



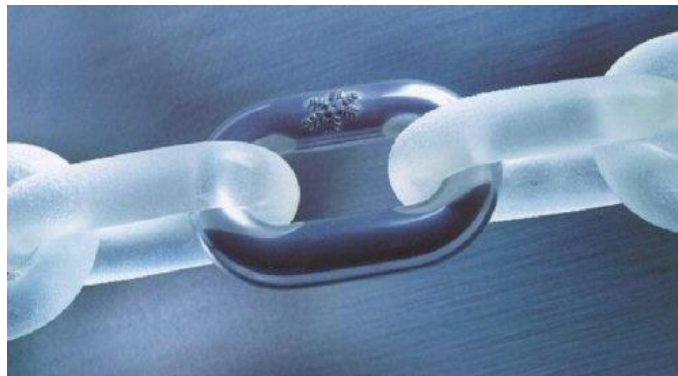
**SCHOOL OF HUMAN SCIENCES**

**POSTGRADUATE PROGRAMME OF STUDIES**

**SUPPLY CHAIN MANAGEMENT**

**POSTGRADUATE DISSERTATION**

**“Order processing in a logistics service company: the case of the cold supply chain”**



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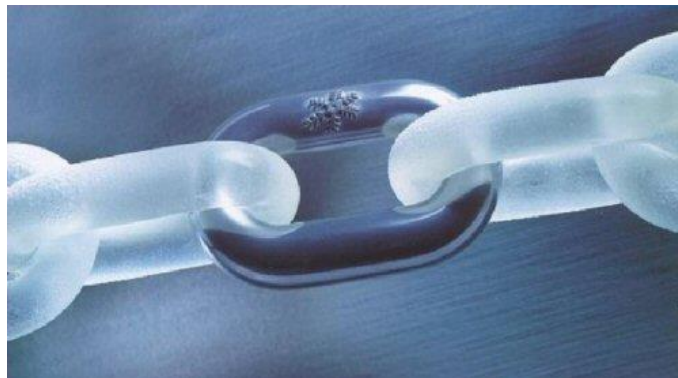
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Supervising Committee

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### *Acknowledgments*

I would like to express my gratitude to Dr. D. Folinas, for his inspiration and support, to my family and friends for their patience, belief in me and backing me up, and to all those who replied to the questionnaire, providing with the valuable information to the research.

## **Abstract**

The cold chain (CSC) aims to integrate existing facilities into a holistic infrastructure, ensuring deliveries without delays from suppliers to users. This involves storing in cold facilities, sorting, packing, freezing, order processing, and delivering in strictly maintained temperature-regimes. The solution to problems in CSC requires joint efforts from production, trade, logistics companies, consumer communities, and the state. The study seeks to depict a sketch of expanding at high-speed CSC in the world and Greece, focusing on order processing problems in cold service companies.

The research was completed on the basis of a qualitative methodology. A questionnaire was used as the primary research technique. The sampling was carried out in Greece, with the participants – cold 3 PLs – responding via email or filling the Questionnaire via Google Forms.

The study reveals that the CSC in Greece has seen a shift towards technology, with some trends of traceability. To ensure correct order implementation, the following criteria must be implemented: relevant CSC training of managers and employees, electronic order processing, vigilant control, tracing and immediate actions when there is a CSC disruption, use of RFID scanners, sensors, thermographs, cryogenic premises and vehicles meeting the different temperature-environment prerequisites. The implementation of AI in order processing can set the first steps towards creating a resilient CSC. External subcontractors must have the necessary qualifications and skills to guarantee proper transportation or cross docking of perishables.

The replies received from the respondents, as well as conclusions can bring the awareness and serve as a guide for improving the state of things on the CSC market in Greece.

The majority of researches focus on the general idea of CSC, sustainability, and green CSC, neglecting order fulfilment and its problems. The implication of Greek cold service agents providing their feedback on order processing is the originality of this study, and could be of interest and provide suggestions not only for Greece, but for the international audience as well.

**Keywords**

Cold supply chain, order processing, cold service companies or cold 3PL.

## «Διαχείριση παραγγελιών σε εταιρείες παροχής υπηρεσιών Logistics: η περίπτωση της ψυχρής εφοδιαστικής αλυσίδας»

Ελενα Γκρέσεβα-Δρακούλη

### Περίληψη

Η ψυχρή αλυσίδα (ΨΑ) αποσκοπεί στην ενσωμάτωση των υφιστάμενων εγκαταστάσεων σε μια ολιστική δομή, εξασφαλίζοντας παραδόσεις χωρίς καθυστερήσεις από τους προμηθευτές στους χρήστες. Αυτό περιλαμβάνει την αποθήκευση σε ψυκτικές εγκαταστάσεις, τη διαλογή, τη συσκευασία, την κατάψυξη, την επεξεργασία παραγγελιών και την παράδοση σε αυστηρά διατηρούμενα θερμοκρασιακά καθεστάτα. Η επίλυση των προβλημάτων της ΨΑ απαιτεί κοινές προσπάθειες από την παραγωγή, το εμπόριο, τις εταιρείες logistics, τις καταναλωτικές κοινότητες και το κράτος. Η μελέτη έχει ως στόχο να δώσει μια εμπεριστατωμένη εικόνα της ραγδαία αναπτυσσόμενης ΨΑ παγκοσμίως και στην Ελλάδα, εστιάζοντας στα προβλήματα διαχείρισης παραγγελιών σε εταιρείες ψυχρών υπηρεσιών.

Η έρευνα ολοκληρώθηκε με βάση της ποιοτικής μεθοδολογίας. Ως πρωτογενής ερευνητική τεχνική χρησιμοποιήθηκε το ερωτηματολόγιο. Η δειγματοληψία πραγματοποιήθηκε στην Ελλάδα, με τους συμμετέχοντες – εταιρείες παροχής υπηρεσιών ψύχους – να απαντούν μέσω ηλεκτρονικού ταχυδρομείου ή να συμπληρώνουν το ερωτηματολόγιο μέσω Google Forms.

Η μελέτη αποκαλύπτει ότι η ΨΑ στην Ελλάδα έχει σημειώσει μια στροφή προς την τεχνολογία, με έμφαση στην ιχνηλασιμότητα. Για να διασφαλιστεί η ορθή εφαρμογή των παραγγελιών, πρέπει να εφαρμοστούν τα ακόλουθα κριτήρια: σχετική εκπαίδευση

των διευθυντών και των εργαζομένων της ΨΑ, ηλεκτρονική επεξεργασία των παραγγελιών, συνεχής έλεγχος, εντοπισμός και άμεσες ενέργειες όταν υπάρχει διακοπή λειτουργίας της ΨΑ, χρήση σαρωτών RFID, αισθητήρων, θερμογράφων, κρυογονικών εγκαταστάσεων και οχημάτων που πληρούν τις διαφορετικές προϋποθέσεις θερμοκρασίας-περιβάλλοντος. Η εφαρμογή της τεχνητής νοημοσύνης στην επεξεργασία παραγγελιών μπορεί να θέσει τα πρώτα βήματα προς τη δημιουργία ανθεκτικής ΨΑ. Οι εξωτερικοί συνεργάτες πρέπει να διαθέτουν τα απαραίτητα προσόντα και δεξιότητες για να εγγυηθούν τη σωστή μεταφορά ή διασταύρωση των ευπαθών προϊόντων.

Οι απαντήσεις που ελήφθησαν από τους ερωτηθέντες, καθώς και τα συμπεράσματα μπορούν να ευαισθητοποιήσουν και να χρησιμεύσουν ως οδηγός για τη βελτίωση της κατάστασης της αγοράς ΨΑ στην Ελλάδα.

Η πλειονότητα των ερευνών επικεντρώνεται στη γενική ιδέα της ΨΑ, της βιωσιμότητας και της πράσινης ΨΑ, παραμελώντας την διαχείριση των παραγγελιών και τα προβλήματά της. Η συμμετοχή στην έρευνα των Ελλήνων επαγγελματιών ψυχρής αλυσίδας που παρέχουν τα σχόλιά τους σχετικά με την επεξεργασία των παραγγελιών αποτελεί την πρωτοτυπία αυτής της μελέτης, και θα μπορούσε να έχει ενδιαφέρον και να προσφέρει προτάσεις όχι μόνο για την Ελλάδα, αλλά και για το διεθνές κοινό.

## **Λέξεις – Κλειδιά**

Ψυχρή εφοδιαστική αλυσίδα, διαχείριση παραγγελιών, εταιρείες ψυχρών υπηρεσιών ή 3PL.



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## **List of Abbreviations & Acronyms**

3PL – Third Party Logistics

4PL – Fourth Party Logistics

5PL – Fifth Party Logistics

AI – Artificial Intelligence

ATP – Accord Transport Perissable

CC – Cold Chain

ChatGPT – Generative Pre-trained Transformer

CO<sub>2</sub> – Carbon Dioxide

CSC – Cold Supply Chain

ERP – Enterprise resource planning

FAO – Food and Agriculture Organization of the United Nations

FEFO – First Expire First Out

FIFO – First In First Out

IoT – Internet of Things

KPI – Key Performance Indicators

LIFO – Last In First Out

NECP – National Energy and Climate Plan

NGO – Non Governmental Organisations

NTP – National Transport Plan

RFID – Radio Frequency Identification

SC – Supply Chain

SCM – Supply Chain Management

## **Introduction**

Exposure to cold is a process ensuring the life prolongation of products or goods, providing thus qualitative and non-hazardous conditions for foodstuffs. Temperature control decreases any biological process, thus monitoring the speed of ripeness, micro-organism development and dehydration (Erkmenand & Bozoglu, 2016). Chilling is the sole way of saving the food without its taste to be altered for a certain period of time, therefore refrigeration with the help of appliances became widespread at home and in the shops and warehouses. With the mass production of refrigerators for the home use in the 40-ies, people became depended upon food preservation, and thus changing their diet and habits. The cooling became part of people’s lives, and set the first brick creating the cold supply chain (Schwartz, 1985).

The cold supply chain (CSC) is a complex of logistics measures ensuring a constant temperature and other parameters necessary for the proper maintenance of the goods throughout the chain of all the steps — from production to the consumer. The CSC is responsible for packaging, transportation and allocation of temperature-dependent goods on the local level and around the world. The state of the goods and the unchanged chilled conditions during the transportation play an important role in the preservation of the commercial value, as the slightest alteration in colour, texture and shape may downsize the profit. A failure in temperature control at any step jeopardizes the efforts of all the other stages and may cause deterioration of the quality or appearance of the product.

Therefore, the first aspect of the CSC is the preservation of the sensitive products in order to keep their qualitative and commercial value. It is a challenge for the CSC logistics as the diversity of the food and medical products varies, goes in parallel with the

temperature regimes, requiring special conditions of delivery and the lead time. The second aspect of the CSC is the safety of the products for people’s consumption, as the degradation of the quality of the edibles may result to severe consequences. Another difficult task that the CSC faces is the set of norms that specify the sanitary condition, the aesthetic aspect as well as the texture of the product to remain pristine (Aung & Chang, 2023). The third aspect is the timely delivery of the perishables in the integral condition to the final destination that is a double-dare due to the constant exposure to the external and internal risk factors.

## Chapter 1

### *1.1 Significance of the research*

The total number of people living on Earth has reached the number of 8 billion people (United Nations Population Fund, 2023), and all of them need food to survive. The need to supply food for everyone in the most cost-effective way has prompted the global economy to look for inexpensive resources and cheap transportation, also known as globalization.

With the constantly growing market for chilled products, as well as the increase in transportation length and steps in the global transport system, the demand for transportation and storage with a special temperature regime has increased.

The growth of consumption markets and globalization in logistics increase the requirements for the equipment and information technologies used. The transportation time has become longer, and the supply chain is becoming more complicated with the appearance of additional links like distribution centres, cross-dock platforms, etc. In the process of moving goods, there is a need to control the stages of their transportation, where a violation of temperature regimes can occur, which leads to the loss of the quality of goods sensitive to temperature changes. Insufficient and improper refrigeration is a major factor to nourishment loss, accounting for 526 mln tons of alimentary fabrication, as per Figure 1, translating into 12% on the worldwide scale, as per data of International Institute of Refrigeration 2021a for the year 2017 (Sarr et al, 2021). The situation is expected to worsen as Food Logistics states, if no measures are taken, and skyrocket up to 2,100,000,000 tons corresponding to 1,5000,000,000,000 \$ (White, 2023).

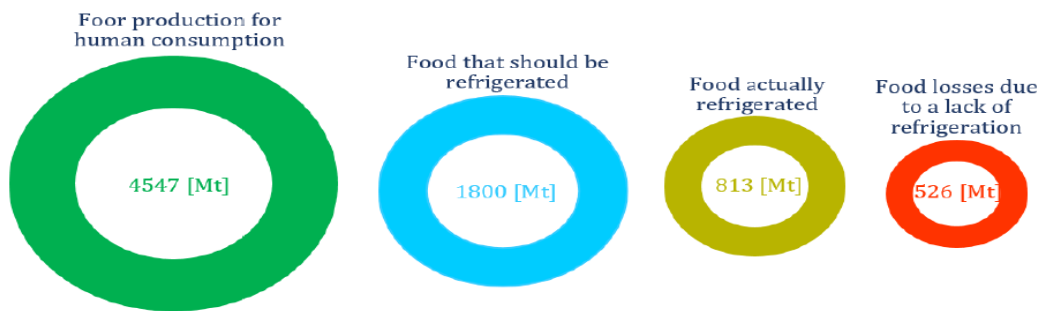
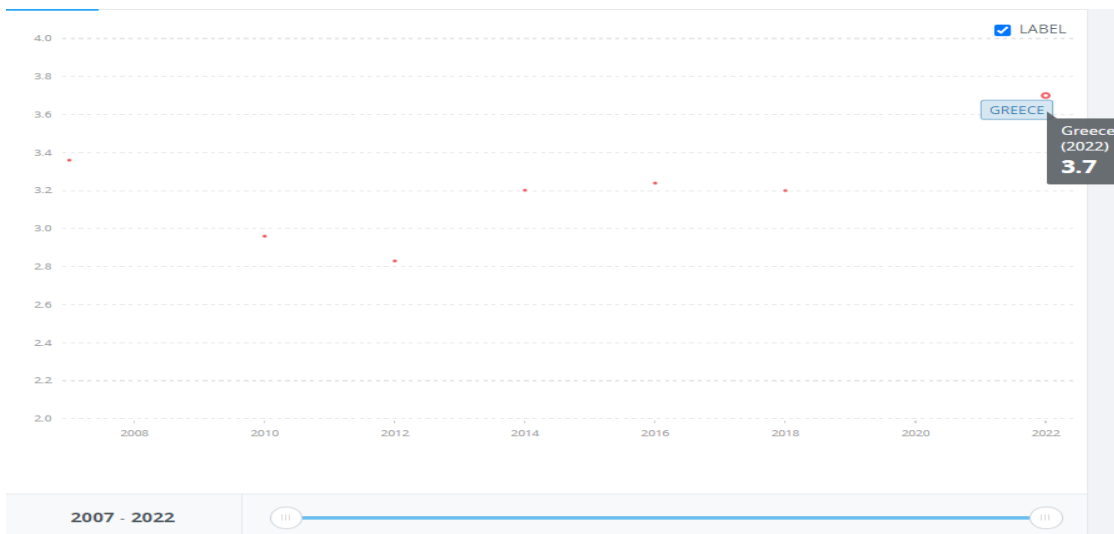


Figure 1 Worldwide wasted alimentary (2017) as a result of an absence of refrigeration  
(Sarr J. et al, 2021, p 4)

The instability of Greek political and economic situation for decades, as well as a short period of social and economic progress under the PASOK government in the 80ies and 90-es, has left a significant mark on the geopolitical map of the country. The World Bank analysis of the condition of the agricultural lands per country has shown that Greek quota of arable land from 1961 to 2020 has dropped from 65.57 % down to 45.52 % (The World Bank (WB), Agricultural land of Greece). The decrease is related to the use of fields and arable lands as plots for building villas, houses and road infrastructure. Concurrently, the growth of population for the same period has increased almost 11% from 8.331.725 up to 10.566.531 people (WB, Population of Greece). This is the reason Greece has turned to external sources for extra quantities of food of all the categories, that brought the necessity to develop the supply chain in general and CSC in particular, when it comes to temperature-sensitive products.

The World Bank has mapped Greece on the 23<sup>rd</sup> place in 2023 based on six Logistical activity principles: 1) competitiveness of infrastructure, 2) customs processes, 3) excellence of service, 4) surveying of management and records of the products, 5) competitiveness of prices and timely forwarding of the load (Arvis et al., 2023).





**Figure 2 Logistics performance index - Greece, as per World Bank 2023**

For the sake of comparison, Greece was on 42nd place in 2018. The World Bank has provided the overall Supply Network mark to Greece in 2023 equal to 3.7 with 5 as the highest mark, meaning there is an obvious improvement on the logistical market in Greece for the last decade.

The value of the present dissertation is in the examination of the core of the cold SC – the order and its processing. The distinction from the previously-performed studies is that we analyse the major elements of the order, the arising difficulties and the potential problems, as well as the possible solutions are cited. This also represents the originality of the work, alongside with the participation of the Greek cold 3PL and companies acting on the cold Greek market.

## ***1.2 Aims & Objectives***

Traditionally the aim of the cold chain aims to the integration of the existing facilities into a holistic infrastructure assuring deliveries without breaks and delays, from the supplier to the final user. That implies construction and maintenance of infrastructure facility throughout the entire SC, embracing preliminary sorting and packing in special cooling storage units, individual quick freezing and blast freezing, order processing in the

distribution hubs and delivery using refrigerating installations. Since the transportation may take place by air, land and water, the cold chain must ensure planning and implementation emphasizing on integral infrastructure control.

It is worth noting that the solution to the problems that have usually arisen in cold supply chains is possible only through the joint efforts of production, trade, and logistics companies, as well as the consumer community, with the reasonable intervention of the state. Still, to eradicate any difficulty, one must search for the problems from the basis – that is the process of receiving and implementing an order in the cold chain. The present study provides an in-depth analysis of aspects related to the order processing in a cold chain. The inclusion of cold providers in the study makes it possible to ensure a broader comprehension of the topic to be investigated and to analyse the perspectives on further expansion of the market of perishables in Greece.

The **aim** of the dissertation, therefore, is to investigate the current state of the CSC agents in Greece through the process of order implementation.

Subsequently, **the objectives** of the current thesis are:

1. To analyse the major difficulties and problems arising during the order processing in the cold sector in Greece,
2. To identify the factors resulting in the creation of these problems,
3. To analyse the factors eliminating and improving the current problems,
4. To provide recommendations that could be applicable to the operations management with regards to ameliorating the effectiveness of cold 3PLs.

### ***1.3 Procedure***

The questionnaire was used as the primary research technique for this study (Brace, 2004). The whole sampling procedure was carried out in Thessaloniki and other towns of Greece, with the participants responding via email or filling the Questionnaire via Google Forms. The questionnaire used to perform this study was created and weighted in Greek to ensure that all questions are understood by the participants and that the research is carried out successfully (A. Williams 2003). For the sake of the present thesis, the questionnaire was translated in English.

### ***1.4 Tools***

Since there was no previous study analysing that would have indicated a normative set of questions, the following questionnaire was elaborated following the Deming's “plan, do, check, and act” (Parmenter, 2019). A customized questionnaire was created for the study's objectives, and it comprised open-end questions regarding the participants' professional data. More specifically, participants were asked about their educational and professional level, as well as general and relevant CSC experience. The set of questions regarding the order processing in CSC depicted the state of things through open-end questions, as well as identified the critical facts and problems. And finally the last questions addressed the ways to solve and possibly to improve the existing condition.

### ***1.5 Structure***

The Greek and foreign literature, on the basis of which the research was performed, was weighed on a theoretical level. The first chapter contains 5 sub-chapters, explaining the significance of the research, aims and objectives, procedures and tools, and provides the analytical structure of the dissertation.

The second chapter is divided into five subsections that address the phenomenon of the CSC and cold 3PL, and represent a literature review around the phenomenon. The five sub-chapters (2.1-2.5) clarify the peculiarities of order processing under the cold management aegis as a notion of marketing and operational management, the difficulties that arise from the lack of specialized warehouses and finally the role of cold 3PL in Greece and Europe.

The third chapter, divided into five subchapters (3.1-3.5), compiles a list of the most fundamental ideas and models that attempt to describe the topic and theoretical framework. The purpose of the work, the methodological background, specifically the research questions, the participants of the research, the chosen method for carrying out the study. The limitations of the particular work are being mentioned, alongside with the content of the questions.

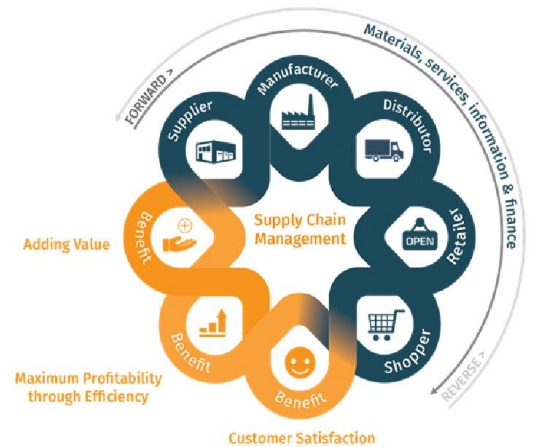
The fourth chapter covers the findings of the research based on the qualitative method – the questionnaire. The data analysis method, the reliability and validity of the research are being evaluated and verified with the help of the VOSviewer, and presented in the fourth chapter.

