that obtained the highest level of consensus among experts, regardless of their size and based on the sum of the levels of Agreement, Disagreement and "Neither Disagree nor Agree".

Table 5. Statements with the highest level of agreement in the 1st round.

Dimension	Statement	Percentage	Level
Economic Reasons	Pandemics/Wars that influence fluctuations in the sector	80%	Agree + Totally Agree (55% + 25%)
Economic Reasons	Annual growth of trade transactions in the maritime sector	72%	Agree + Totally Agree (40% + 32%)
Economic Reasons	Sending empty containers may be economically unviable	62%	Agree + Totally Agree (42% + 20%)
Reasons for abandonment	The main function of terminals is to accumulate various containers	63%	Totally Disagree + Disagree (30% + 33%)
Solutions for the future	Reduction in visual environmental pollution through the adoption of reverse logistics for containers	67%	Agree + Totally Agree (52% + 15%)
Solutions for the future	Implementation of logistics systems that promote communication between ports	66%	Agree + Totally Agree (33% + 33%)

We can observe that with a high percentage level, five of the six statements presented belong to the levels of "Agree" and "Totally Agree", between 62% and 80% and therefore, we can understand that the 40 experts reached a consensus of on average 68%, regarding the positive statements presented.

It is also extremely important to emphasize that the two statements that obtained percentages of 72% and 80% are related to the annual growth of commercial transactions in the maritime sector and that both wars and the pandemic influence its undulations. That said, it is noteworthy that this medium is increasingly important in transactions between international markets and that any unexpected situation can influence the way the sector is stipulated, requiring the implementation of quick and effective solutions.

Then, the data obtained will be discussed in more detail, taking into account the dimension in which they are found and the percentage of agreement or disagreement collected in this first phase.

In the first dimension, "Economic Reasons" in the containerized goods transportation sector, in Table 6, there was a consensus, which was around 30% to 55%, ranging from "Strongly Disagree", "Neither Disagree nor Agree" and "Agree". At level 4 of "Agree", the

experts reached a possible conclusion, that the present statements justify the annual growth of the sector in question, despite considering external factors, namely pandemics/wars and discrepancies in demand and supply in the sector.

Table 6. Percentage of answers regarding the first round in dimension "Economic Reasons".

Statements	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Discrepancy between supply/demand	23%	10%	20%	45%	2%
Pandemics/Wars that influence the sector's fluctuations	7%	5%	8%	55%	25%
Strong dependence on material imports	10%	10%	30%	32%	25%
Lack of international logistics systems	18%	18%	50%	12%	2%
Annual growth of trade transactions in the maritime sector	0%	8%	20%	40%	32%
Reverse logistics is financially rewarding for companies	3%	17%	40%	30%	10%
Shipping empty containers may be economically unfeasible	8%	10%	20%	42%	20%
Monetary impact of visual environmental pollution	3%	20%	43%	32%	2%
Production has a lower cost compared to the recovery of a container	30%	13%	28%	22%	7%

Furthermore, statements are also included indicating that imports are a major factor in the volume of containerized transactions. Likewise, sending empty containers ends up not being the most reliable solution to this problem.

Furthermore, it was not possible to reach a positive or negative conclusion, at least in this round, in relation to the statements, which indicated, that there was no international method, that this would not monetarily compensate companies and that there could be an impact in monetary terms of the existing environmental pollution. However, with the exception of the statement "Lack of international logistics systems", all the others belonging to the "Neither Disagree Nor Agree" level are biased towards the positive levels of "Agree" to "Totally Agree".

In the last statement, experts agreed that production has a higher value than the recovery of a container, which may indicate that companies related to the sector are interested in recovering containers or that they are interested in this being an advantageous factor in the future, despite it not being a habit today.

The level of consensus reached in the second dimension "Reasons for abandonment" was between 25% and 48%, among all the levels presented, as can be seen in Table 7.

In this dimension, the level that was most preferred by respondents was "Neither Disagree nor Agree", which can be translated into a greater difficulty in connecting the physical reasons for a high VEP, with a possible increasing abandonment of containers, by those participating in the questionnaire.

