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Postgraduate Thesis

“Enhancing Disaster Response and Recovery through Collaborative
Humanitarian Logistics and Operations”

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Komotini, Greece, January 2025

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Abstract

This thesis explores how collaborative humanitarian logistics and operations can enhance disaster response and recovery, focusing on Rhodope, Greece. It aims to address challenges in preparedness, resource allocation, and inter-organizational coordination. The insights of the research were gathered from a structured questionnaire, answered by stakeholders that belong to one of the following four key groups: the military, Local Government Authorities (LGAs), Non-Governmental Organizations (NGOs), and National Emergency Aid Centre (NEAC). On the basis of the local practices emerged through the research, as well as the international theoretical frameworks of the existing literature, applicable strategies for improving the resilience and effectiveness of the region’s humanitarian supply chain are identified. By promoting a collaborative culture, this paper provides a roadmap for taking the first steps in order to mitigate the socio-economic impacts of disasters and ensuring equitable and timely aid delivery. Final recommendations target to bridge existing operational gaps and contribute to building a robust response mechanism tailored to the unique challenges of the area.

Keywords

Disaster response, Humanitarian logistics, Collaboration, Supply chain

“Ενίσχυση της Αντιμετώπισης Καταστροφών και της Ανάκαμψης μέσω Συνεργατικών Ανθρωπιστικών Logistics και Επιχειρήσεων”

Κωνσταντίνος Μανανάς

Περίληψη

Αυτή η διπλωματική εργασία εξετάζει πώς οι συνεργατικές ανθρωπιστικές εφοδιαστικές και επιχειρησιακές διαδικασίες μπορούν να ενισχύσουν την ανταπόκριση και την ανάκαμψη από καταστροφές, δίνοντας έμφαση στην περιοχή της Ροδόπης. Στόχος είναι η αντιμετώπιση των προκλήσεων που σχετίζονται με την προετοιμασία, την κατανομή πόρων και το συντονισμό μεταξύ διαφορετικών οργανισμών. Οι πληροφορίες της έρευνας, συλλέχθηκαν μέσω ενός δομημένου ερωτηματολογίου, το οποίο απαντήθηκε από ανθρώπους που ανήκουν σε μία από τις τέσσερις παρακάτω βασικές ομάδες: τον στρατό, Οργανισμούς Τοπικής Αυτοδιοίκησης (ΟΤΑ), Μη-Κυβερνητικές Οργανώσεις (ΜΚΟ) και εργαζόμενους του Εθνικού Κέντρου Άμεσης Βοήθειας (ΕΚΑΒ). Βασισόμενη στις τοπικές πρακτικές που αναδείχθηκαν από την έρευνα, καθώς και στα διεθνή θεωρητικά πλαίσια από την υπάρχουσα βιβλιογραφία, η εργασία εντοπίζει εφαρμόσιμες στρατηγικές για τη βελτίωση της ανθεκτικότητας και της αποτελεσματικότητας της ανθρωπιστικής εφοδιαστικής αλυσίδας της περιοχής. Μέσα από την προώθηση μιας συνεργατικής κουλτούρας, η έρευνα αυτή παρέχει έναν οδικό χάρτη για τα πρώτα βήματα προς την κατεύθυνση της προσπάθειας μείωσης των κοινωνικοοικονομικών επιπτώσεων των καταστροφών και της εξασφάλισης ισότιμης και έγκαιρης παροχής βοήθειας. Οι τελικές προτάσεις στοχεύουν στη γεφύρωση των υφιστάμενων επιχειρησιακών κενών και στη συμβολή δημιουργίας ενός ισχυρού μηχανισμού ανταπόκρισης, προσαρμοσμένου στις μοναδικές προκλήσεις της περιοχής.

Λέξεις – Κλειδιά

Αντιμετώπιση καταστροφών, Ανθρωπιστικά logistics, Συνεργατικότητα, Εφοδιαστική αλυσίδα