The fifth and sixth chapters debate on the key findings of the current study and formulate the conclusions, as well as limits of the current research and ideas for future one. Finally, the employed Greek and foreign literature is presented.

## Chapter 2 – Cold Supply Chain – Literature Review

### 2.1 Logistics Management and Supply Chain Management

Logistics and Supply Chain management are two concepts that are usually used as synonyms, but is it true? Logistics oversees movement of resources, associated documentation, from where they come at providers to the delivery of final merchandise to clients and after-market support, the company's operations, which include procurement, storeroom, transport, and overseas economic actions (Ghiani, et al 2013).



Supply Chain Management (SCM) is a more complicated category that focuses on optimizing supply chain procedures using contractors and taking care of tuned cooperation of the involved parties (Christopher, 2011). Its target is to exploit the business's antagonism and cost-effectiveness throughout the full SC network, together with the final customer. The primary difference is that SCM has a customer-oriented approach and service, it controls stock based on the demand and order forecast and administration, command processing, it administers the volume produced output with regards to stock and purchasing plans, provides design-engineering service, and pull material flow management. Thus, we can state that logistics is a part of SCM.

Logistics is known from antiquity, and its initial aim was to move the military provisions to the troops, whereas SCM is a fairly new phenomenon that is hardly 50 years old (Ghiani, et al 2013).

With a view to anticipate the client's demand and meet up the growing pressure of the market, the SCM has to embrace all the actions acting on the cutting-edge tools while

applying the up-to-date methods integrated and coordinated with all the spectre of the SCM operations. The SCM represents a complex of tactics that empowers the united actions from all the participants of the network, starting with the producer, forwarder, storage-keeping aimed at allocation and distribution in the right time, right way and right place, increasing productivity and at the same time lowering the operational expenses (Simchi-Levi, 2000).

Logistics management is crucial for businesses to ensure liquidity, deliver trustworthy and steady results, reduce freight costs, minimize product damage, and provide rapid response to customer demands. Stock lessening is a significant issue, as it can negatively impact an enterprise's liquidity and interest rates. The goal is to balance stock control with customer service, preventing unnecessary surpluses furthermore decreasing shipping expenses.

Timely and damage-free deliveries are the main criteria affecting the customer's opinion and damage the image of the company, as well as in the long run this may lead to the drop of the profit. According to research done by America's Bureau of Consumer Relations, one unhappy consumer may be anticipated to share with 9 individuals on the events that led to the unhappiness. Happy clients, in contrast, tell at least to 5 additional individuals (Mangold et al, (1999), Knauer, V. (1992).

Reducing damage to goods can be achieved through automated material-handling machinery, load management, and efficient logistical packaging. Rapid response is also crucial for businesses, as using cutting-edge information processing and communication technology can improve decision-making accuracy and speed, allowing for flexible delivery of smaller supplies at the place of consumption (Sople, 2017)

## ***2.2 Logistics and Customer Service***

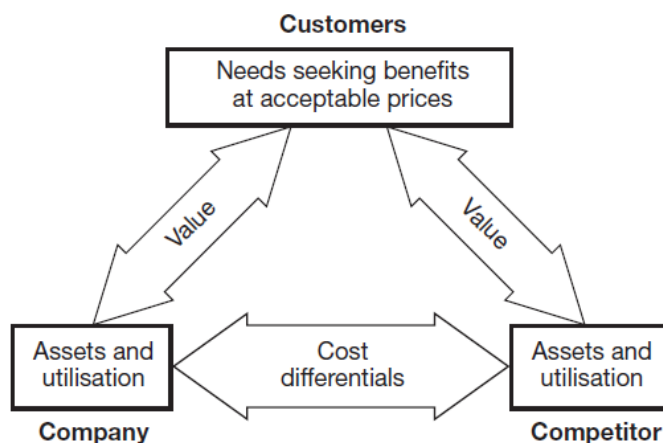
A logistics company's competitiveness is increased not via the capital-intensive development of a new product, but rather through improving the quality of delivery aspects that are crucial to the client. All vendors are obligated to establish their operations on client demand, which is not limited to commodities. Businesses analyse the quality, volume, and type of assistance when choosing a supplier because these are the major characteristics that distinguish the finest market players. The milestone of the SCM after KPMG is the client's satisfaction (KPMG, 2016).

Logistics service is the satisfaction of customer needs, encompassing proper order execution, error-free provision, and continuous improvement. Measuring customer satisfaction is crucial for evaluating service levels in logistics. Special assessment indicators are necessary to track performance and dynamics of integral and partial indicators. Service level indicators vary by enterprise, product type, and client requests. Lead time is a crucial factor in determining service quality. Different approaches exist for analysing supplier quality, including grading systems and consumer surveys. Broad knowledge about service standards is essential for competitiveness. It is possible to divide the market and deliver different levels of service to different market segments, ensuring a competitive edge (Fotiadis, et al, 2022).

A company's service level indicators can assess service effectiveness and compare results with others, enabling setting new objectives. A focused logistics service plan boosts market efficiency and distinguishes a firm, as quality services directly impact market share, costs, and profitability, influencing customer loyalty and potential customers (Folinas, 2018).

Maintaining high service quality is beneficial for both the supplier and the customer. Both aim to reduce time and minimize inventory. Suppliers aim to meet consumers’ needs while accelerating item movement through the supply chain. To achieve order fulfilment time, all supply chain players should receive buyer request information simultaneously. The customer service standard must be set and the minimal overall cost for the enterprise's logistics system determined. This is the fundamental principle of Just-in-Time approach. Adjustments can be made if negative cost deviation occurs. Although overall expenses may rise, sales income may increase due to improved service quality (Bowersox, 1995).

### Competitive advantage and the ‘Three Cs’



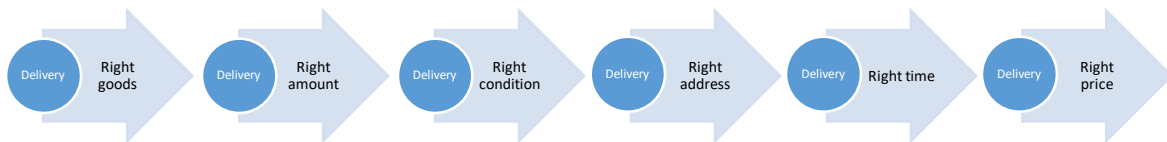
**Figure 3 Competitiveness & 3-C-s Christopher M., (2011) p 4, Ohmae, K., (1983)**

To enhance customer logistics service, initiatives must be implemented. The logistical advantage indicator, which measures the degree of service and the expenses required to obtain it, can be used to gauge logistics efficiency. Therefore the logistical advantage could be expressed as the equation of Quality or level of service divided by Logistical Costs (Bowersox, 1995). Cristopher (2011) on the other hand, sees the vantage point of customer experience in the unity of 3 C: a seller (C) can gain clients’ loyalty (C) through satisfying their needs with regards to competitive prices and service overcoming thus the opponent market-players (C), as per Figure 3.



## 2.3 Order Processing in SC

Every successful business searches for ways to predict and satisfy customer's demand, as well as to implement the order within the time frame, satisfying the client's needs. Any SC order starts with an inquiry, either oral or in electronic form, regarding the type of service, type and size of the load (pallets), delivery time. In case both parties agree on the price and the above mentioned criteria, they sign an agreement based on the payment conditions, time framework of delivery, Incoterms (Folinas et al, 2017).



**Figure 4 The 6 "right" features of the order processing (after Arlington)**

To provide excellent customer service, a supply chain must follow the rule of 6 “RIGHT” characteristics: 1) guarantee the delivery of the right goods, 2) in the right amount, 3) complying with the right commercial state, 4) transported to the right address 5) at the right moment, 6) at the right charge (Arlington, 2007).

Lead-time of an order is a phase covering the start when the confirmation is received until its accomplishment, and in supply chain, it is a time span from the reception of the command until its transfer to the client (Lowe, 2002).



**Figure 3.1** Reducing lead time

Figure 5 Decreasing the order processing time (Folinas D., et al, 2017, p. 63)

It may consist of intermediary steps, like agreeing of the terms and signing the contract, waiting period until the batch is received from the supplier, processing of the

order by the ERP and by the warehouse (picking, assembly, packing, delivery etc.), transit time until the client receives the order.

A new aspect is attributed to the logistics – it is viewed as a part of marketing. Analysing through the prism of integrity, the product development strategy, alongside with advertisement and timely delivery of the services or goods contribute to the major marketing strategy. Marketing logistics is a strategy where logistics and marketing are combined to research market requirements and form a SC. Marketing sets customer service parameters, while sales and marketing data help determine competitive service levels. This approach helps maintain price strategies and achieve profit growth. It was found that almost a half of purchase decisions are influenced by the level of logistical services. The effectiveness of marketing in a company consists of: the effectiveness of the supply chain, consumer's satisfaction, commercial representations and franchises. Therefore, the marketing and SCM interact uniting the company's distribution system, the logistics and the sales with a common target to satisfy the customer in the most efficient way for the business (Folinas et al, 2017).

## ***2.4 Cold Chain & Cold Supply Chain***

The transportation of goods is fundamental part of the SC, and the transportation of chilled products occupies a significant niche of deliveries. There is, though, a significant difference when comparing the transportation of regular goods and perishable goods, as such transportation takes place in special temperature regime conditions. These goods require maintaining a certain temperature regime, humidity and observing specific temperature norms during transportation and storage. When it comes to the logistics of perishable goods, the cold chain (CC) is the answer. It highlights the significance of preserving the goods systematically at the low temperature on all steps of the logistical

network: from the producer, warehouse, reefer, chilling chamber, distribution unit until the home refrigerator (Lowe, 2002). As per Rodrigue J.P., the CC is a SC related to the goods, installations and actions with a purpose to perform uninterrupted deliveries with a certain controlled ambiance, comprising mainly edibles and medical goods (Rodrigue J.P., 2020).

Logistics for perishable goods in a controlled temperature ambiance is often called Cold Chain (CC), and includes transportation, storing and delivery to the final destination (Hundy, et al., 2016). The expression “cold supply chain” (CSC) used in chilled alimentary preservation and shipping as it applies to the entire "network" of processes from initial manufacturing to final showcase. It also responsible for managing all the administrative processes, for planification, production surveillance, and distribution (Óskarsdóttir & Oddsson, 2019). Therefore the two notions shall be used as synonyms.

The focal characteristics of the CSC are: major investment for building the warehouses and equipping with low-temperature installations and refrigeration trucks; strict lead time with severe temperature requirements; constant monitoring of the cost reduction strategies and quality of the products delivered for a successful growth of the CC (Ji & Guo, 2009).

The CSC follows the three-way pattern in five directions of management. For each direction of CSC management there is a specific target. Hence, the 1<sup>st</sup> direction embraces the nature of the product and its boxing, also mentioned as production, fulfilment of the order and wrapping. The 2<sup>nd</sup> direction prioritizes the necessity of the product to meet the health safety measures, that is to be unpolluted, to be stored within the necessary cold temperature ranges to prolongate the shelf life of the product. The 3<sup>rd</sup> one deals with the necessity the product to be shipped, with respect to the lead time, chilled regime and a use

of the appropriate means of delivery. The 4<sup>th</sup> direction obeys the rule of the prompt execution of the delivery, with the agreed amounts and standards. And finally the 5<sup>th</sup> triada foresees that the cold superintendence realizes the necessity of using the appropriate storage locations and reefers with the necessary varieties of cryo-regimes for different types of cold-dependant-products (Aung & Chang, 2023).

The CSC relies on three pillars: competent staff with experience in cold installations, appropriate cooling installations, packaging, and premises, and temperature surveillance devices. These include reefers for temperature-sensitive products, refrigerator spaces for fruits and vegetables, and freezers for storing goods like ice cream, frozen vegetables, and fruits (Rodrigue, 2020). Aung & Chang remind us about the necessity to deploy the necessary management at a certain rate that brings a profit to the cold-chain-services-provider (Aung & Chang, 2023). Temperature surveillance devices measure and register temperature, humidity, and freezer installation operation remotely. Cold track-able devices trail different groups of perishable goods under different cooling requirements. However, improving cargo handling and dynamic system management is crucial to meet consumer needs for healthy food. This includes ensuring temperature control to limit pathogen particles and prevent microbial hazard (Bogataj et al., 2005).

Although the growth of the CSC in Greece has been irregular since the late 1970s, economic crises as well as cuts to European grants for company development have considerably slowed this industry. Therefore we can speak about its rise after 2016, as there was no mentioning of logistics services in Greece in European documents until 2015, leading to the conclusions that their existence and functioning was only locally important or under-developed (Tsamis, et al., 2021).

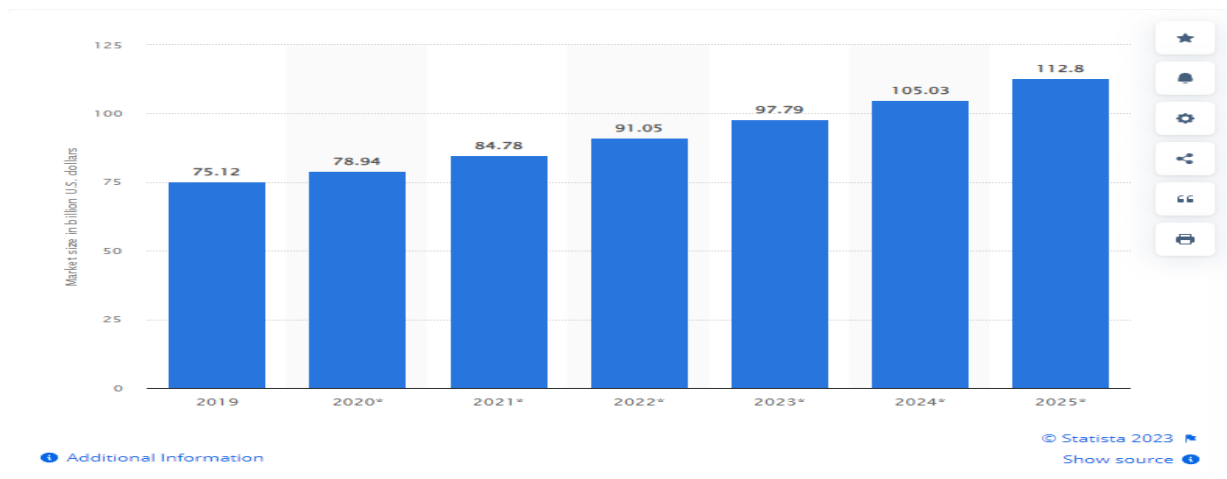
### **2.4.1 History of the CSC**

The use of ice as a mean of preservation was known from earlier stages of the humanity. The first evidence found so far dates back as 2000 BC to Minoan era, and these findings were amphora for chilling used in the basement of the houses found in Greece, on the island of Crete. In the times of Alexander III, king of Macedon, 300 BC, the military spirits were brightened up with snowy chilled beverages; Arabs used snow to preserve the foodstuff carried by the caravans from the 8<sup>th</sup> AD (Koelet & Gray, 1992).

Starting with the XIX century, the ice was imported from the northern countries, like Norway or North America, and sold for the use at home for food preservation. In 1834, Jacob Perkins, the USA citizen, has patented its invention # 6662 in the UK – the vapour compressor appliance (Rees, 2013). Together with other bright physicians, like Faraday, Thomson etc., this thermodynamic invention gave a green light to the appearance of automated chilling (Koelet & Gray, 1992). The first steps towards the creation of the "cold chain" dates back to the 50-ies of the XXth century, when the refrigerator became part of every-day life and when Jones, F. M. has patented his invention of a car with a refrigeration system that has revolutionized the transportation of perishable goods (Jones, 1949).

Due to the difficult economical and political situation after the Second World War, Greece did not take advantage of these inventions immediately. Thus the refrigerators entered the Greek houses in the late sixties – beginning of the seventies. The development of the cold industry progressed steadily with the industrial growth of Greece and urbanization of the cities (Kafentzi, 2012).

In 2019 the European CSC market reached 75 billion \$, and is predicted to achieve 112.8 billion \$ by 2025, as per Figure 6 (Statista Research Department, 2023). CSC includes the carriage of temperature-sensitive goods through the SC channels with chilled wrapping special services that maintain the quality of food i.e. agricultural products, seafood, liable to freezing regimes or medical goods. The Greek cold market is still in its developing condition, lagging behind the international and European in terms of the size of the cold storages and high defragmentation of the sector.



**Figure 6 Size of the CC market in the EU (2019- 2025) (in billion U.S.D.)**

The idea of healthy nutrition that have become popular among the population and people's desire for a healthy lifestyle require high-quality "temperature" logistics. The Greek cold chain industry faces challenges due to poor training, equipment costs, and lack of continuous temperature control systems. Personnel lacks experience in the domain of CSC and often violate established temperature regimes during storage and transportation. The legislation does not provide sufficient detail for transportation and storage requirements, and logistics companies' efforts are not supported by the law. Poorly developed transport infrastructure at significant geographical distances increases costs.

The large number of intermediaries between manufacturers and customers leads to multiple trans-shipments and temperature fluctuations. The need for a frigid supply chain grows as the market for chilled and frozen products develops.

It has been over two decades that the Greek Cold Storage and Logistics Association is trying to raise public's attention and to provide the training and certification for the professionals of the cold industry (GCSLA). In 2022 “The training and certification of workers in the cold chain logistics sector” has been completed within the framework of the programme “Competitiveness, entrepreneurship and innovation”. This programme has been supported by the EU social fund and State resources, covering training to 1,147 employees in 13 regions across Greece (Metafores Press, 2022).

#### **2.4.2 CSC Stakeholders**

The term “stakeholder” may be defined as any association or a party, influencing one another, interacting and inter-influencing each other on the basis of their concern (Heyzer et al. 2017). The CC stakeholders are: professional organizations and unions, academia, governmental bodies, NGOs, suppliers, 3PLs, warehouses, commercial companies, and finally, consumers. For the objectives of this study, a representative sample of existing CC 3PL operating in Greece was chosen.

A thermo regulated storage differs from a regular storage on the operational expenses up to 2-3 times (He et al, 2023). So, a skilled staff and an experienced executive officer are a-must-have to secure an efficient and profitable functioning of the warehouse. The refrigerators need to have a constant surveillance with thermostatic devices, as well as recording the possible temperature alternations and periods of blackouts 24/7 both for security and parsimony reasons.

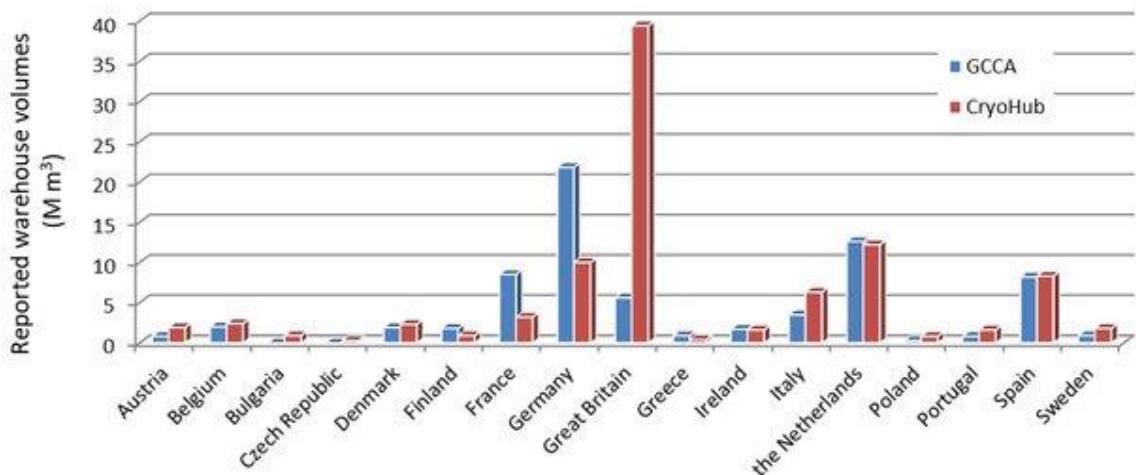
#### **2.4.2.1 Low-Temperature Warehouses**

Chandrasekaran N. and Raghuram G. distinguish two logistic strata: chilling storages and reefers of private or state ownership (Chandrasekaran & Raghuram, 2014). A special category of services is a 3PL, which transports perishables from suppliers to end users. In-time and intact delivery of easily spoiled products is crucial when choosing a carrier/warehouse. Ackerman K.B. mentions four types of cold storages: ordinary, gelato, shock, and cooling. Knowing the type of chilling is essential for planning and avoiding future costs. The building must be heat-proof and temperature-saving, with insulated walls, steel armature, and roofing. (Ackerman, 1997).