As mentioned previously, the experts neither disagreed nor agreed with the fact that there was no international logistics system, which was again verified in the statement that indicates that there is no IL implemented in the sector, due to the percentage obtained (48%). That said, we can reflect that although it is an uncertainty for experts, it is a point

that should be taken into consideration in a future analysis, also due to the lack of planning and guidance from all organizations involved in the process.

Table 7. Percentage of answers regarding the first round in the dimension "Reasons for abandonment".

Statements	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
High cost of returning a container, whether empty or full	25%	7%	28%	30%	10%
Reverse logistics not yet implemented in the sector	13%	17%	48%	15%	7%
Lack of cooperation between companies	3%	12%	28%	45%	12%
Lack of planning and coordination at ports	25%	25%	25%	22%	3%
High level of maintenance in the container life cycle	0%	23%	33%	27%	17%
The main role of terminals is to accumulate various containers	30%	33%	15%	20%	2%
Lack of planning in the reception and dispatch of containers	20%	22%	33%	20%	5%
The life cycle of a container is very long	10%	10%	30%	35%	15%

Participants also indicated that reshipping a container is costly, regardless of whether it is full or empty. They also agreed that companies involved in the sector do not cooperate with each other, which ultimately makes it difficult to implement viable solutions.

Regarding statements related to maintenance and life cycle, participants indicated that they did not have a defined position, but were more biased towards the positive side of the statement, respectively. While, in particular, the life cycle is very long, 35% agreed that containers could be "discarded" earlier and not only later, after 10 years, on average [51].

Regarding the statements that mention terminals/ports, it is possible that, because the questionnaire was shared by several companies in the sector, the responses presented a greater concentration of disagreement levels.

While on the one hand, this result may indicate biased responses, on the other hand, given that the survey was answered individually and without the influence of external factors, it may also indicate that, regardless of the sector in which the participant works, there is a more generalized opinion.

Finally, the third dimension (Table 8), related to the possible solutions that respondents could consider relevant to reduce the impact of CRL. At this point, the level of consensus obtained, although more stable in terms of response levels, was between 33% and 52%.

However, the experts gave a positive opinion on the statements related to the creation of temporary commercial spaces, the reduction in pollution levels, the implementation of the method in question, the implementation of logistics systems between ports and the evolution of model architecture. This indicates that despite negative or inconclusive opinions on the previous dimensions, these positive points are considered to be important aspects to mitigate the impact of the CRL.

When analyzing the statements in Table 8 that obtained equal percentages in more than one level, or the highest percentage was in the intermediate level, we can see that only the statement "Adoption of strict measures on the dispersion of containerized waste" has higher values in the Disagreement levels. It is therefore concluded that, although the respondents did

not take a defined position in relation to the other statements, in this aspect they disagreed with this statement regarding the reduction in the number of abandoned containers.

Table 8. Percentage of answers regarding the first round in the dimension "Solutions for the future".

Statements	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Creation of sustainable temporary commercial spaces	8%	8%	35%	42%	7%
Implementation of a global regulatory system for the sector	5%	10%	40%	35%	10%
Reduction of visual environmental pollution through the adoption of reverse logistics for containers	3%	2%	28%	52%	15%
Adoption of taxing measures on the dispersion of containerised waste	8%	23%	45%	22%	2%
Implementation of global fees for the distribution and collection of containers	3%	10%	40%	37%	10%
Implementation of logistics systems that promote communication between ports	0%	10%	25%	33%	33%
Evolution of modular architecture	0%	10%	40%	40%	10%
Adoption of a minimum number of uses before container abandonment	0%	5%	40%	35%	20%

From the comments obtained in the first round of the survey, one of the experts indicated that despite having fully responded to the survey, he disagreed with its intention, due to the fact that, from his analyst perspective, he considers that there are not excess containers spread across several cities, but that there is a lack of containers for the volume of current commercial exchanges. Which, based on the analysis verified previously, is interconnected with the opinion given by other individuals involved in the research.

5.3. Delphi Survey: Round 2

In this second and final round of the survey, which took place from March 18th to March 23rd, 2025, only the responses of experts who, in the previous round, had responded correctly and completely on the Welphi platform were considered valid. However, due to the expected dropout rate in the first round, at this stage, a certain percentage of experts dropping out was expected. However, this did not occur and there were no withdrawals from experts, compared to the previous round, and it was therefore possible to maintain the total participation of 40 experts.

As defined by the research method, by enabling constant feedback to experts and allowing them to compare the answers given with those of other participants, it was possible to verify an increase in the percentage of consensus, on average 76%, compared to the 68% obtained in the previous round.

When analyzing Table 9, we can conclude that the level of consensus of the statements presented is between 72% and 87%. This indicates, as in the previous phase, that experts reach consensus regarding the statements presented in the three dimensions throughout the research.

As observed in the previous round, it is extremely important to highlight that the two statements that obtained the highest percentage level of consensus, between 79% and 87%, are

related to the growth of the sector, which translates into a reaffirmation by the participants of the increasingly notable importance of transactions between international markets.

Table 9. Statements with the highest level of agreement in the second round.

Dimension	Statement	Percentage	Level
Economic Reasons	Pandemics/Wars that influence fluctuations in the sector	87%	Agree + Totally Agree (60% + 27%)
Economic Reasons	Annual growth of commercial transactions in the maritime sector	79%	Agree + Totally Agree (47% + 32%)
Economic Reasons	Sending empty containers can be economically unviable	72%	Agree + Totally Agree (50% + 22%)
Reasons for Abandonment	The main function of terminals is to accumulate various containers	73%	Totally Disagree + Disagree (33% + 40%)
Solutions for the Future	Reduction in visual environmental pollution through the adoption of reverse logistics of containers	72%	Agree + Totally Agree (57% + 15%)
Solutions for the Future	Implementation of logistics systems that promote communication between ports	72%	Agree + Totally Agree (40% + 32%)

All other statements obtained higher levels of consensus than those presented in the first round, which means that the experts, when receiving uninterrupted feedback, were able to rethink the options chosen and compare their answers with the answers given by the other participants in the research. The only statement found at the level of disagreement remained related to the main function of the terminals being to accumulate several maritime containers; however, as expected, the level of consensus among them rose from 63% to 73%.

Taking this into consideration, the data collected in this second round will be analyzed in more detail, depending on the dimension in which they are found and the level of percentage of agreement or disagreement obtained.

In the first dimension, "Economic Reasons" in the Containerized Goods Transportation Sector, in Table 10, there was a consensus, which was between 37% and 60%, varying between the levels of "Neither Disagree nor Agree" and "Agree". This translates into an increase in the percentage of consensus among experts, who in the previous round divided opinions between 30% and 55% and in terms of levels were between "Totally Disagree" and "Agree".

As highlighted in Table 6, all statements that were previously at the "I agree" level saw their percentage increase in this second round, even though there were only slight increases in the percentage levels.

The two statements that remained at the "Neither Disagree Nor Agree" level saw a reduction in consensus among experts and there was a slight change of 5% towards positive consensus levels, as can be seen from the analysis of Tables 6 and 10.

In the last statement, the experts, who had previously reached a consensus level of 30% that production would cost more than recovering a container, in this round reached a consensus percentage of more than 50%. This change can translate into a better understanding of the statements presented and the feedback obtained from the results collected previously. This is in line with the research question of this study and a possible justification for the problem of excess containers in Portugal.

Table 10. Percentage of answers regarding the second round in the dimension "Economic Reasons".

Statements	Totally Disagree	Disagree	Neither Agree nor Disagree	Agree	Totally Agree
Discrepancy between supply/demand	25%	10%	15%	47%	3%
Pandemics/Wars that influence sector fluctuations	8%	5%	0%	60%	27%
Strong dependence on imported material	3%	10%	20%	45%	22%
Lack of international logistics systems	18%	20%	45%	15%	2%
Annual growth of commercial transactions in the maritime sector	0%	8%	13%	47%	32%
Reverse logistics is financially beneficial to companies	3%	20%	28%	37%	12%
Sending empty containers may be economically unviable	8%	10%	10%	50%	22%
Monetary impact of visual environmental pollution	3%	20%	38%	37%	2%
Production has a lower cost compared to the recovery of a container	23%	10%	5%	52%	10%

In the second dimension, "Reasons for abandonment," the level of consensus was between 27% and 52%, as can be seen in Table 11. This increase in percentage, as in Table 12, was verified by the increase in consensus among the experts involved in the study.