The warehouse uses wide-aisle and narrow-aisle technology for optimal processing speed and efficient space use. Modern IT solutions are used for technological process management, including tiered frontal racks, lifting vehicles, and back-up electricity and temperature. The dry warehouse's roof is a thin steel framework with insulation whereas the roof of a cold storage unit is covered with cellulose board, foam padding, and particle board, with a single-ply polyurethane top shielded by an inner gravel layer. That is how the structure supports the cooling system (Ackerman, 1997).

According to Greek legislation, the refrigeration premises must have sufficient equipment for monitoring and recording storage conditions, store frozen food carefully, and maintain ventilation. Cold rooms must be cleaned according to regulations and disinfection rules, and products must maintain their pristine properties. Storage conditions should be similar to chilling rooms, and temperature, humidity concentration condition, and storage time must comply with Article 62 on Preserved Food of the Food and Beverage Code (<https://www.aade.gr/en/himeio/vi-preserved-foods 31.12.1987>).





**Figure 7 Chilled storages in EU (Fikiin K. et al, 2019, p. 5)**

Greece has a feeble infrastructure of the cold storage premises, as the main stakeholders are the privately owned warehouses. Greek cold warehouses' capacity is below 5 000 m<sup>3</sup>, in comparison with neighbouring countries like Bulgaria that has at least double in size premises, and Italy, that has a higher rank Fig.7 (Fikiin et al, 2019, p. 5).

In the majority of cases these warehouses have refrigeration installations. That means that there is a great need of Greek government to undertake either the sponsorship of creation of such infrastructure, or attract the necessary investments to provide the necessary funds and land to create the cold infrastructure. Nabard describes the types of storages that are common in India, that go along with the territory division that could be applicable to the Greek standards. Thus there are public state storages of the countrywide rank, the regional and the community storages. All of them account to the centrally governed organization called Central Storage Concern (CWC). This allows centralized management of the dry type storage of products like wheat, as well as subcontract the cold warehousing from the world-rank leaders like Blue Star, Snowman, Voltas (Nabard, 2011).

#### **2.4.2.2 Cold 3PL, 4PL and 5PL**

Businesses that supply the services upon agreement, as well as transit businesses that additionally provide 3PL services, are included in the 3<sup>rd</sup>-party logistics service industry (Lowe 2002). 3PL subcontractors are essential for supply network activities and commercial and industrial businesses' acceptance of contracting out. They provide logistical solutions like packing, organizing, managing inventories, shipping, and delivery. The shipper or 3PL user is the provider of the goods. They offer perishable cargo storage and processing in cold warehouses using warehouse management software. The warehouses are equipped with fire safety measures, ventilation, backup power sources, risk management plans, and emergency protocols. The cold chain ensures seamless operation of validated equipment and documented activities of certified staff.

The most current developments and predictions for the industry's future belong to logistics-subcontractor segmentation lately carried out by the Economic Unit of ICAP CRIF S.A. According to ICAP, storage services (both dry and cold) contributed for about 61% of the overall value of 3PL services in 2020, based on a study done on non-refrigerated and refrigerated facilities. Non-refrigerated storage services, for instance, accounted for around 48% of the entire market, while chilled storage services accounted for 13%. Distribution services came in second with a 33% share over the same time period, as per Figure 8 (Sideri, 2022).

The last decade is prominent with the appearance of the 4PL providers or 4<sup>th</sup> Party Logistics that offer tailor-made solutions in addition to creating commodities routes from the cargo owner to the receiver and participate in strategic planning. A fourth-level provider combines its organization's resources and capabilities with the resources and

capacities of another logistics enterprise, and performs IT integration between the systems of all commodities chain players to more thoroughly address the client's problem. In addition to carrying out the whole spectrum of logistical operations, the 4PLs coordinate all the SC tasks, freeing up enterprises to handle business. In other words, the 4PL becomes the owner of its customer's logistics chain (Paula et al, 2019).

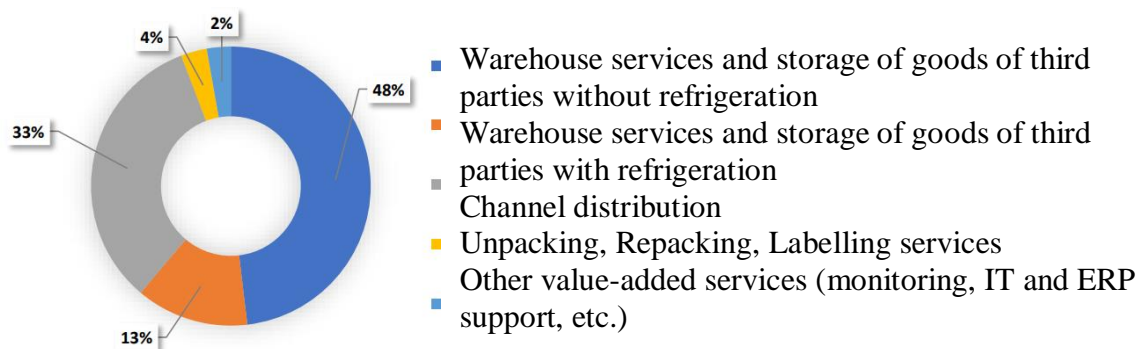


Figure 8 – 3PL Market Breakdown by Service Type in Greece (2020) (Sideri F., 2022)

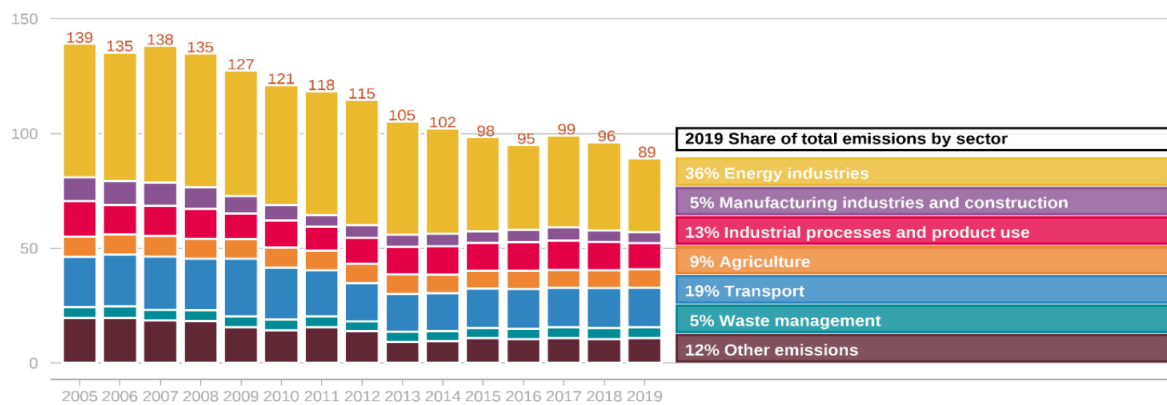
The key distinction between a 3PL and a 4PL is that the latter does not typically have its own storage or reefers, but it does have extensive experience in managerial operations and the provision of IT services. A 4PL's initial action will be to analyse and evaluate the client's existing commodity routes. A 4PL may also select a partnering 3PL, insurance, or any other business whose services are necessary during the entire shipping process. Documentation, stock management, and decreasing the time between order creation and payment are all responsibilities of a 4PL operator. Furthermore, the 4PL operator completes customs processes and advises customers on any logistical issues that may arise.

The contracted services comprising additional logistics solutions into a whole supply chain network through most recent technologies indicate the emergence of fifth-party-logistics (5PL) (Hosies P. et al 2012).

### 2.4.2.3 Transportation

Chilled and frozen products are the two main types of products that require special cool conveyance for shipping via rail, sea, road, and air. These goods are further classified into four categories: vegetation type (e.g. herbs, vegetable, fruit); dairies, ice cream, baked and confectioned sweets; foodstuffs of animal and bird origin, seafood, sauces, herbs, salads etc., drugs and vaccines.

Cold chain shipping (CCS) is a crucial process for maintaining high standards and ensuring efficient transportation of thermolabile products. It involves a network of multilateral components, including producers, reefers, cold warehouses, and temperature sensors. IoT-supported control and trackable device ensure the goods are delivered in pristine condition and in compliance with laws. Modernization of existing systems is essential for efficient routing and transportation (Phadnis et al, 2022).



**Figure 9 Evolution of CO2 pollution by different industries in Greece**

(Simões, 2021, p.3)

Freightforwarding accounts for over one-fifth of total carbon dioxide released in Greece, making it one of the most potentially polluting sources. Cold shipping and preservation are the most energy-intensive processes, resulting in the largest CO2 emissions, Figure 9 (Simões, 2021).

Electronic shipping involves organizing and managing the transportation of commodities using electronic means, such as online platforms for paperwork, monitoring deliveries, and interacting with vendors and consumers. However, the brittle nature of these networks can lead to cyber-attacks, disrupting the natural flow of operations. In 2020, Americold, a major American 3PL of CSC, was forced to cease operations due to a malware infection.

PRC delivers things faster and cheaper than nearly any EU logistics service company using both conventional means and the latest equipment. An order from a major retailer frequently arrives in less 12 hours during a day in a big city like Shanghai, as opposed to less than one hour for orders from local grocery stores. This speed is mostly due to massive, digitalized 3PL integrators as Cainiao is. An intelligent system called Cainiao improves privately held equipment and systems all around the country, including storage facilities and shipping trucks (Grant et al. 2023).

The European logistics market has established some modern methods, while Greek chilled market is lagging behind EU and American indexes. The Greek chilled market has high development potential, but the economy's uncertainty makes it difficult to predict its future. The high cost of running the business is combined with difficulty in obtaining a necessary certification. For example, an ATP certificate is necessary for transporting thermolabile foods and goods, subject to both European and American rules, Fig 10 (UNECE, 2022).



**Figure 10 – ATP Certification Label**

<https://coch.pl/en/atp-plate/> access 22/10/2023

The Treaty on the World-wide Transportation of thermolabile foods and goods, valid since 1976, is revised and reorganized on the yearly basis by the Committee in Charge of the Carriage of Sensitive Alimentaries. Greece plans to transform its freight policy, with the National Energy and Climate Plan (NECP) aiming to achieve power and environment goals by 2030, including transportation goals, and the National Transport Plan for Greece (NTP) laying the groundwork for long-term logistics and service growth (Tsamis A., et al 2021).

### ***2.5 Peculiarities of Order processing in CSC***

The main difference between the order execution in a dry SC and the CSC is the sensitivity of the state of the perishable goods, in combination with augmented pressure of Just-in-time delivery and right temperature. The delay in delivery or remaining outside the specific conditions will result in inevitable deterioration of the quality with a definite loss of the qualities and even to the complete loss of its value, whether it is a nutritional one, or monetary.

The accuracy of information processing is a key figure in the SC, as it is a mile stone in the precise order execution. When it concerns the perishable goods, the precision

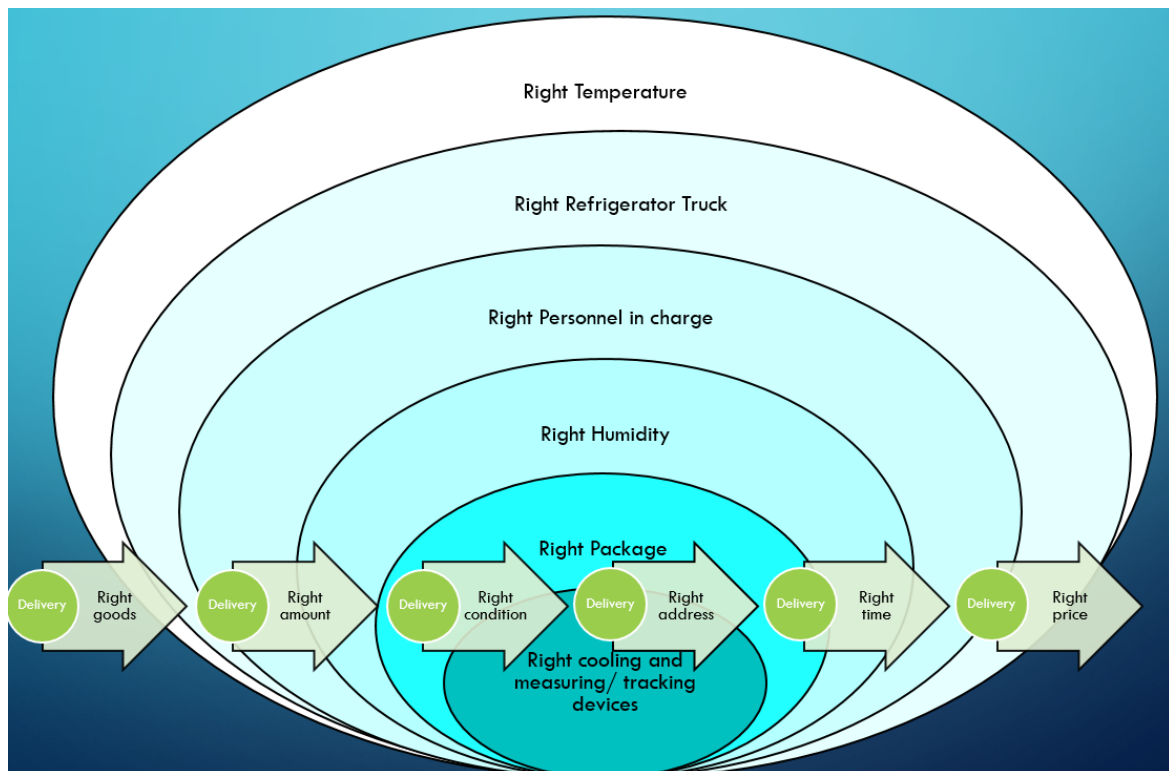
is of vital importance and the prerequisite is the type of refrigerator trailer, the temperature management of the load both within the truck and at the warehouse, as well as special requirements in case of transshipment. That makes the cold chain and the concepts of visibility and trackability of crucial interdependence (Óskarsdóttir & Oddsson, 2019).

Precision and accuracy in order processing are important, but they are not the only factors. Every person involved in the order processing, picking, implementation, and delivery must have successfully completed a CSC-specific training course. The certification of the business and its personnel is crucial to building a strong brand and a successful marketing campaign (Folinas D., 2017). The trained personnel can not only identify the possible problems in the chilled areas or while loading the order to the reefers, but also act instantaneously since the knowledge and speed while decision making are of vital importance. They can also prevent the inevitable wastage in case of incident.

Lately, the idea of "cold trackability" was created, which necessitates the use of instruments and equipment like thermal sensors, thermo/cryo meters, and registers working within timely and thermal regime, primarily for a methodical approach to perishable commodities quality control. The idea of tracking of vulnerable-to-change-of-temperature products like products originating from livestock, vegetative and herbs, desserts and frozen sweets, dairies that are delivered with varying needs for refrigeration. (M. Bogataj et al. 2005). Consequently, the correct processing of a cold order is crucial in its implementation, as the manager in charge for collecting the accurate information on type of cargo, the obligatory temperature emballage, storage and transportation regime requirements, as well as the allowed time for the lead time (Turban et al, 2018).

Whether it is a cold 3PL, or a warehouse providing its storing cold services, a major producer of the chilled/ frozen goods, a medical producer searching for a 3 PL or 4PL partner, the cold order execution comprises the following steps, as per Figure 11:

1. Quotations to a client’s request. The price is determined by the loading location, destination, allowable transit duration, temperature regime, and any unique requirement or certificates required for project completion. The mode of transportation and execution alternatives are investigated to ensure project realization if the offer is subsequently accepted.



**Figure 11 Order Processing in Cold SC (self-designed scheme based on research)**

2. If the client accepts the offer, the following information is meticulously collected:

- A. Full details of the sender/ receiver/ working hours for programming loadings and delivery, freight data, including handling instructions (Temperature regimes, shelf life, and any other peculiarities must be considered during shipping),
- B. The loading strategy, transit time, transit storage and the temperature regimes are programmed in consultation with the partners using the details mentioned above.



C. Monitoring the cargo's transit and notifying on its arrival. In the event of export, the proof (CMR / BL of the delivery together with the thermograph certificate) must be created and sent to the customer along with the shipment.

3. In a case of cold 3PLs, they are in charge for monitoring all the data using an electronic platform for inventory display and assignment of import-export requirements by the client. Inventory is managed following the FEFO (1st Expiration-1st Out) rule per code (Aung M. et al 2023).

- A. A manager appoints an employee/employees responsible for the orders,
  - B. The authorized employee checks the requirements on the screen, and is guided to the location of the item for picking,
  - C. A control is performed, including counting and temporarily placing the mixed pallets if it is a case picking, or taking the pallets directly to the ramp if it is pallet handling.
  - D. The delivery manager provides the order to the vehicle after performing final checks executed by the management system.
4. Transportation, storing or cross-docking is performed with the delivery to the consignee.

- A. Documentation is provided (CMR, thermograph certificate),
  - B. Acceptance of the goods from the client, inspection and feedback.
- A part of the order is maintenance of the Guidelines for Licensing & Operation Sanitary rules, requiring that the Refrigeration storage place of vehicle vehicles must be clean, suitable for food transportation, and resistant to detergents and disinfectants. They should only be used for food, with separate storage areas for other items, and no physical or organoleptic contact to prevent food contamination. Before loading the food-products, cleaning and disinfection are necessary to prevent contamination of the new load, clean non-food items, prevent external factors from contaminating the product, ensure appropriate

conditions for the container or vehicle, and have them certified by competent services for their suitability for the food type being transported (Guidelines for Licensing & Operation, 2012).

Despite the internet age, a provider might compensate for competition by better understanding the customer's needs. Not only online, but additional services may also reap significant advantages from expanded partnership between companies through entering among buyers and producers. Distributors can also become create add-ons to the existing goods and services. The American online grocery store Streamline invented the unmanned receiving of items at the buyer's house. The customized fridge that is placed in the client's garage has 3 sections for various temperature requirements with additional locker for security (Hoover et al, 2000).

There could be introduced the latest market tendencies with cold twist. It is almost a year since the launch of the “Box-it-now” service in Greece, allowing to pick up the orders at any convenient for a client time. It could be applicable to sensitive orders on a smaller scale combining cold installations for cold products storage.

### **2.5.1 Disruption of the CSC and the arising issues**

The failure to sustain any of the cold chain network's liaisons represents a disruption. The European Parliament and Council Regulation (EC) No 853/2004 of 29 April 2004 on food hygiene states that "the cold chain must not be interrupted." The interruptions inflict not just economic damage to a business and a society, but also food loss, leading to food scarcity and even starvation. This is a top priority for underdeveloped countries where the cold chain has not yet attained the required degree of development (FAO. 2011).

The CSC interruptions are affected by geopolitical situations. These risks exacerbate corporate tensions due to their unpredictability. The breakout of the COVID pandemic delivered a shocking lesson to the world, but it also opened the first path toward troubleshooting and overcoming logistical and supply chain network challenges. The war between Russia and Ukraine has caused a second setback to long-standing trade ties. As if that wasn't enough, on 17/07/2023, Russia expressed its refusal to continue the Black Sea Grain Initiative (BSGI), lowering the global grain budget (World Bank, 2023). The October added more tension to the geopolitical situation with a war between Israel and Palestine.

The following are some potential issues in case of the malfunction of the CSC:

1. Failure of the cooling function,
2. Inadequate cooling chamber conditions,
3. Inability to locate required trailers owing to high criteria,
4. Thermograph and recording device damage,
5. A decline in the quality of services supplied,
6. A customer's dissatisfaction,
7. Goods destruction and claims for various damages (financial, loss of trust and credibility),
8. An increase in shipping costs due to a lack of availability or standards.

### **2.5.2 KPIs**

The Key Performance Measures, or KPIs, are the business resultativity metrics that enable the top management to assess and determine if a firm is moving in the correct direction or not (Marr, 2012). The corporation has the compass and understands which

direction to go when selecting the appropriate measurements and the appropriate number of these measures. KPIs must be calculated and their changes monitored in order to offer accurate information, so regular measurements and evaluations must be made.

According to PriceWaterhouseCoopers a company needs 4-10 key performance indicators (KPIs) for an effective measuring of success (PWC 2007). These metrics help to “calculate” the problematic areas and address them directly as the problem appears. Chae votes for a small number of KPIs for a more qualitative check-list of a company measurement performance, and proposes a double-fold metrics system: central and auxiliary. The central KPIs comprise the precision of prediction and “as scheduled” shipment that account for a general SCM operation and are controlled systematically by administration. The auxiliary KPIs comprise more analysed parameters possibly influencing the overall condition of the central ones, and interpret the reason of increased or decreased levels (Chae 2009).

For CSC the chief markers of successful completions relate all to alternation of temperature conditions and possible deterioration of the product or its quality, and therefore could be mentioned as follows:

- 1) Marker of exposure to non-compliant temperatures. As a rule of thumb, the alternations in temperature conditions or a lengthy exposure to non-compliant thermal conditions reflect the quality of storage and shipping. Thus, this meter could be calculated as the delivery with thermal interruption divided by the overall number of thermally-administered deliveries. The closer the value is to 1, the better quality of chilled delivery/storage is.
- 2) Marker of itinerary efficiency means timely delivery

3) Marker of 100 % intact delivery of the perishable batch and as scheduled

CSC stakeholders must adopt general CSC criteria for successful operation, including routine evaluations, well-trained employees, advanced technology, detailed records, and professional consultations. Regular temperature checks and examinations are essential to prevent temperature fluctuations. Up-to-date freezers and temperature monitoring devices are necessary to prevent costly errors. Detailed records of temperature and equipment maintenance are also crucial for compliance. Professional consultations are recommended when unsure about conformance.

The CSC has yet to attain the required level of development. The biggest challenges include delays in supplying the essential tools and installations, such as the deployment of reefers, which can take up to 1-2 years. The hazards and rapid price changes must always be mentioned in the agenda (Global Cold Chain Alliance, May-June 2023).

## **Chapter 3 – Research Context – Theoretical framework**

### ***3.1 Purpose of the Work and Research Questions***

The key purpose of the dissertation is to investigate what are the genuine problems related to the order implementation in a company that deals with cold service, what are the ways to resolve it, suggestions and solutions. To find these answers and therefore provide some suggestions, a questionnaire-based-research was prepared implementing the Business Process Methodology (BPM) approach (Parmenter, 2019).

In this research we collected the material from cold 3PL businesses and companies involved in CSC. This research was implemented in 18 companies acting on the Greek market: cold-warehouse services, chilled products producers or processing entities, and cold 3PLs.

Before choosing the research methodology, there was performed a thorough diagnostic investigation of the researchers, scholars and scientists, both Greek and foreign, who have dealt with the subject of cold chain and 3PLs (Hague P. et al., 2016). These observations are mirrored in scientific publications, periodicals, high school papers and symposiums. World-wide web sources, particularly the scholar works, serve as a qualitative well of materials of credibility and evidence-based. It should be pointed out at this point, that most of the information in this paper is based on scientific articles from the expert research websites such as Science Direct, Emerald, Elsevier, as well as professional publications of Pearson, Kogan Page, Springer, Wiley and etc., and are listed in the final part of the thesis in detail.

### **3.2 Elaboration of the Research**

#### **3.2.1 Research Methods**

The basic goal of this study is to sketch a general and basic picture based on qualitative and selected research data. The present study examines the use of specialized programs while attempting to explain the market state and upgrade systems such as the use of ERP, WMS and RFID for stakeholder engagement. It offers the opportunity to have a representative sample of the population of cold chain processing companies and to develop theoretical hypotheses with specific control of variables capable of solving modern containment problems completely, and thus develop the cold market through the use of questionnaires. Ultimately, this allows the goal to be tied to the exploration of broader industrial patterns. A range of methodologies were applied to carry out the analysis that served as the framework of our strategy guidance:

Evaluation of the scientific publications. We analysed current scholarly journal publications and policy studies on CSC, both international and Greek, with a focus on Greek economy in general. We also studied related material in economics and industrial organization expertise, International experience research.

Research into global experiences – a comparing practices study was performed, concentrating on lessons learned in Greece and abroad.

Questionnaire. We have applied the methodology as suggested by Deming – the Business Process Modelling that advises the review of the problem, discussions with the stakeholders, key factors of the order process fulfilment, and what the suggestions for improving the state of things are.

A qualitative study looks for complexity as well as accuracy of the data frequently using a small specimen, as opposed to statistical analysis, that is primarily concerned with

larger numbers. The line separating qualitative and quantitative studies cannot be determined with absolute certainty by numerical data, thus 30 to 50 answers is often considered a qualitative study, whereas more than 100 responses is considered a quantitative study. The qualitative methods were used for the research as they helped in extracting more information about the research topic. Qualitative research methods are the set of interpretative and investigative approaches used to describe and interpret the topic to be examined (Hague et al., 2016).

One of the assets that the qualitative questionnaire provides is the possibility to track the answer with the help of the prior findings exploration, attributing visibility, as well as the detailed presentation of the accomplished study. Another is the simplicity in understanding the research topic and the saturation in the answers received. As a result, sharing interim outcomes is critical (Jonker & Pennink, 2010).

### **3.2.2 Questionnaire Design**

For the preparation of the questionnaire, a review was performed based on a study of Greek and international literature and articles. The questions used in the questionnaire were, for the most part, direct, structured open to increase the participation and the responsiveness level (O'Cathain & Thomas, 2004). The research of this paper has been carried out with a questionnaire comprising 15 open-ended questions to allow the participants to add possible comments (Bradburn et al. 2004). The questions were elaborated based on BPM Practises, and addressed to the cold businesses:

- How order fulfilment is performed?
- What are the critical success factors?
- What are the main problems?
- What are the suggested solutions? (Jeston & Nelis, 2013)



A three-part structured questionnaire was used. The first section asked the participants about their professional status (5 questions), the second section asked how the orders were processed in the CSC (8 questions), and the third section asked about their suggestions and solutions for fixing the issues with order processing in the cold chain (2 questions). The open-ended type of question has the ability to boost responses, expand answers to predetermined statements, and enable participants to discover fresh subjects uncovered by the closed-ended inquiries, whereas the close-ended or multiple choice help to eliminate the answers from a group of respondents whose who has a smaller weight in the total research elaboration (Ricci, et al., 2019).

### **3.2.3 Sampling**

The sample was taken using the convenience sampling method. The population was 30 CSC businesses or cold 3 PLs. 18 companies have answered the questionnaire, and we thank them for their feedback. 18 responses are considered a satisfactory rate for the population as it represents 60 % of the research sample. For our study, it was considered as an optimal choice for the questionnaire to be answered by executives of the cold 3PL companies and companies CSC members, CEO and heads of Sales, Warehouse and Logistics departments. We are grateful for their responses, time and effort taken to provide the precious information, help in the research and the valuable insight into the problematic.

## ***3.3 Conducting Research***

The data collection process was done using questionnaires in order to extract as much valid information as possible. The questionnaires were sent to 30 Greek companies

via email using the Google Form template or Word file. It was followed up with a telephone call to validate the receiving of the questionnaire and the data received.

In the table below the names of the businesses-respondents acting in the Greek cold market are listed in a chronological order.

**Table 1 - List of Respondents to the Questionnaire**

#	Date of response	Company Name
1	02/10/2023	Anonymous cold 3PL company
2	03/10/2023	Cold Stores Alpis Lambrouli – Papagianni S.A.
3	05/10/2023	Barba Stathis S.A.
4	06/10/2023	Makios Logistics
5	10/10/2023	Kayak Ice Cream
6	13/10/2023	Galifruit Group Greece
7	13/10/2023	Anonymous cold 3PL company
8	16/10/2023	FDL Group (DC2) Greece
9	25/10/2023	Anonymous International Forwarder Greece
10	26/10/2023	Anonymous International Forwarder Greece
11	30/10/2023	Alaska Cold Stores S.A.
12	06/11/2023	Fairplay Forwarding S.A.
13	21/11/2023	Provil S.A.
14	23/11/2023	Anonymous Meat Storage and Processing Company
15	28/11/2023	Transhelit SA
16	30/11/2023	Anonymous Cold 3PL company
17	30/11/2023	Anonymous Cold 3PL company
18	04/12/2023	Anonymous Cold 3PL company

### ***3.4 Research Limitations***

There are some limitations of the qualitative method of research. For instance, the desk investigation although providing an enormous amount of information may have certain gaps and inaccuracy. Therefore, questionnaires were sent to the target groups and the professional of the respective area with the scope to eliminate any inaccuracy and fill in the blank spaces.

Due to the strict time framework of the winter semester in combination with the increased load of work of the CSC stakeholders and the augmented pressure and accessibility, the sample received is small, yet satisfactory for the research.

The limitations imposed by personal information sharing, as well as a reluctance to share any information because of competitive or sensitive reasons, the percentage of the responses was 60% from the total number of questionnaires sent. A general tendency is to consider a social or market research feedback over 50 percent to be a satisfactory result, whereas 60 and 70 percent are viewed as a good result (Sivo, et al., 2006).

It is significant to note that, even in 2023, not all companies have a website or email address to support online research and communication. It was also challenging to receive a response from some companies since the owners of the company were responsible for managing the cargo, responding calls, and resolving any problems that could arise. Without secretarial assistance, these situations were typically challenging to gain a response from. There were also replies containing unwillingness to share any kind of information with us, or no reply at all.

The researches covering the analysis of the CC relate mainly to the general notion, services, and the difficulties arising from the CSC, to the peculiarities of the handling of Fruits, vegetables, meat and frozen delicacies. A big wave of investigations has been done

lately about the medicaments and the handling of the vaccine after the outbreak of the COVID pandemic. A new tendency is analysing the CSC through the sustainability prism, and therefore there is a number of researches dedicated to the Green Cold Chain. There were no investigations undertaken related to the order processing in the CSC that can be rated as a root problem, and therefore a key factor for the solutions. That made us undertake the current research with the aim to provide in-depth analysis and the objective to sample it on the Greek cold 3PLs.

### ***3.5 Content of Questions***

This questionnaire is about a research on cold chain companies and the data collected will be used ONLY applicable to the dissertation " *Order processing in a logistics service company: the case of the cold supply chain* ".

The 1<sup>st</sup> group of questions that could be described as professionally-demographic, consisted of the questions below:

1. What is your level of education? PhD [ ] MSc [ ] Bachelor of Arts [ ] Bachelor of Technology (TEI) [ ] Other [ ]
2. What is your position in this company?
3. What is your role and your responsibilities in this company?
4. How many years have you been in your current position and in this company?
5. How many years have you been working in general?

The 2<sup>nd</sup> group of questions asked how the orders are processed in the CSC, and the main important criteria and problems that might occur (8 questions):

6. Describe the primary procedures in completing a significant customer's order (volume – quantity – history of purchases/ yearly turnover).
7. Who is involved in fulfilling the ordering process?

8. Which order forms/blanks do you use?
9. Do you use technological and special systems?
10. What are the important criteria in order execution?
11. What are the difficulties that you encounter fulfilling an order?
12. What are the consequences of these issues?
13. What are the most common customer complaints during order execution, and how does this affect the customer's opinion?

The 3<sup>rd</sup> pair of questions asked about the suggestions and solutions for fixing the issues with order processing in the CSC (2 questions).

14. What solutions do you suggest for dealing with the issues mentioned in question #11?
15. What suggestions do you have for improving the order execution process?

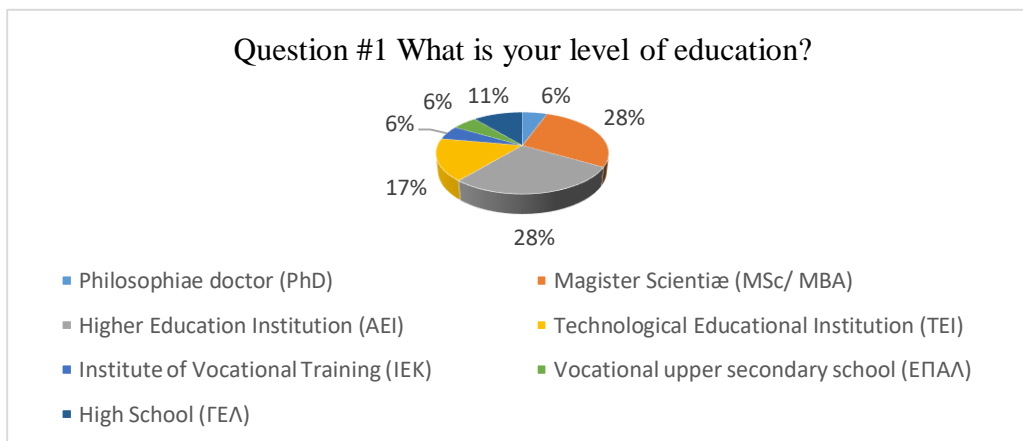
The names of the respondents will remain confidential except the replies and findings that will be mentioned in the next chapter.

## Chapter 4 – Findings

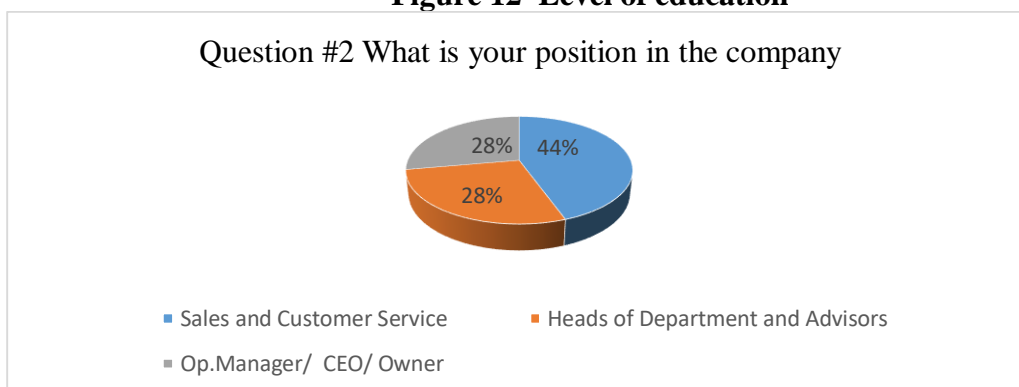
### 4.1 Study of the answers provided to the questionnaire

#### 4.1.1 Responses to the questions

The majority of replies to the *Question #1* “What is your level of education?” was a “Master” or “Bachelor Degree” (24 % and 24 %). A significant number have graduated from a Technological Institutions or High Schools (18 % and 12%), 2 have received a vocational training, and 1 person possesses a title of PhD. That proves that the feedback was given by professionals with a higher education.



**Figure 12 Level of education**



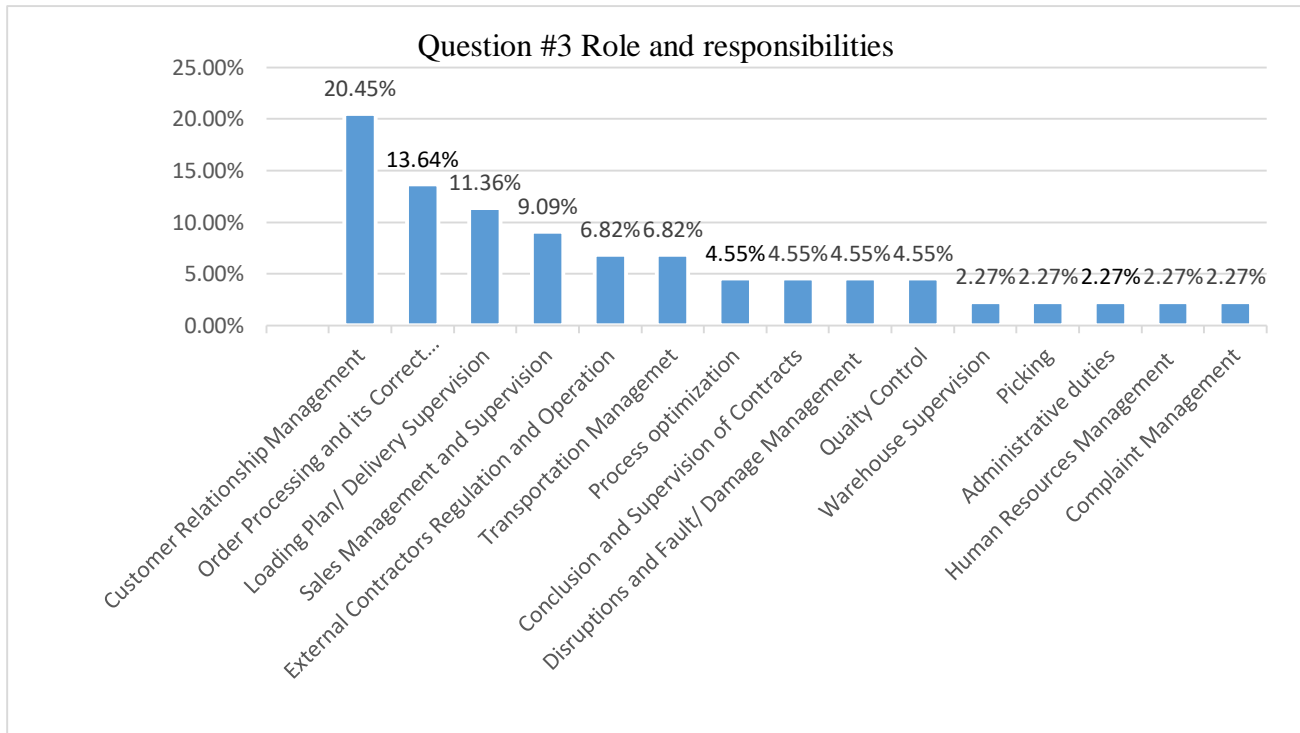
**Figure 13 Position in the company**

According to answers provided to the Question # 2 “What is your position in this company?” the majority of the respondents were: Sales and Customer Service department

managers (47 %), Heads of Department and Advisors (5 persons), and Operations

Manager/ CEO/ Owner (4 persons).

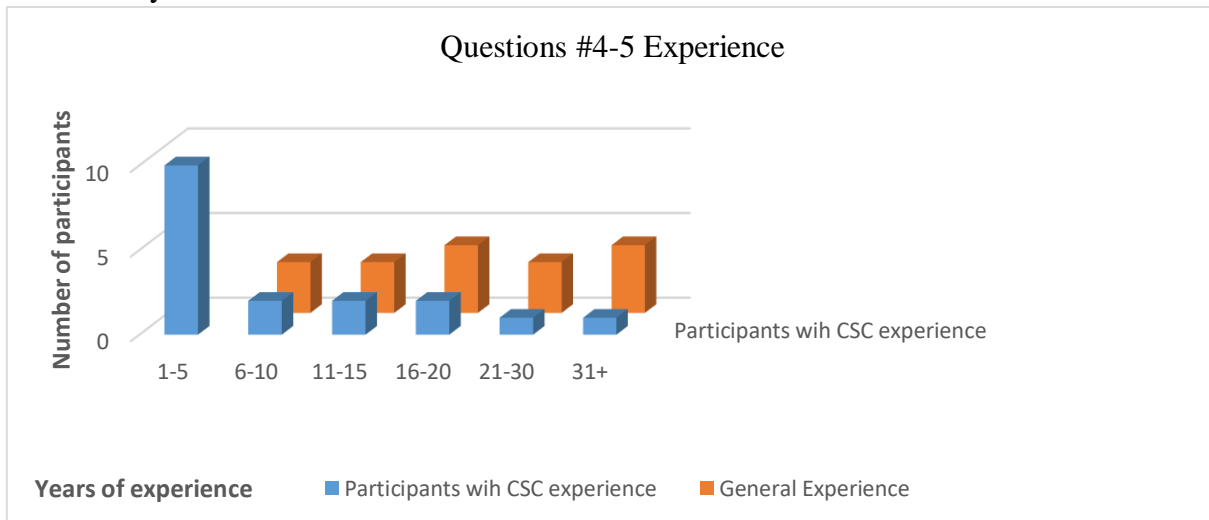
The most of the respondents of the *Question #3* have declared that they were responsible for Customer Relationship Management (20 %), Loading Plan & Supervision



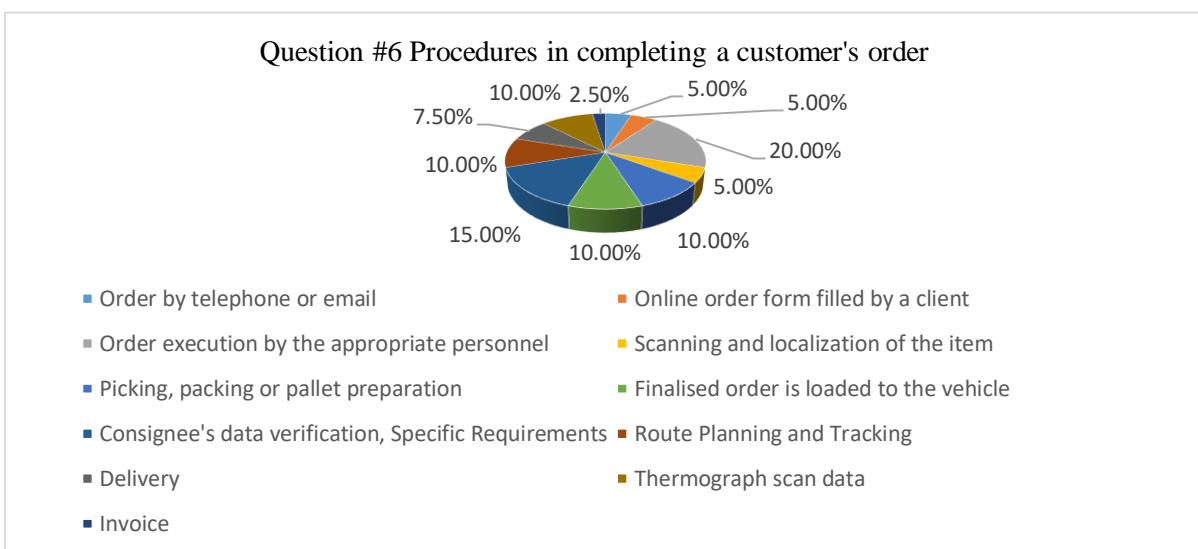
**Figure 14 Role and responsibilities**

(12 %) and Order Processing and its correct implementation (15%). External Contractors Regulation (7.5 %) and Operation and well as Sales Management are (7.5 %). The rest of responsibilities mentioned are Quality control, Administrative duties, Conclusion and Supervision of Contracts, Warehouse and Logistics Management, Picking, Process optimization, HR, Complaint Management and Reduction of Administrative costs.