Table 11. Percentage of answers regarding the second round in the dimension "Reasons for abandonment".

Statements	Totally Disagree	Disagree	Neither Agree nor Disagree	Agree	Totally Agree
High cost of container return, whether empty or full	28%	10%	20%	32%	10%
Reverse logistics not implemented	13%	22%	48%	12%	5%
Lack of cooperation between companies	5%	13%	18%	52%	12%
Lack of planning and coordination at ports	23%	32%	23%	20%	2%
High maintenance level in a container's life cycle	0%	23%	28%	32%	17%
The main function of terminals is to accumulate various containers	33%	40%	10%	15%	2%
Lack of planning in the reception and dispatch of containers	23%	27%	25%	20%	5%
The life cycle of a container is very long	10%	18%	25%	35%	12%

On the contrary, to what was analyzed in Table 10, the level that obtained the greatest consensus was not "Neither Disagree Nor Agree", but rather "Agree". This may indicate that the experts, who were previously apprehensive or had doubts about which level to choose for each statement, were able to rethink and opt for a better choice when receiving feedback on the other responses given.

Table 12. Percentage of answers regarding the second round in the dimension "Solutions for the future".

Statements	Totally Disagree	Disagree	Neither Agree nor Disagree	Agree	Totally Agree
Creation of sustainable temporary commercial spaces	8%	10%	28%	47%	7%
Implementation of a regulatory system for the sector at a global level	5%	10%	35%	40%	10%
Reduction of visual environmental pollution through reverse logistics of containers	3%	2%	23%	57%	15%
Adoption of strict measures on the dispersion of containerised waste	8%	22%	40%	25%	5%
Implementation of distribution and collection fees for containers worldwide	5%	13%	35%	37%	10%
Implementation of logistics systems that promote communication between ports	5%	10%	18%	40%	32%
Evolution of modular architecture	0%	7%	38%	45%	10%
Adoption of a minimum number of uses before container disposal	0%	7%	33%	40%	20%

Regarding the statements that had previously been rated "Agree," in this round, their consensus percentage increased, indicating that experts reaffirmed their understanding of the statements that indicated plausible reasons for what leads maritime companies to abandon containers.

As shown in Table 7, the statements that retained consistent levels of disagreement are those related to or referencing sea terminals and ports. This pattern may suggest a degree of bias in the responses, potentially stemming from the survey's distribution among companies within the same industry. Additionally, it could reflect operational differences between terminals and ports, or conflicting priorities among stakeholders.

Finally, in the third dimension, "Solutions for the future" (see Table 12), the level of consensus among participants rose noticeably, reaching between 37% and 57%, resulting in the dimension with the highest level of consensus. Regarding the levels presented in Table 8, opinions were divided between the levels of "Neither Disagree nor Agree", "Agree" and "Totally Agree", compared to those in Table 12 which after the feedback received by the experts in the first round, increased to the level of "Agree", the majority of opinions.

Excluded, the statement about the adoption of tax measures, which as highlighted in Table 8 and despite having suffered a 5% reduction, at the level of consensus among experts, they maintained the opinion on whether this statement would be the major factor in reducing the impact of the CRL.

The two rounds of the Delphi survey revealed that there was an increase in the levels of consensus among the experts, which means that constant and intuitive feedback and clear statements on the topic in question helped them.

Statements such as the implementation of logistics systems, the reduction in the VEP index or the disagreement about the main role of terminals were key points for the development and conclusion of this study.

In the first round, the experts ended up dispersing their opinions more regarding the statements presented in each dimension, which meant that the levels of consensus were more distributed across the different levels. In the second round, a higher level of consensus

was reached, reflecting the effectiveness of the Delphi Method in reaching consensus among the opinions given by the participants.