The biggest part of the respondents of the *Questions #4-5* have experience in the CSC up to 5 years, 2 persons have 6-10 years, 2 persons have 11-15 years, and the rest have experience over 20 years. The general experience is marked with the orange colour on the Diagram 14. The general experience prevails the CSC experience due to the relative novelty of the CSC on the Greek market.



**Figure 15 Experience**



**Figure 16 Procedures in completing a customer's order**

The respondents of the *Question #6* have described the main stages of the order fulfilment, and the list included the following:



Order by telephone or email	Scanning and localization of the item
Online order form filled by a client	Invoice
Consignee's data verification, Specific Requirements	Route Planning and Tracking
Order execution by the appropriate personnel	Finalised order is loaded to the vehicle
Picking, packing or pallet preparation	Thermograph scan data
	Delivery

According to one of the Anonymous respondents of a cold 3PL company, the main procedures in completing a customer's order are cited below.

“1. Quotation is provided depending on the place of loading/ destination/ acceptable travel time/ temperature regimes of the cargo/ distinctive specifications if needed or certificates for the execution of a project;

2. In case of order, the following data is obligatory:

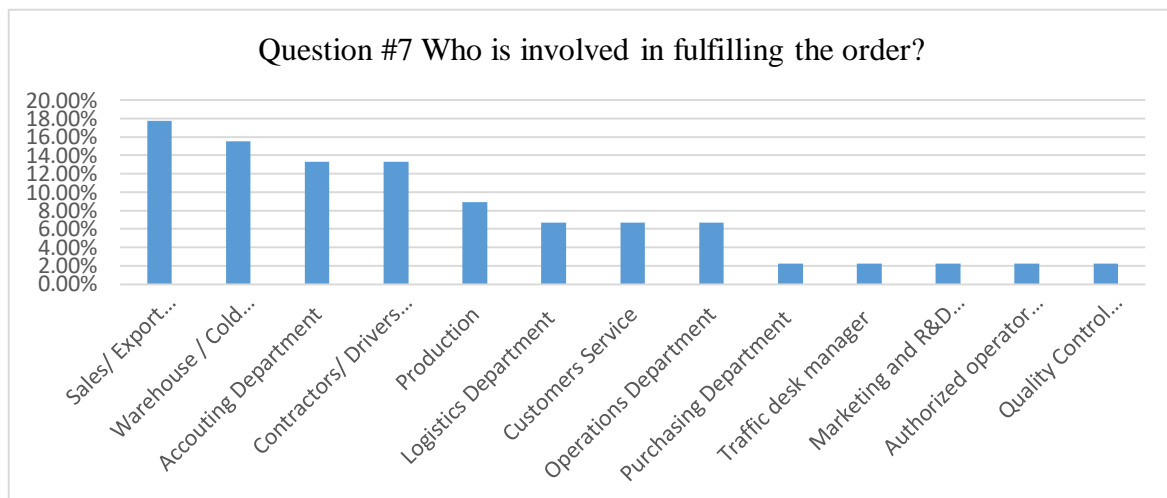
A. full details of the consignor / consignee / time of loading - pick-ups

B. Full cargo details with specification of its management (Temperature ranges, Shelf life or any other peculiarity are taken into account during the storage and transportation).

C. Planning of the shipments with partners.

D. Monitoring of the delivery progress and informing upon the arrival. Sending the proof documents (CMR / BL of delivery together with the thermograph certificate).”

The biggest quota of the respondents of the *Question #7* mentioned the Sales or Export department as the main facilitator of the order processing; second came the Warehouse, and third was the Accounting department, leaving Production, Logistics and Customer Service on secondary but still important places. What attracts the attention is the fact that only 1 respondent mentioned the participation of the Authorized operator with RFID device.

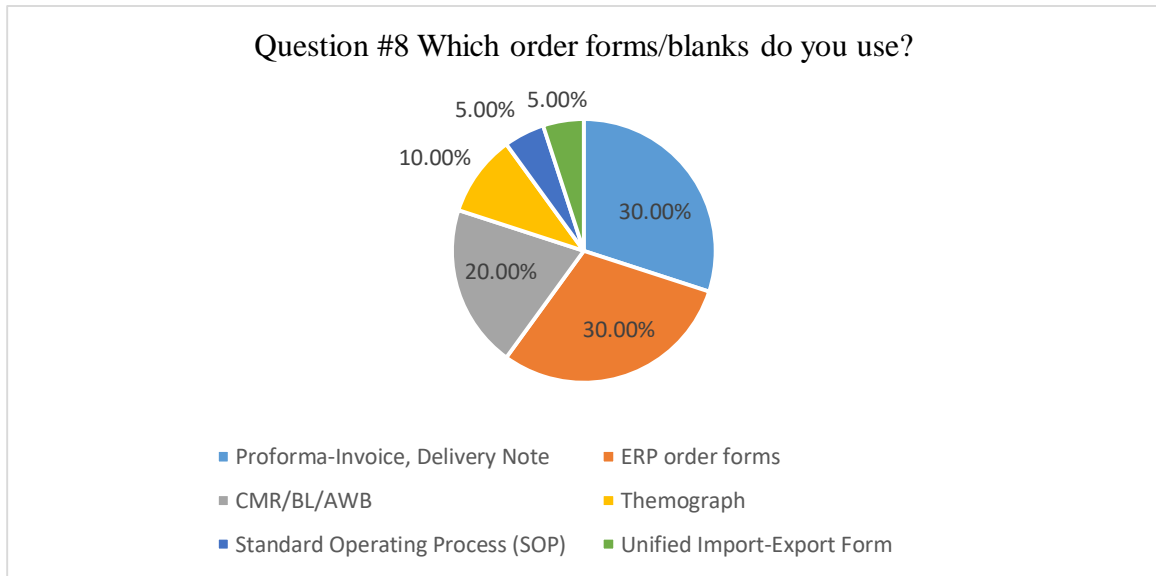


**Figure 17 Who is involved in fulfilling the ordering?**

One of the Senior Managers of Provil SA have cited the following departments involved in the order processing: “Production Unit, Purchasing Division, Quality control subdivision, Sales Team, Warehouse & Logistics subdivision, Accounting, Marketing and R&D executives”.

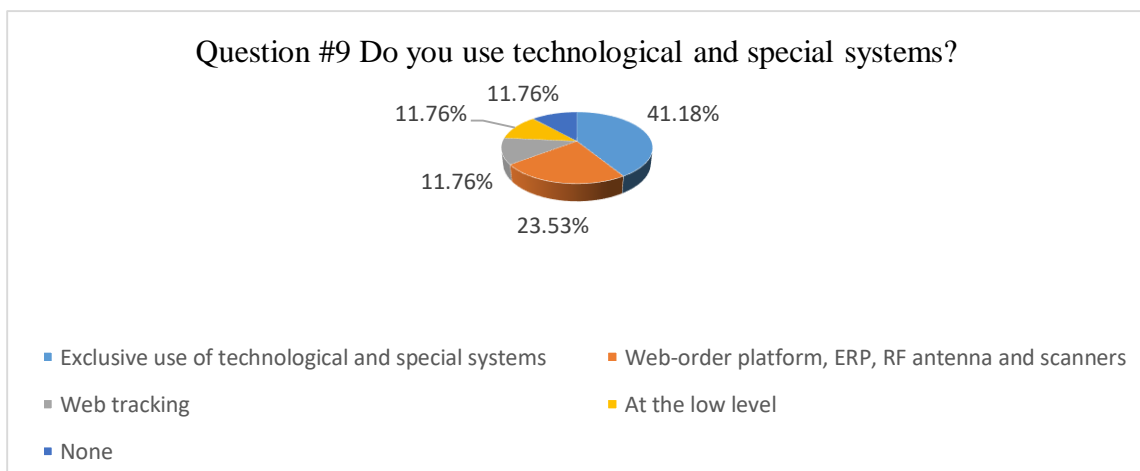
The highest proportion of the respondents to the *Question #8* regarding the Order Forms mentioned Proforma-Invoice, Delivery Note as the main form for implementing the order, as well as ERP electronic forms. Significant part of the replies contained CMR/BL/AWB and Thermograph Data results. Still there were replies with a Unified Import-Export Form. The Senior Advisor of the cold 3 PL “ALPIS” Cold Stores S.A.,

mentioned “Order form and delivery note” as the main order forms used for order fulfilment.



**Figure 18 Which order forms/blanks do you use?**

Over 40 % of the respondents to the *Question #9* state that they use exclusively the technological or special systems while implementing the orders, 23 % use Web-order platform, ERP, RF antenna and scanners, almost 12 % use web-tracking. The remaining 23 % declare they use at the low level or none. “Everything is done electronically, via email, SAP for invoicing and Aberon WMS for order management in the warehouse”, tells one of Senior Managers of Barba Stathis S.A.

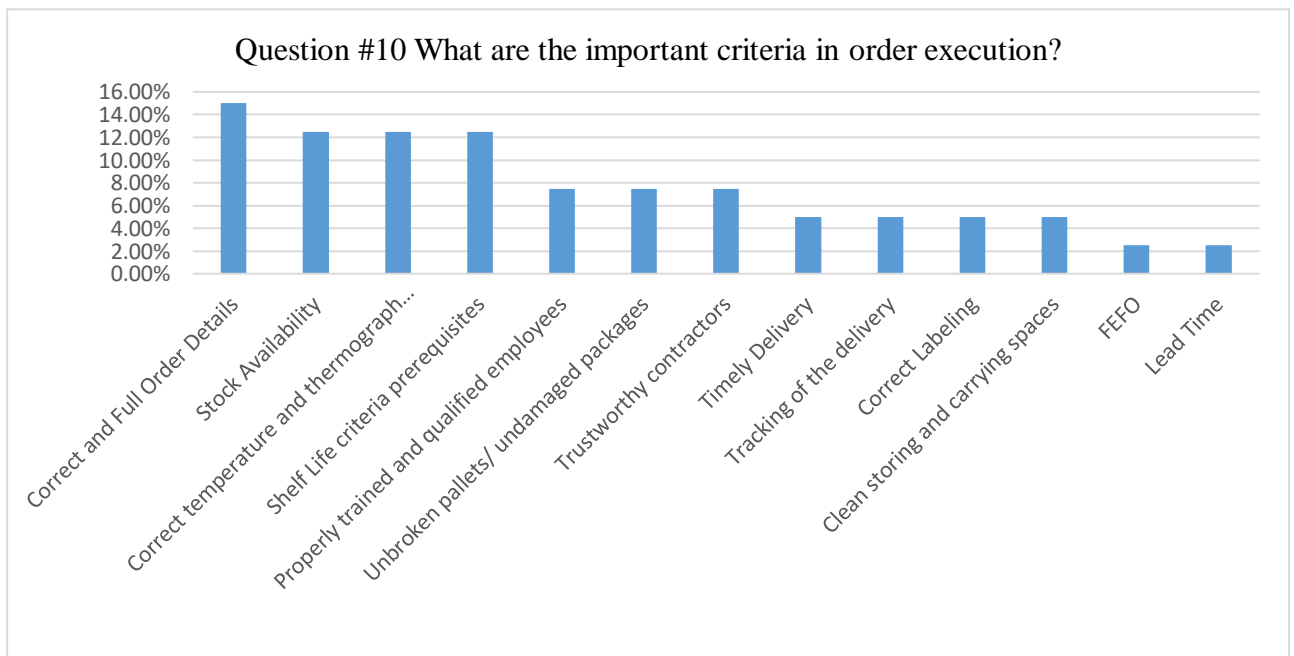


**Figure 19 Do you use technological and special systems?**

Based on the replies of the *Question #10* the most crucial criteria are considered to be the Correct and Full Order Details, Stock availability, Correct temperature and thermograph use and maintaining the correct Shelf Life conditions (over 50 % in total). A moderate number of replies have gathered the Properly trained and qualified employees, Unbroken pallets/ undamaged packages and Trustworthy contractors (over 20 % in total). Timely Delivery, Tracking and correct labelling have attained only 15 %. What is interesting, only 1 reply was given with FEFO and lead time. The critical factors in the execution of an order; as per one of the Senior Managers of an Anonymous cold 3 PL are:

“1. Knowledge of the basic parameters for correct and safe transportation and storage (temperature regimes, shelf life or combination of loads, chamber condition, manufacturer’s specifications);

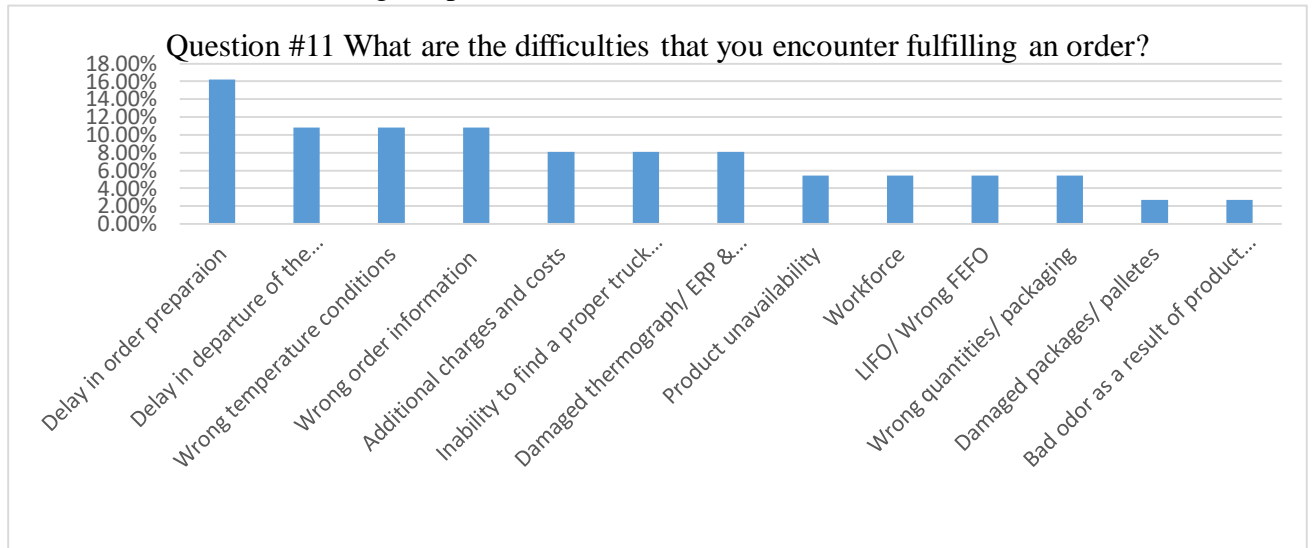
2. Monitoring and compliance with the above mentioned requirements.”



**Figure 20 What are the important criteria in order execution?**

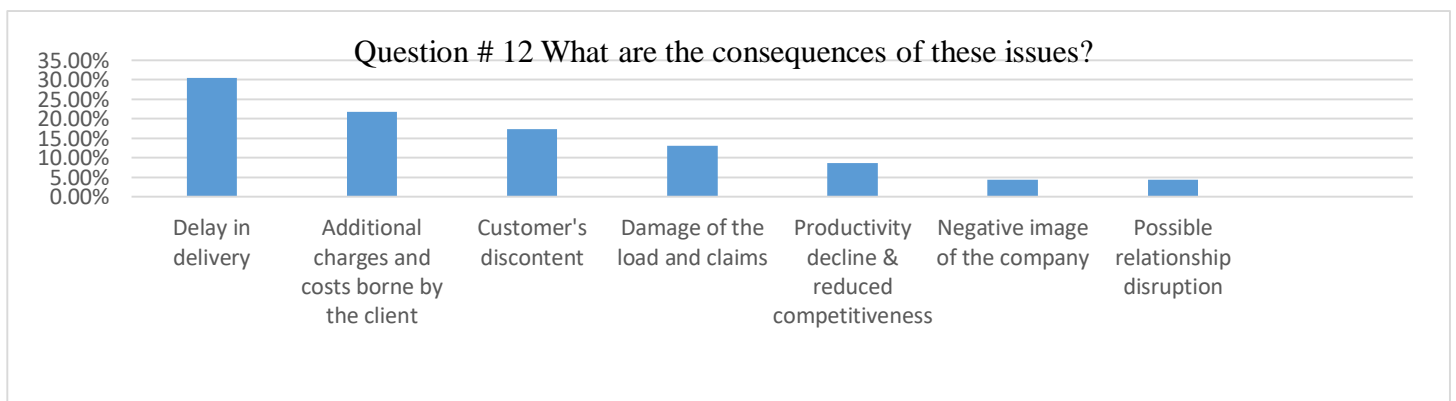
According to the replies of the *Question #11*, the cold service companies encounter often the following difficulties: Delay in order preparation, truck/ vessel departure, Wrong temperature conditions and wrong order information (almost 50 % in total). Additional

charges and costs, Inability to find a proper truck due to high requirements, Damaged thermograph/ ERP & WMS desynchronization have a total weight of 25 %. Product unavailability, workforce, wrong quantities, LIFO and noncompliance with FEFO have a total weight of 20 %. Damaged package and Bad odour as a result of product deterioration are the most minor among the problems – 5% in total.



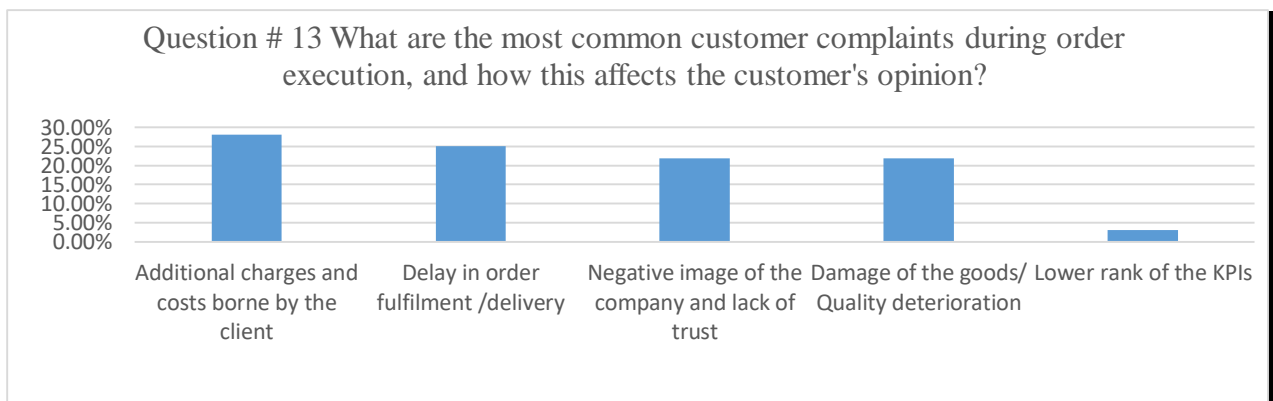
**Figure 21 What are the difficulties that you encounter fulfilling an order?**

One of the Managers of the Anonymous 3PL Company mentions “1. Cooling malfunction; 2. Incorrect chamber condition; 3. Failure to find the correct reefer, when there are high specifications, 4. Fault in thermograph data recording” as some of the possible difficulties that may arise during the order processing.



**Figure 22 What are the consequences of these issues?**

As per replies received for the *Question #12*, the consequences of the abovementioned difficulties are: delay in delivery (30%), additional charges borne by the customer (20%), customer’s discontent (15%), as well as damage of the load, claims, negative image of the company and further commercial relationship disruption. One of Kayak Ice Cream Executive Manager mentions “Deterioration of service quality in the client's perspective, 2. Customer unhappiness, 3. Destruction of products and claims with various negative implications (financial, loss of trust and loyalty)”.

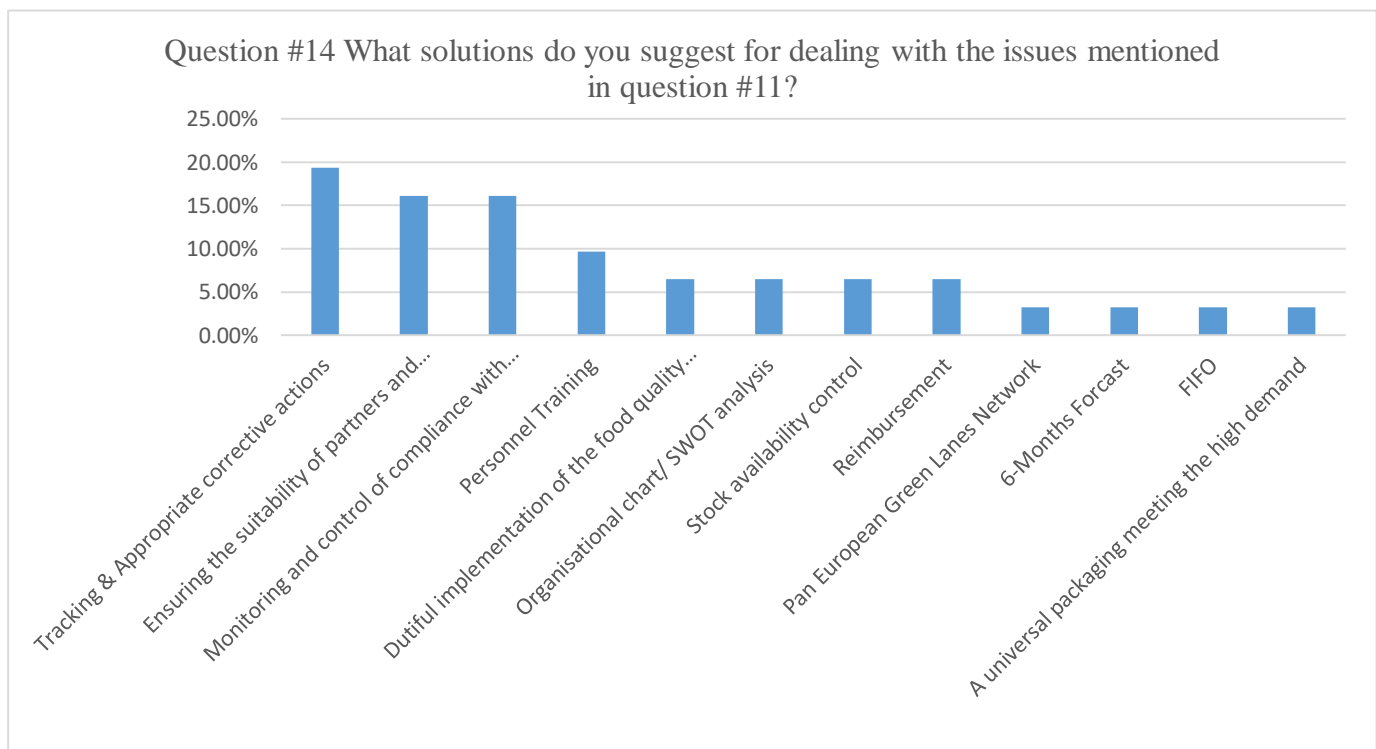


**Figure 23 Complaints relating to order execution ad customer's opinion**

As per replies received for the *Question #13*, the most common complaints are: additional charges borne by the customer (28%), delay in order fulfilment /delivery (25%), Negative image of the company and lack of trust (22%) as well as damage of the load (22%), and lower KPIs (3%). One of the Managers of Makios S.A. mentions “Delays in giving the finest service to the client, cargo damage during collection/loading have a negative impact on the total rank of the KPIs.”

The solutions that the participants suggest for the *Question #14*, are as follows:

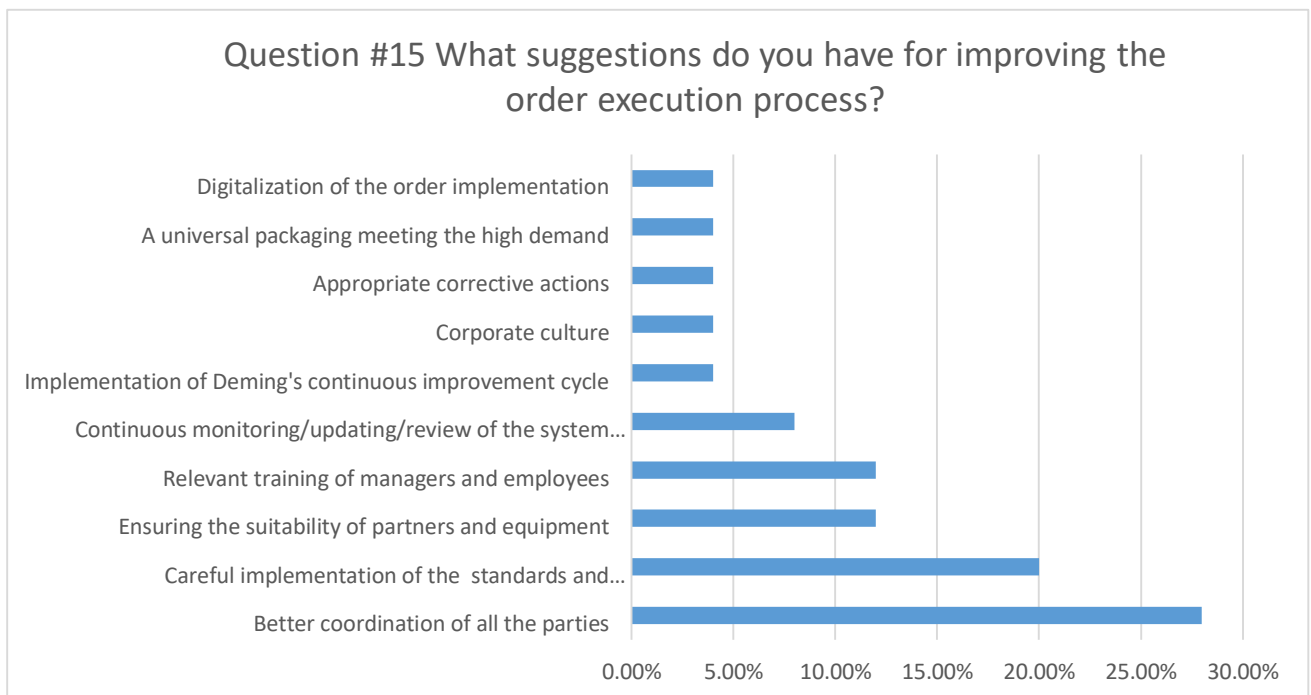
Tracking & Appropriate corrective actions (19%), Ensuring the suitability of partners and equipment (16%), Monitoring and control of compliance with the agreed terms (16%), Personnel Training (10%), Dutiful implementation of the food quality and safety management manual (6%), Organisational chart/ SWOT analysis (6%), Stock availability



**Figure 24 Solutions**

control (6%), and Reimbursement (6%), and also mentioned the creation of the Pan European Green Lanes Network, forecasts, FIFO and A universal packaging meeting the high demand (in total almost 13 %). The chief executive officer of Alaska cold 3PL acting in Greece, suggests “Dutiful application of the food quality and safety management handbook, along with its ongoing assessment and improvement in response to new developments. Training, organizational charts, continual improvement, analysis of issues and dangers, and communication routes with internal and external parties are all examples”.

The improvements suggested in *Question #15*, are: Better coordination of all the parties (28%), Careful implementation of the standards and temperature requirements (22%), Ensuring the suitability of partners and equipment (12%), Relevant training of managers and employees (12%) and Continuous monitoring/updating/review of the system processes (12%). The rest of suggestions refer to the corporate culture, Deming’s Circle, Appropriate corrective actions, Digitalization of the order implementation and universal packaging meeting the high demand (in total 20 %). The CEO of Alaska, suggests “The thorough implementation of a documented management system in accordance with the needed standards, following applicable training of managers and other personnel, and ongoing monitoring/ updating/ review of the system procedures. Deming's continuous improvement cycle shall be implemented on every step of CSC”.



**Figure 25 Improvements**



## 4.1.2 Thematic Analysis

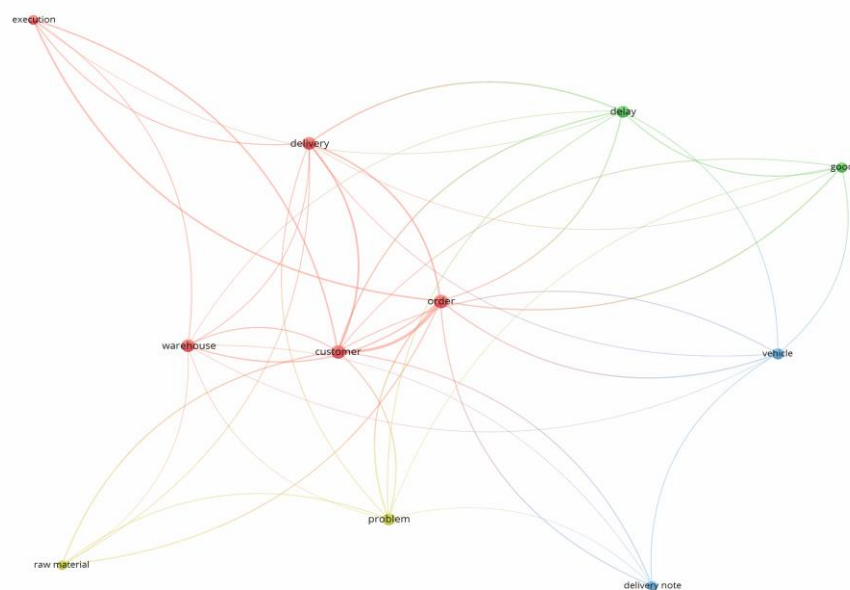
### 4.1.2.1 Binary-Based Exploration

The evaluation of quality is increasingly being used in scientific domains. The use of specific programs is required to demonstrate that the study was carried out appropriately, as well as to authenticate the results and validate the conclusions (Nowell, et al., 2010). Our thematic Analysis was performed with the help of VOSviewer, a program analysing the frequency and relevance of the terms.

We first collected the replies provided by the respondent into a single text file and uploaded it into the VOSviewer for analysis. Secondly, we applied a binary-based analysis, and we received a diagram of the most common terms and their relation. Below there are illustrated the 4 major knots resulting from binary counting a limit of 4-times-happening of the terms. The four colours represent 4 separate knots.

The biggest knot is #1, and it contains “Customer”, “Order”, “Delivery”, “Execution” and “Warehouse”, which are the core of the research problematic.

VOSviewer analyses the mapping or relative position and gathering / colouring of knots.



**Figure 26 VOSviewer Diagram of Relations and Knots - Binary Calculating**

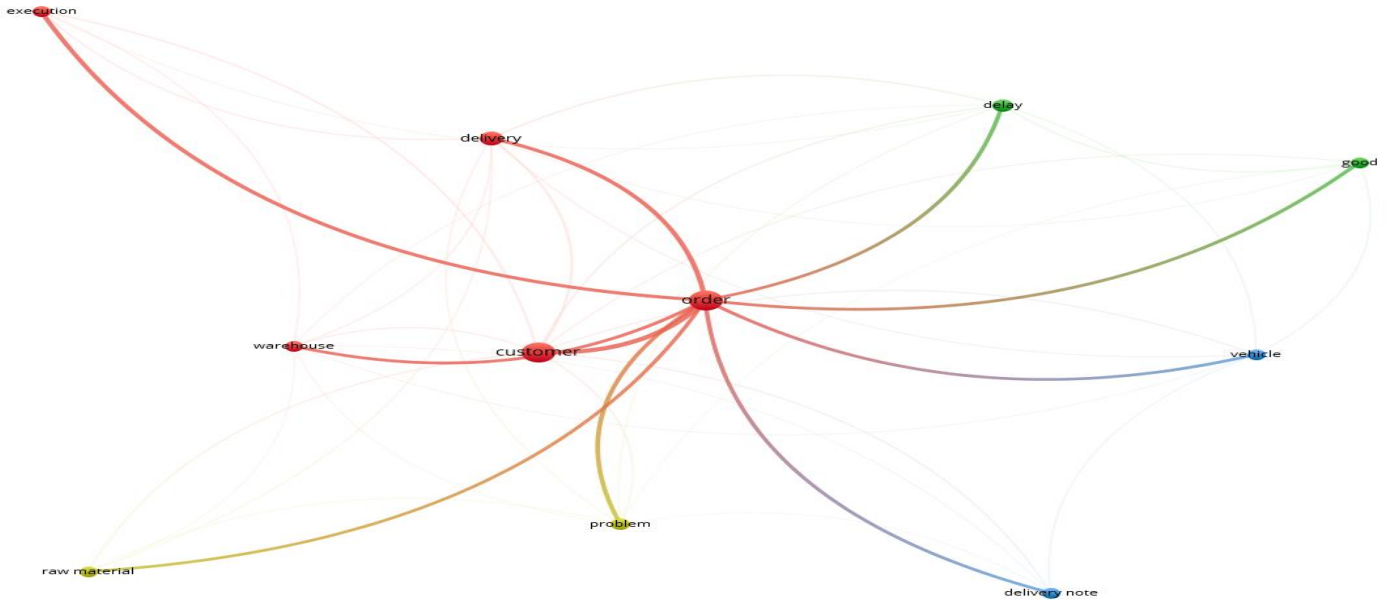
The result of the diagram located to the **left upper** corner usually shows the core of the problem or the research (Waltman et al., 2010). It attributes red colour to the adjusted cluster #1 due to the number of relations and their total power ( $\Sigma$  11 terms,  $\Sigma$  Knots – 4, Relations – 41,  $\Sigma$  Power of Relations – 127).

**Table 2 VOSviewer Binary Calculating Table of Relations and Knots**

id	tag	x	y	knot	Weight <Links>	Weight <Total link strength>	Weight <Occurrences>	
1	customer	-0.191	-0.0894	1	10	50	24	Red
2	delay	0.4469	0.4911	2	8	21	9	Green
3	delivery	-0.2556	0.4153	1	9	30	12	Red
4	delivery note	0.5132	-0.6547	3	5	10	6	Blue
5	execution	-0.8739	0.7128	1	5	17	7	Red
6	good	0.9382	0.3573	2	6	13	6	Green
7	order	0.0402	0.0329	1	10	53	25	Red
8	problem	-0.0781	-0.4927	4	8	16	8	Yellow
9	raw material	-0.8098	-0.6041	4	5	12	6	Yellow
10	vehicle	0.7968	-0.0941	3	7	16	7	Blue
11	warehouse	-0.5269	-0.0745	1	9	16	7	Red

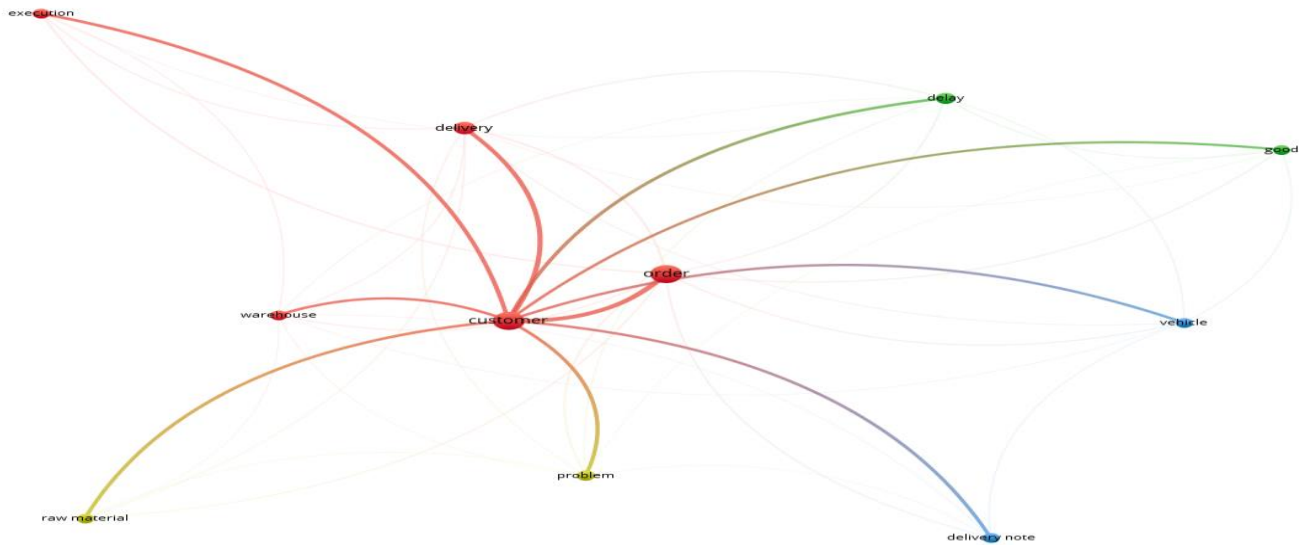
With the help of the VOSviewer analysis we deliver a proof of relativity and importance of the notions, as well as their interconnectivity. The whole calculating considers each utilization of an expression in the material to determine the resemblance, whereas fractional/binary calculating considers simply the word-frequency. Therefore, the given analysis based on binary-calculating is bias-free. The diagramming illustrates the findings, whereas the knots represent the most basic notions of the phenomenon Order

Processing in the CSC service companies, as well as their adjusted importance (Waltman et al., 2010).



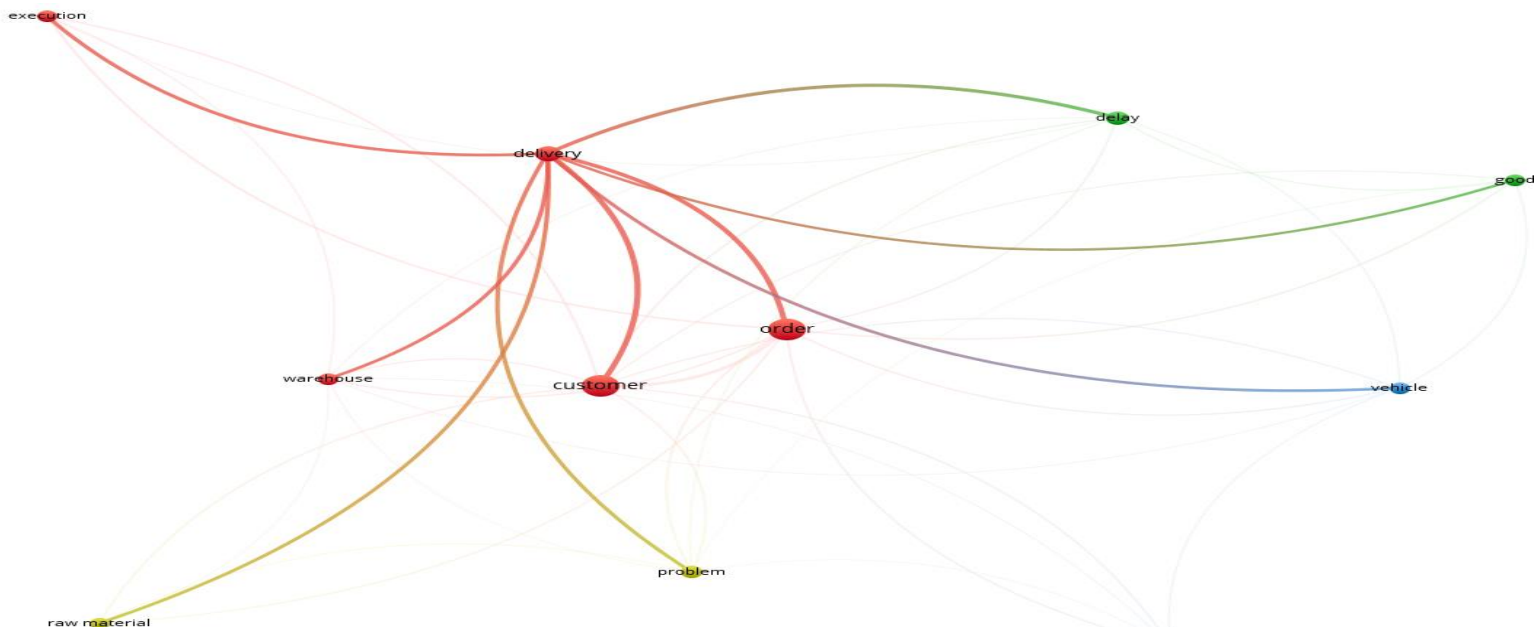
**Figure 27 VOSviewer Knot of "Order" – Binary Calculating**

The knot “Order”, being the stumbling block of the work, returns the most powerful relations ( $\Sigma 53$ ) with the rest of the terms, and occurs 25 times in the replies. The red color in the connections illustrates its strongest relation to Customer, Delivery, and Execution. The knot “Customer” (10/50/24) comes second right after the term Order, and it proves the importance of this notion. Its immediate relation to Order, Delivery and Execution continue to be in the strongest terms of the research.



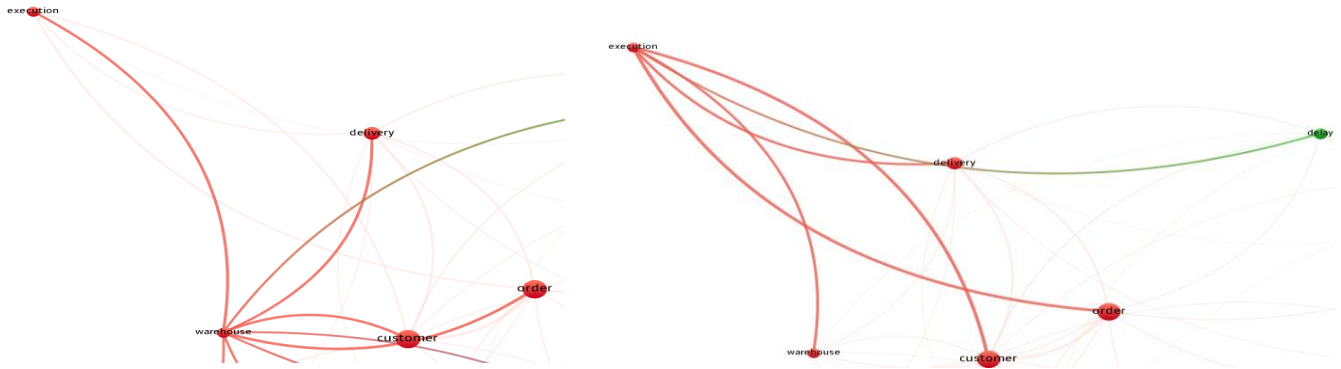
**Figure 28 VOSviewer Knot of "Customer" – Binary Calculating**

The knot “Delivery” (9/30/12) comes third after the term Order and Customer, and it proves the importance of this notion. Its immediate relation to Order, Customer and Execution continue to be in the top-4 strongest terms of the research.