The results presented suggest that, in order to reduce excess containers in Portugal, shipping companies must take into account numerous factors and the current state of the sector. Furthermore, the sector is considered slightly unstable, in the sense that it grows annually, as does the quantity of containers transported, but due to the possibility of disruptions arising from wars and/or pandemics, it does not always show positive growth.

6. Conclusions

This section synthesizes the principal conclusions of the study, presents its inherent limitations, and proposes directions for future research.

6.1. Conclusions of the Study

The present study aimed to identify the CRL problem, the time lag between container entries and exits in Portuguese Ports, as well as the impact on VEP.

Using the Delphi Method, the study involved a panel of experts in areas related to maritime transport and/or container maintenance, in order to gather diverse perspectives on the sector in question. The selection of experts and constant feedback made it possible to cover key dimensions such as the economic reasons in the containerized goods sector, reasons for abandoning containers and solutions for the future.

In the first round, regarding economic reasons, experts had an average consensus of 68%, with emphasis on agreement with statements about the impact of pandemics and wars on the maritime sector (80%) and the annual growth of commercial transactions (72%). Regarding the abandonment of containers, the results showed a lower level of consensus, with many experts opting for neutrality, demonstrating uncertainty or lack of knowledge about the statements presented. In terms of solutions for the future, there was greater consensus on proposals related to the effective implementation of the CRL and the creation of interport logistics systems.

In the second round, all experts responded to the survey again, and the average consensus increased to 76%. The statements that generated the greatest consensus are related to the impact of global events and the growth of the sector, reinforcing the growing importance of maritime transport. The statement regarding the role of terminals in accumulating containers continued to generate disagreement among experts. In future solutions, the importance of measures related to the effective implementation of the CRL and communication between ports was confirmed. However, the adoption of strict measures did not achieve consensus among experts.

Overall, the two rounds showed that the Delphi Method allowed for deeper reflection among experts, leading to a higher level of consensus. The study concludes that addressing the problem of excess empty and/or abandoned containers requires considering economic, environmental, structural, and logistical factors, highlighting the need for coordinated strategies that can be adapted to the volatile nature of the maritime sector. Additionally, the study suggests the urgent implementation of container reverse logistics to remove, and reuse abandoned containers at terminals.

This work highlights some practical implications such as, (i) effective coordination and information sharing among all stakeholders in the maritime sector, (ii) maximizing the reuse of containers stored and abandoned at terminals and consequently (iii) the decrease in economic and environmental costs. The solution to this problem will necessarily involve the effective and correct implementation of reverse container logistics.

6.2. Limitations of the Study

This study has some limitations that deserve to be acknowledged. Because it is a case study based on the Delphi Method, caution is needed when generalizing possible results and conclusions. Furthermore, due to the confidentiality of sociodemographic data, the study became more complex and made it difficult to perform a more detailed characterization of the sector during the more detailed analysis.

Another limitation was the time constraint. To minimize the impact on experts, given the timing of the quarterly closing for companies in the sector in question and the chosen timing, only two rounds were conducted. However, it would be beneficial to conduct another study with more rounds to understand whether it would be possible to increase the level of consensus among experts on the various dimensions presented.

6.3. Future Research

Future research should expand the sample size of experts used to include experts from other regions who did not respond to the survey, as well as from the islands of Madeira and the Azores. This change would increase the generalizability of the results, due to potential new insights into the study topic. Furthermore, a study that compared the conclusions of each sector/organization on the topic rather than aiming to reach a possible consensus among all would be somewhat interesting.

Carrying out similar studies in other countries (e.g., Spain) to make comparisons and become aware of innovative measures that may have been taken related to the effective application of the reverse logistics process for containers.

Furthermore, mixed methods could be implemented in future research, using both quantitative and qualitative data, leveraging the strengths of both types of research to gain a more detailed understanding of the phenomenon studied. This approach would provide a more holistic view, capturing all and any potential experiences of the experts, which, given the chosen method, are more difficult to explain and share during the case study.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data collected for this study can be accessed through a formal request to the author, through the means of communication previously available.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

CML	Loures City Council
CRL	Container Reverse Logistics
RL	Reverse Logistics
VEP	Visual Environmental Pollution

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