**Figure 29 VOSviewer Knot of "Delivery" – Binary Calculating**

The knots “Warehouse” and “Execution” were ranked as the fourth (9/16/7) and fifth (5/17/7). These knots represent although valuable for the research, minor for the diagram units as each of them bring a pair of terms:



**Figure 30 VOSviewer Knot of “Warehouse” & “Execution” – Binary Calculating**

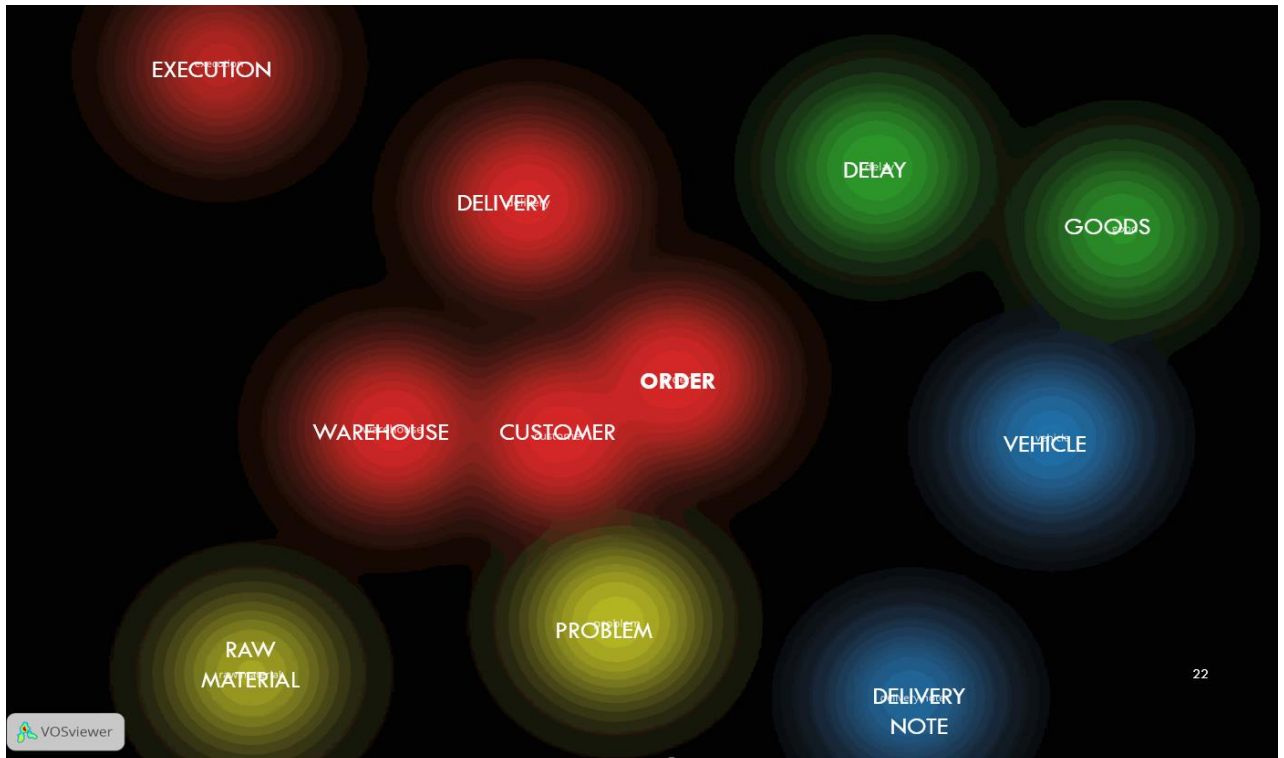
The #2 knot contains such terms as “Delay” (8/21/9) and “Goods” (6/13/6). The #3 knot contains such terms as “Delivery Note” (5/10/6) & “Vehicle” (7/16/7). The #4 knot contains such terms as “Problem” (8/16/8) & “Raw Material” (5/12/6).

The dual use of charts and knots depicts the organization of the field of scientific research data. The left-hand section of the chart provides the data pursuing part of the subarea, while the right-hand section of the chart indicates the quantitative aspects of information area. It is the left angle that usually serves as a core of the research (Waltman et al., 2010).

The thickness charting helps us to see the major conglomerates and their interconnections. The biggest knot with the closest relation is the first red knot and the notions Order, Customer, Warehouse and Delivery are the most related.

The Binary Calculating approach of the VOSviewer revealed the highest dependency of the correct order implementation with: 1) correct order information coming from the customer, 2) correct order processing by the 3pl’s personnel, 3) correct picking by the warehouse and 4) right order execution, 5) timely delivery within the requested temperature range. The 3 other categories of the significant associations to the order

processing are Delay and Goods, Delivery Note and Vehicle and Finally Problem and Raw Material.



**Figure 31 VOSviewer - Thickness of the knots – Binary Calculating**

#### **4.1.2.2. Full-Based Exploration**

In the continuance, we ran the VOSviewer analysis with the full calculating method, which is considered as a traditional way of counting the term-happening in the text. Below there are listed the 2 major knots resulting from the regular counting with a limit of 5-times-happening of the terms.

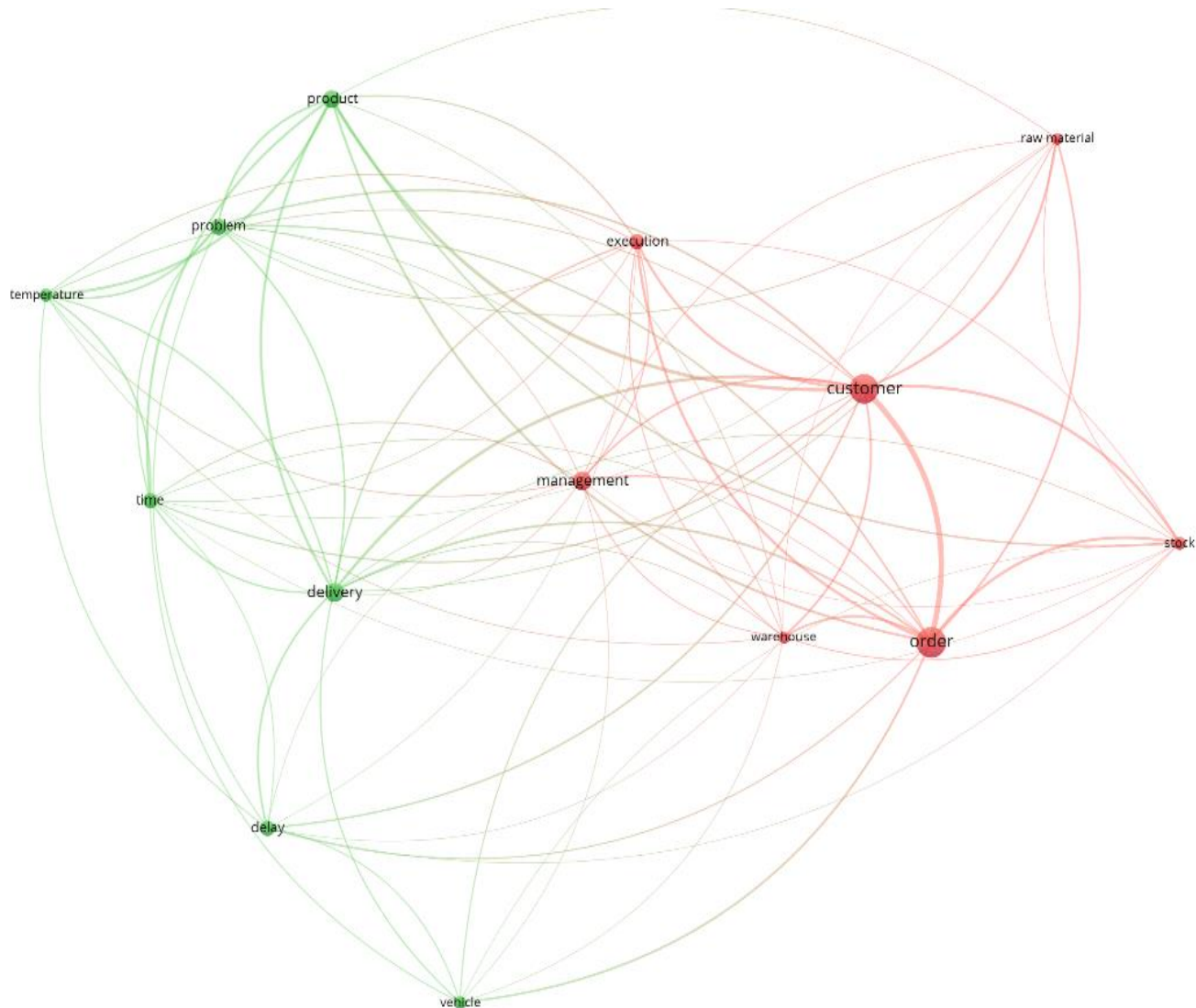
**Table 3 VOSviewer Full Calculating Table of Relations and Knots**

id	label	x	y	cluster	Weight <Links>	Weight <Total link strength>	Weight <Occurrences>	colour
1	customer	0.5347	0.1422	1	13	197	39	Red
2	delay	-0.5137	-0.6051	2	11	34	11	Green
3	delivery	-0.3975	-0.2025	2	13	91	16	Green
4	execution	0.1343	0.391	1	11	56	10	Red
5	management	0.0375	-0.0126	1	12	36	16	Red
6	order	0.6513	-0.2872	1	12	166	41	Red
7	problem	-0.6009	0.4188	2	11	60	13	Green
8	product	-0.4021	0.6336	2	10	106	14	Green
9	raw material	0.873	0.5666	1	9	36	7	Red
10	stock	1.0894	-0.1194	1	11	54	8	Red
11	temperature	-0.9038	0.3019	2	9	52	8	Green
12	time	-0.7206	-0.0476	2	12	50	11	Green
13	vehicle	-0.1755	-0.9004	2	8	25	8	Green
14	warehouse	0.394	-0.2795	1	12	39	7	Red

The biggest knot #1 consists of “Customer”, “Execution”, “Management”, “Order”, “Raw Material”, “Stock”, “and “Warehouse”. The number of relations and their total power ( $\Sigma$  14 terms,  $\Sigma$  Knots – 2, Relations – 77,  $\Sigma$  Power of Relations – 501). The

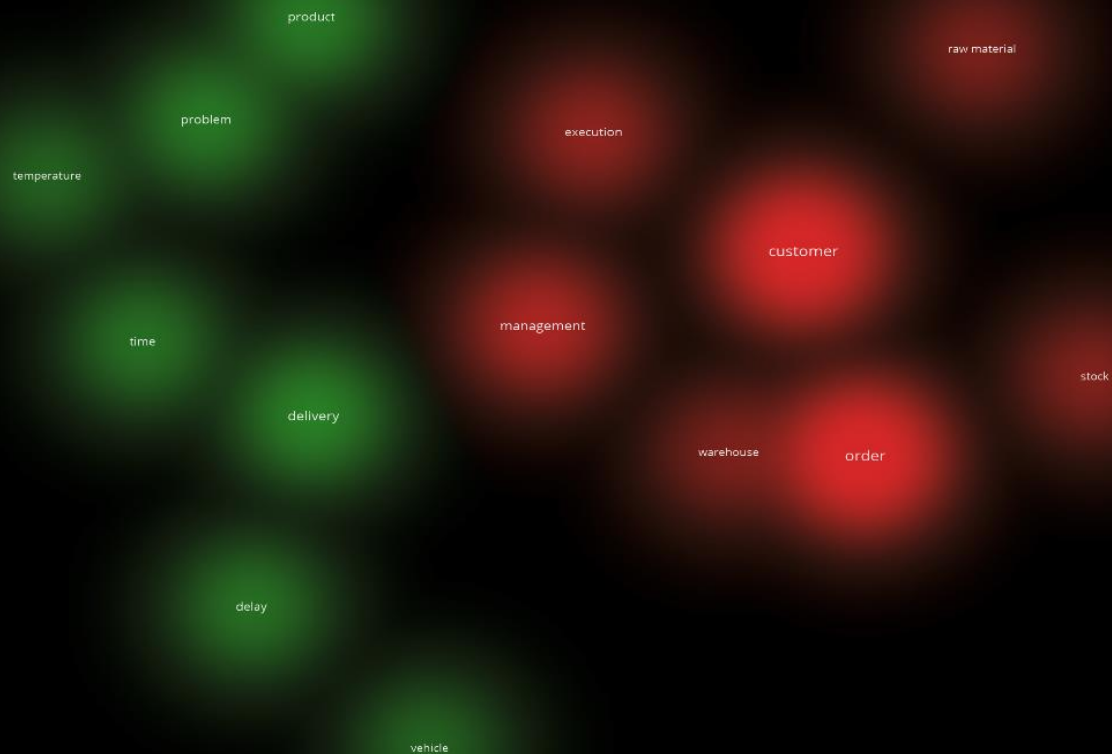


first detail that captures our attentions is that the total calculating brings a bigger number of relating terms in the 1<sup>st</sup> knot (7 versus 5 from the fractional calculation). Moreover, the above-mentioned terms have the biggest weight. Secondly, this knot is located to the right centrally-low angle, tht does not make it the core of the research, as the theory of this diagramming supports.



**Figure 32 VOSviewer Diagram of Relations and Knots - Full Calculating**





**Figure 33 VOSviewer - Thickness of the knots – Full Calculating**

Creating cartography with the help of visual word analysis brings several constraints. One of them is the the availability of information, as it is usually restricted, and secondly, there will be always "intrusions" creating bias. Distortion in information can originate via a variety of somewhat random judgments made by researchers. Thirdly, a visual representation treats the information in a less complex way than de facto, and that may result in distortion (Sashi et al, 2020).

#### ***4.2 Current impediments for the CSC and cold 3PLs in Greece:***

The share of the CSC in Greece accounts for 6-11 % of the GDP of the country as per information provided by the Greek Cold Storage and Logistics Association (GCSLA). Although the CSC made its appearance in Greece decades ago, there is still a number of challenges. The Cold infrastructure is still inadequate due to the reasons listed below:

1. Lack of skilled staff – On the grounds that the product range of perishables is enormous, and they require various temperature regimes, lack of skilled labour force as well as greater permanent expenses for their training reduce revenues. CC professionals not only must know the necessary product maintenance requirements, but also run the specific devices, as well as being able to fulfil correctly the order from the very beginning until its completing taking into consideration all the important criteria of the perishables.

Correct order processing competence starts with the computer and ERP literacy, something that is not valid for all the companies. Even today some of the respondents have declared that they use little or no electronic devices or computers for order implementation. The majority of the respondents had the CC experience up to 5 years, with only 2 persons having over 21 years of CC experience.

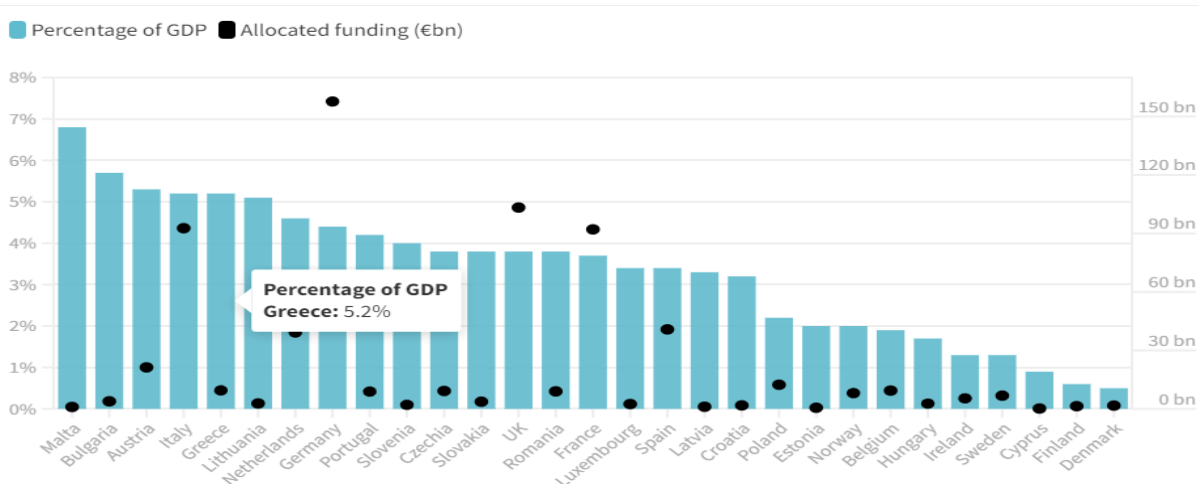
The skilfulness is the primary quality that goes alongside with the correctness of the order fulfilment. Thus picking, packing and pallet preparation are mentioned as one of the most important criteria in correct order implementation, as well as ERP procedures, RFID scanners and thermograph use. Sales manager, alongside with warehouse employees and the Accounting department employees are the 3 mostly cited professions which are necessary in implementing the order.

2. Inadequate and Poor Cold Infrastructure – Greek companies traditionally store dry cargo. However in recent years the refrigerated merchandise (e.g., food/medicine) has

made its appearance on the Greek market, yet the CC industry is still fragmented to a large extent. The disorganised CSC and a scarce post-harvest solid foundation result into the loss of qualitative foodstuff in Greece. As a result, the quality of goods, in combination with substantial loss increase every year. There are few or not adequate premises/equipment or infrastructure, or they are obsolete.

3. Increasing Costs of running the Cold 3PL. Electricity is still one of the only ways to power the chilly devices. Based on Eurostat statistics, the power costs constitute about 5.2 % of the Greek GDP, being one of the 5 highest in the EU, and therefore all the expenses for Greek cold 3PL, compared to the EU, are higher, as shown on the Fig 34 (Sgaravatti et al. 2021).

Consequently, the Cold storage units require suitable backup, which raises expenditures on capital costs. Though this is widespread around the world, in Greece, the reliance is extremely high, making the cold storage uneconomical. The expenses associated with ineffectiveness are not countable and obvious and therefore increases the cost of running business.



**Figure 34 Allocation of funds as a quota of the European GDP**

<https://www.bruegel.org/dataset/national-policies-shield-consumers-rising-energy-prices>

access 02/09/2023

The rise of semi-finished meals, ecological cultivations of fruits and vegetables, and regulated commerce sectors provides enormous possibilities in the field for the CSC. In addition, the authorities must attract collaborations using commercial businesses. Focalising and addressing the infrastructural drawbacks, as well as implementing the international benchmarking through the collaboration with 3PLs and using environmental friendly technologies, is of mutual beneficence for all the CSC stakeholders (Chandrasekaran & Raghuram, 2011).

4. Food Waste – Around 20% of what is produced is wasted worldwide owing to inadequate CSC capacity and procedures. Around 2 million tonnes or 173 kg/person of food grow or produced are wasted annually in Greece due to blank spaces in the CSC. Other factors that contribute to the worsening of the situation are: the high defragmentation of the CC institution, unapproachability and low number of cold storing premises to the harvesting areas, delivery network that is overloaded during the harvest-seasons or peaks. In fact, optimization of CSC and after harvesting procedures decrease the alimentary disposal (EBRD 2019).

5. Financial and Bureaucracy issues – The bank loans are tough to get and have unfavourable conditions, it is impossible to secure government loans or investment; the establishment and expansion of business parks is critical; difficulty in registering as a Cold Service Provider and acquiring the necessary special licenses; high degree of competitiveness among neighbouring nations, particularly non-EU members;

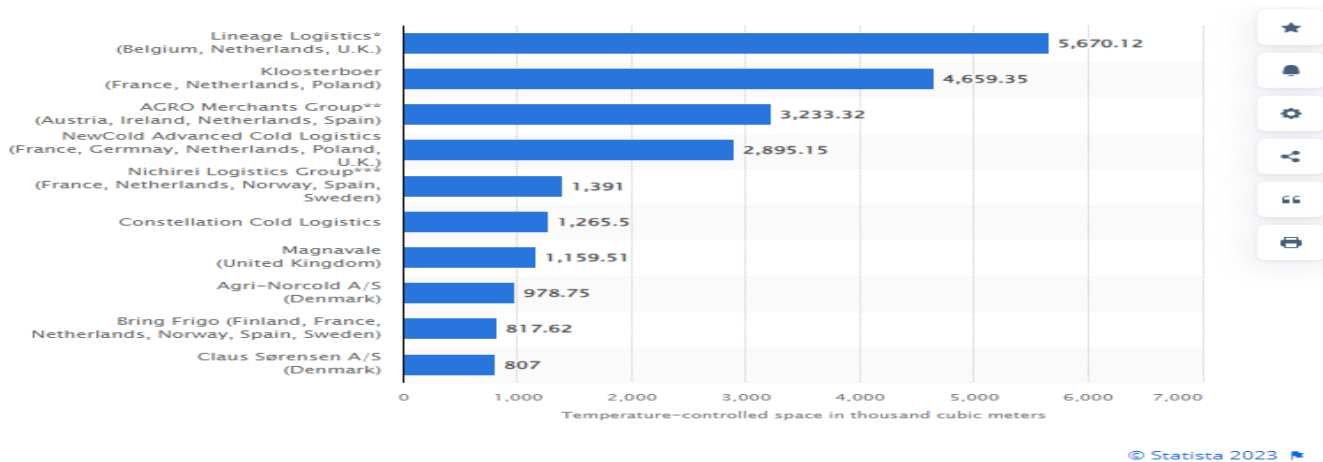
6. Highly fragmented local CSC market, represented mainly by medium and small cold 3PL. There is a growing need to settle a well-tuned collaboration network that would allow quick reactions on every step of the order implementation.

To be able to meet up the global development and standards, the GCSLA has initiated in May 2023 the 4<sup>th</sup> Pan-Hellenic Research on CSC, in collaboration with the stakeholders and the respective organizations and associations (Supply Chain and Logistics #134, 2023). The results has demonstrated: 1) the cold 3PL are rather small companies, having under 10 000 m<sup>2</sup> spaces; 2) the inability to find financial support prevents their development; 3) lack of cold-chain-professionals, especially difficulty in finding th professional drivers of reefers (Supply Chain and Logistics #138, 2023).

Greece needs more cold-3PL agents with higher capacities, as well as coverage of the territory of the Greek islands. 37% of the cold 3PLs have a maximum storage volume under 5,000 m<sup>2</sup> ([https://www.metaforespress.gr/logistics access](https://www.metaforespress.gr/logistics_access) 30/11/2023). Cold storing premises need to be increased in number and capacity, especially in the areas of sea ports and airports. The legislation must be reviewed to the extent to which buildings may be built, as nowadays there is a land management regulation with regards to square meters index, because of which the cold storage investment costs per square foot tend to rise.

The rise in the pricing of industrial production caused by SC interruptions and increased costs of energy do not allow the companies to allocate the profits for future investing plans (European Commission, Staff working document 2023). The CSC is a branch of the SC that totally depends on the energy resources, and therefore is highly energy consuming. According to the oldest CSC 3PL in Greece Lekkas Ioannis cold

stores, the major costs relating to the energy spent for the refrigeration accounts for up to 65% of the total operational costs (Supply Chain and Logistics 132, 2023).



**Figure 35 Major cold 3 PL in EU in 2020, by size (in 1000 m3)**

With the energy cost growing constantly, and reaching up to 70 % for the last 3 years, the CSC enterprises turn to the new solutions regarding the energy saving methods. Taking into account the above-mentioned, it is challenging to put Greece on the international market of cold services in the near future, despite its favourable location in the Balkans. The European leaders of the CSC are still the northern countries like Belgium, Netherlands, Denmark, UK as per Figure 35 (Placek, 2022). To make a difference, Greece must face the challenges and find the solution to overcome them. Only then we can speak about the order processing improvement in the CSC. Only then the new technologies and AI can be introduced to CSC and make the know-how approaches like storage-upon-need as familiar as keeping the products safe in the refrigerator to prevent them from spoiling.

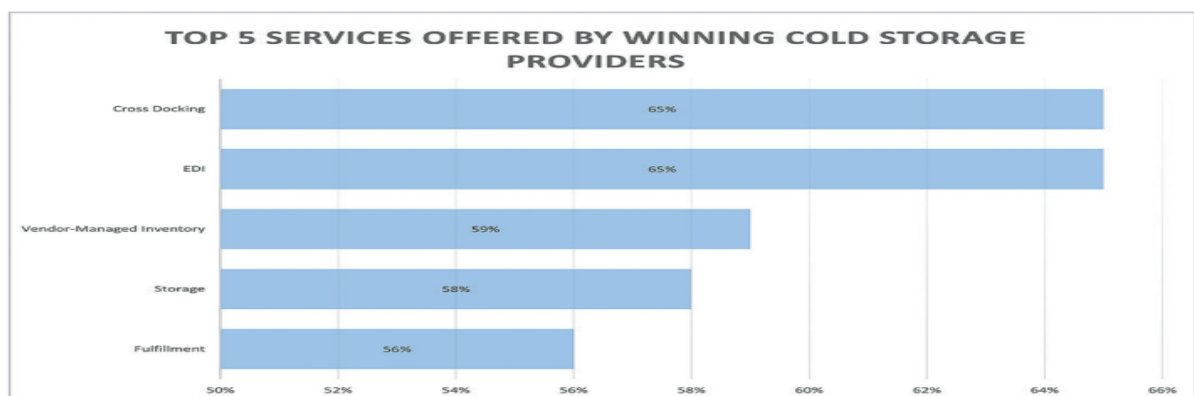
### ***4.3 Possible solutions to improve the Greek CSC:***

#### **1. Education and Training**

- Educational programs to familiarize 3PL staff with temperature sensitive situations and job requirements.
- To introduce the obligatory training regarding the disposal of food, closing the refrigerator door to lessen energy consumption.
- Add the 4<sup>th</sup> option “CSC” alongside with other 3 major sub-categories to the postgraduate course the Supply Chain Management.

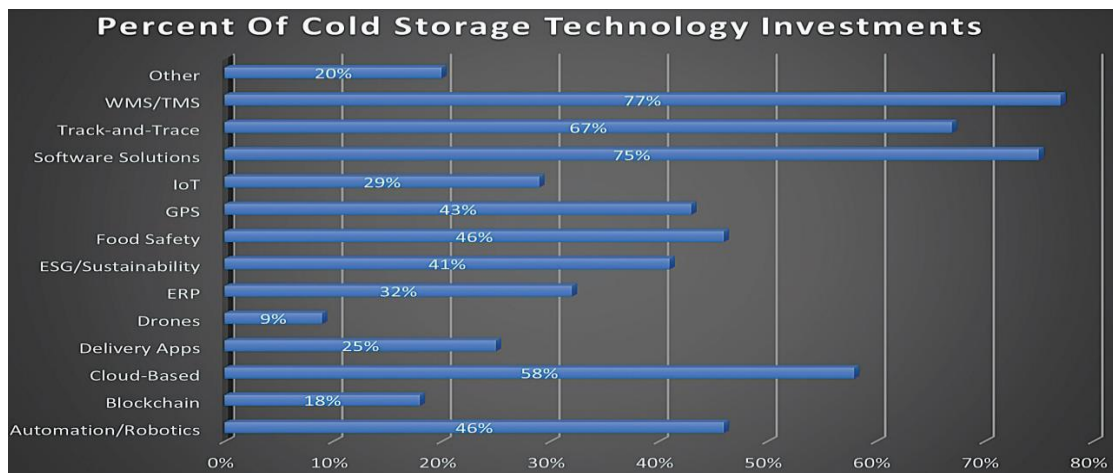
## 2. New technologies and devices

- Active use of the modern technologies like RFID, thermo tags and sensors, as well as more active implementation of centre of transshipment, block-chains, EDI, “cloud” for exchange of information can ensure quality of the service and responsiveness in case of CC disruption, Figure 36;



**Figure 36 Services provided by Top Cold 3PL in the world (Mayer M., 2023, p 19)**

- Creation of cold storages for rental based on the internet platform, both for domestic and bulk loads;
- Implementation of robotic picking and unmanned order processing to lessen the human mistake factor, Figure 37;



**Figure 37 Technological CSC Updates (Mayer M., 2023, p 19)**

- Implement the “based-on-traffic-route-planning” regulated by the time-frame provided by the customer in combination with electricity need and electric battery stamina, these measures will reduce the circulation overload and decrease the expenses related to delivery (Callejas-Molina et al 2020).

### 3. Operational:

- Verifying the appropriateness of partners and equipment through contractual agreements and by supporting the collaboration transparency. Monitoring and controlling compliance with the agreed-upon terms and conditions;
- Informing all the relevant parties in the event of a change/ emergency/ CC disruption and taking appropriate corrective measures;
- Rental of tax free special cold storages close to the ports of Thessaloniki and Piraeus to facilitate export/import procedures.
- Creation of Frigo-Parks acting as incubators with a free trial period to support the new businesses and ease from the financial burden the existing ones.
- Reducing the tax burden through more favourable fee scales or tax exemption.
- Simplifying registration and permissions issuing processes,



#### 4. Financial:

- Government projections and public support for recruiting local and foreign investments.
- More loans with better conditions shall be made available.

#### 5. Environmental

- Increase in the usage of solar panels to reduce electrical energy consumption and CO<sub>2</sub> emissions. Net metering must be used in highly energy-consuming CC enterprises that keep products in professional cold storages. Currently the only way to cut energy costs is by placing solarpanels in freight storages, while the solution is to deploy photovoltaics on warehouse rooftops. The cost of maintenance is inexpensive, and the life expectancy surpasses 20 years (Naves et al., 2021)
- Application of electric power or solar panel generated for transportation for perishable goods. The EU favours the use of electric cars by applying zero or symbolic circulation fees. The same must done to the trucks and refrigerator trailers, as they are the main source of CO<sub>2</sub> pollution (Harvard Business Review 2024).
- Eco-friendly delivery must become a solid goal, implemented in everyday routine, not just a slogan.
- There are substantial discrepancies in our understanding of global alimentary loss and waste caused by disruptions or obstacles in the CC infrastructures. Further research in this area is critical.

## Chapter 5 – Discussions

The CSC is a domain that captures the attention of the researchers year after year, and in the light of the globalization and international trade the CC becomes a key success element. The COVID pandemic, the 2 wars that we face for the last 2 years, have showed the fragility of the CSC that the disruption may happen at any point of time. For that reason the strong collaborations between all the members of the CSC, robust systems and chilling devices, alongside with precise meters, sensors and scanner are the major components of continuity of the CSC.

Claassen et al. (2023) approach the issue of CC order processing by applying the EOQ model, whereas Qian et al (2022) as well as Zhang et al (2023) mention the internet of things as well as the Blockchain as the possible ways to keep the order flow constant and unbreakable.

The 4th Industrial revolution dictates the digitalisation on every step of our life. Companies avoiding to accept the rising technological advances risk becoming obsolete (HBR, 2024). Digitalization of the small and medium enterprises in Greece evolutions with small paths, reaching just 41 percent that possess an adequate degree of digital literacy, which is much lower than the EU average (European Commission, Staff working document 2023). The Greek private businesses are lacking behind when it comes to EU norm for large informations acceptance, and behind the cloud calculating service area and digital intellect (AI). Order processing in the CSC environment has to become updated to fit in the framework of the Industry 4.0 (Sashi et al, 2022).

The latest tendencies view the development of the CSC in a smart direction. ChatGPT or Generative Pre-trained Transformer is introduced by Microsoft to its Microsoft Office package that shows already the high degree of penetration of the AI in

everyday life (HBR, 2024). They improve employee productivity, make based on information jobs easier to do, and improve client service and involvement, finally beginning to improve the quality of people's choices and efficiency. Human beings in combination with modern science may really interact inter-complementing and mitigating flaws.

Mejjaoui S. and Babiceanu R. suggest the use of data center operating virtually with the help of Artificial Intelligence that can change the plan of delivery in case there is a disruption (Mejjaoui & Babiceanu, 2018). Tsang Y.P. et al, believe that the prognosis and estimate of risks thought the prism of knowledge engineering, specifically IoT, can keep the CSC solid (Tsang et al). Phase change materials (PCM), embedded Bluetooth, Internet of Things (IoT) gadgets, satellite positioning, and thermometer technologies are all features of smart CSC with AI for packaging. They provide firms with immediate access to information and data, enabling them to be flexible, adaptable, and robust (Nilsson 2006). The combination of meteo warnings, monitoring items across aquatic environments, detecting the repeated usage of CC packaging, organizations can decrease wastage and reduce discrepancies, allowing for a stronger cold chain (Lagin et al, 2022).

Recent studies address the CSC as the Green CSC, meaning the reuse of the shipping pallets/boxes/containers. The regenerative cold chain is a new concept that discusses resilience and cold chain sustainability (Kumar et al, 2023). The sustainability is more than just recycling, it encourages involvement of every stratum of society, beginning with the regulations established by the government, the participating components, the provider, and the customers. James & James (2013) believe that a transition from a produce-consume-dispose SCM mind-set to a no-waste generative-and-material-recovery resource network mind-set must happen now (James & James 2013).

To counterbalance the decrease of the CO<sub>2</sub> discharge, the farm-to-fork approach emphasizes the consumption of home-grown foodstuff. The farm-to-fork approach reduces carbon dioxide emissions by promoting home-grown food. Rethinking regular energy imports due to energy demand is crucial.

Since the CSC is more than just a temperature-dependent SCM, it must be viewed as an ambient-administered management of chains. Additionally, the prism needs to consider carbon neutrality and social continuity. This is because, unlike the dry cargoes, the energy needs for fresh logistics also include the cooling energy necessary to maintain the product quality along every step of the chain.

A group of Chinese researchers vote for a sensor technology driven by the sun to monitor alimentary products (Xiao, et al. (2022)). M. Bogataj et al. (2005) ask what are the circumstances and limitations of supervising the dynamic system to the extent that the quality of the foodstuff is preserved throughout the whole chain. No matter the tendency, the allegation of AI or “Green filter”, the Alimentary safety and sufficiency continues to be the key concern in many parts of the developing world. Since the global population is growing each year, food availability is crucial, and one of the ways is to encourage food loss reduction (Gustavsson et al., 2021, FAO).

Pursuant to the United Nations Environment Programme (UNEP) (2021) Greece has a high discarded alimentary reaching 142 kg per annum individually and 1.483.996 tons per annum domestically (UNEP, 2021). The correct fulfilment of the orders in CC, as well as a clock-wise collaboration between all the parties, timely and correct-temperature-delivery, with a backup from the Government and international organizations, can be a key. The CSC could become a primary catalysts of minimizing loss of food and combating environmental worsening conditions.

Due to deep recession, economic slowdown, and inadequate infrastructure for high-level logistics, Xenou E. et al raise our attention to the lack for public storages on the Greek market, and Digital Cargo Hub (DCH). However, "upon the need" services are prevalent in other industries like Airbnb and are gaining market share in the logistics and SC subdivision. The main challenge is the lack of widely used solutions for "upon the need" storage. Digital Cargo Hub aims to address this by offering collaborative storage options, flexible on-demand storage rental options, and connecting consumers seeking warehouse space with those with surplus or underutilized space via a single digital platform (Xenou et al, 2021). Such kind of services could be available for cold storage as well; the pandemic experience has demonstrated it with vaccines storing difficulty and chain disruptions.

Inefficient employment legislation, work inequalities in skills, poor administration efficiency and a lack of technological advancement in private and public sector have a detrimental impact on the job efficiency. Therefore the implementation of ISO norms is necessary if not obligatory to tune the collaboration of all the cold-members of the CSC (Tsai, 2018).

Due to a high dependency of people on the food chain and at the same time its scarcity, it is certain that the subject of the cold chain and its efficiency will keep on providing theme for discussions to the scientific society and the professionals in search for solutions and generation of new ideas.

## Chapter 6 – Conclusions

This chapter describes the key contributions and conclusions of the performed research. At the end, some possible directions of further research are mentioned.

The theoretical research conducted and the interpretation of the findings resulted in the subsequent assumptions with regards to difficulties relating to the CSC in Greece are:

- Insufficient and unsteady demand for cold storage, low number of cold-meeting-criteria-reefers, low number of logistical services having the necessary equipment and installations with a specific temperature control;
- The biggest challenge of the cold 3 PLs is the compliance with storage conditions at every step of the chain. As a result, it demands an extensive network of chilling systems, a big tracking fleet meeting the specific-storage-conditions requirements and quick delivery. The insufficient number of modern warehouses with chilling equipment is challenged with a big range of temperature regime options;
- The complex nature of CSC also includes: a constant control at every stage, temperature regime fluctuations control, lack of subsidiaries and monetary funds from local or foreign investors, and diligent collaboration of all the stakeholders of the CSC.
- Lately the CSC has seen a substantial shift to the technology, with a new emphasis on the tracing and monitoring. Route control, quality control inspections on refrigerated trailers, incoming merchandises, appointment scheduling, shelf-life compliances, lot management, automation, and cold storage regulations are just a few of the components that the latest technology platforms offer.

According to the outcome of the practical investigation, based on the questionnaire, we can conclude the following. The problems relating to the order processing in the Greek cold 3 PLs are:

1. Incompetent workforce can cause incorrect order formation resulting in multiple consequences and delays;
2. Mistakes in order information may lead to wrong quantities, product unavailability, delay in order preparation, truck/ vessel departure;
3. Any delay in order processing leads to a deterioration in product quality and customer dissatisfaction, which may result in an unbalanced financial state for the firm as well as a degradation of the company's image,
4. Wrong temperature conditions, as a result of inappropriate reefers, warehouses of storing places not meeting the standards for specific cold products; Damaged thermograph/ ERP & WMS desynchronization,
5. Inability to find a proper truck due to high requirements,
6. LIFO and non-compliance with FEFO,
7. Damaged package and Bad odour as a result of product deterioration.

Consequently to achieve the correct implementation of the order the below benchmarks are obligatory:

1. A relevant and compulsory training of managers and employees of all levels of the CSC, that should include a computer and ERP literacy, use of RFID scanners and thermographs, use of “cloud” for exchange of information, tracing and troubleshooting;
2. The order has to be processed in an electronic form, making sure all the data is filled-in correctly, and is available and transparent to all the parties of the CSC, on every step;

3. A vigilant control of a correct order implementation is a vital part in the cold environment, and presupposes tracing, and control, as well as the immediate corrective measures on every step;
4. The CSC stakeholder must have the necessary installations, RFID scanners, sensors, thermographs and relevant premises to provide proper temperature regulation meeting preservation needs of various food categories.
5. The external subcontractors must have the necessary qualifications, skills, premises and reefers to guarantee the correct transportation or cross docking of the perishables. The trustworthy collaborations, as well as well-coordinated joint actions of all the stakeholders can be time-saving and cost effective element;
6. Dutiful implementation of the food quality and safety management manual, Deming’s plan for constant improvement, SWOT and KPIs control to ensure the achievement of the business plan and the financial stability of the entity;
7. Introduction of the universal packaging meeting the high demand of the CSC.
8. Adoption of the blockchain technology to guarantee the transparency of all the actions and tracing of the load starting with the supplier and until the final customer.

The possible directions of development for CSC are the initiation of government support programs to reduce financial costs for the creation of chilled warehouses, a more favourable taxation scale favouring the reduction of overhead costs, decrease of energy consumption costs by improving insulation, increase in night bill charging and solar power and alternative ways to initiate the sustainable approach in the CSC. The compulsory education starting from the elementary school of minimization of fridge door opening time as well as respecting the temperature regimes necessary for different products. The



necessity to implement the powerful ERPs like SAP, and use of Block-chain technologies could provide the resilient platform for disruption-proof CSC functioning.

Greece hosts the new modern hubs for world leaders like Pfizer, Microsoft, Deloitte etc. This could be a good start to attract even more foreign companies or foreign investors to develop the cold chain infrastructure. Greece has paid up its International Monetary Fund (IMF) debts two years early 04/2022, this has paid a positive role and Fitch Ratings raised Greek extended overseas coinage Issuer Default Rating (IDR) to 'BB+'. Moody's reiterated its "stable" prognosis for Greece's banking sector and Standard & Poor's improved Greece's creditworthiness to BB+ (<https://www.state.gov/reports/2023-investment-climate-statements/greece/>).

The 4 Greek ports Piraeus, Thessaloniki, and Heraklion serve as free commercial areas for local and international enterprises, where the goods are kept or in transit duties and fees exempted (<https://www.state.gov/reports/2023-investment-climate-statements/greece/>). These areas could also be used for hosting there public or private cold warehouses. The biggest cryogenic storages are located in the northern and central Europe. Therefore, Greek ports could enter as cold-storage hubs because Greece is located on the cross road of Europe, Africa and Asia.

To build a better CC embracing a complex of measures, new technological apparatus or devices, implementation of AI in order processing can set the first steps towards the creation of a resilient CSC. The cold chain status quo cannot tolerate disruption or absorb change, according to the foremost lesson learnt from the pandemic, as the halt of the production, in combination with the climate change and lack of the workforce result in irreparable damage.

No matter what changes can be introduced, we must always bear in mind, that the CSC, as a part of SC, must remain true to its goals, that is to provide the utmost customer

experience, as well as do it in the most effective, cost-efficient and profitable for the business way, within the correct temperature ranges.

The further researches could be focused on the quantitative assessment of the order processing in the companies using the up-to-date technologies and IoT, and comparing it to the companies that do not use these options. Another interesting approach could be undertaken, seeing the order processing in Greece through the lens of green CSC and sustainability.

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