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Abbreviations

Branch & Price – BPC

Capacitated Vehicle Routing – CVR

Central Warehouses – CWs

Global Positioning System – GPS

General Data Protection Regulation – GDPR

Greedy Randomized Adaptive Search Procedure – GRASP

Emergency Medical Services – EMS

Information Technology – IT

Local Distribution Centres – LDCs

Local Government Authorities – LGAs

National Emergency Aid Centre – NEAC

Non-Governmental Organization – NGO

Split Delivery Vehicle Routing – SDVR

Supply Chain Management – SCM

Support Vector Regression – SVR

United Nations – UN

Εθνικό Κέντρο Άμεσης Βοήθειας – ΕΚΑΒ

Μη-Κυβερνητικές Οργανώσεις – ΜΚΟ

Οργανισμός Τοπικής Αυτοδιοίκησης – ΟΤΑ

1. Introduction

1.1 Background

The world has encountered numerous humanitarian crises throughout history, extending into the present day. However, the responses to these crises have not always been the same. Kent (2004), highlights that prior to the year 2000, relief operations were not consistently regarded as significant events, yet over time this has changed. The shift in approach to addressing humanitarian crises appears to be a natural consequence as, according to the *World Disasters Report 2022: Trust, Equity and Local Action* the need for humanitarian assistance has been maximised as the number of disasters has increased dramatically over the last six decades. Especially in the years following the entry of the new millennium, humanity has faced enormous challenges. From earthquakes and terrorist attacks to wars and the COVID-19 pandemic. Crises of this magnitude must serve as a wake-up call for all stakeholders with respect to the renewal and improvement of the methods they use to deal with them (Gazi & Gazis, 2020).

However, the crucial concern is not solely to update and enhance disaster response tools, but to employ them effectively. Humanitarian relief efforts inherently entail complexity, attributed to their nature and the engagement of multiple stakeholders. Therefore, effective utilization equates to thorough planning (Wisetjindawat et al., 2014). Nonetheless, the high degree of unpredictability stemming from hazards, particularly natural hazards, renders the process of disaster preparedness extremely challenging (Yu et al., 2018). Hence, coordination between government bodies, local agencies, the military, private companies, Non-Governmental Organizations (NGOs) and any other aid provider is vital both for the delivery of optimal assistance to the victims and for the best possible management of future incidents (Ugwu & Onwuka, 2018).

To accomplish this goal and in view of the fact that there is a constantly increasing need for humanitarian aid, all referenced actors are working to evolve and develop their supply chains, particularly through the implementation of new technological systems (Ergun et al., 2014). As Pettit & Beresford (2009) note, the innovations and new methods that are emerging in the management of commercial Supply Chain, successfully contributing to its improvement, are and should continue to serve as a guideline for humanitarian agencies as well. Yet, the focus on the humanitarian supply chain appears to be inadequate. The funding and resources

dedicated to its operations significantly fall behind to those provided to commercial enterprises (Van Wassenhove & Pedraza Martinez, 2012).

The parties engaged in disaster relief efforts must insist, demand, and secure all the essential supplies required for their efficient operationalization and, consequently, for the recovery of those affected. Specifically, humanitarian organizations, which predominantly rely on donations, should exert greater diligence in demonstrating rapid progress, favourable outcomes, and transparency in their operations. In any other case, donors or other financial institutions may discontinue to provide their support (Khan et al., 2019). This fact points the constant necessity of adapting to new circumstances and practices, with the ultimate goal of continuing the social work and delivering it in the most optimal way possible.

As previously stated, success at a great extent depends on the coordination and collaboration of all parties involved. In a business context, the arrival of new technological tools and most importantly information systems have significantly enhanced the quality of communication between firms and consequently the functionality of their supply chains (Dehgani & Jafari Navimipour, 2019). Advantages and improvements including fewer delays and errors, the establishment of more dependable relationships, and practical benefits like reduced production costs stem from the capability to exchange large amounts of data directly within a supply chain network (Baihaqi & Sohal, 2013).

But regardless the presence and ongoing development of new technologies that significantly enhance knowledge acquisition and commercial supply chain efficiency, humanitarian organizations have not managed yet to fully exploit these advancements for their benefit. Over the years, there have been numerous instances of poor or mistaken communication and cooperation during humanitarian operations, leading to problems like the misuse and misallocation of resources, as well as delays in delivering aid or intervening at the frontline (Bharosa et al., 2009). This was one of the main reasons that made the intervention, at a global level, of an organization like the United Nations (UN) necessary. Through the involvement of Inter-Agency Standing Committee (IASC), the longest-running and highest-ranked humanitarian coordination forum in the UN system, norms and institutions were established, like the Logistics Cluster System, which were previously non-existent, and have improved the level of cooperation and effectiveness in humanitarian logistics and disaster response (Logistics Cluster, 2023).

1.2 Problem Statement

In the dynamic field of humanitarian logistics, the challenge of enhancing disaster response and recovery remains critical. Despite recent advances in technology and supply chain management mechanisms, there are still significant gaps in the efficiency and effectiveness of responses to catastrophic events. Often, actors involved in delivering humanitarian aid, due to the pressure arising from disaster consequences, are led to miscommunication and unsuccessful cooperation between them (Negi, 2022). These challenges underline the need for more resilient and integrated supply chain structures that can adapt to the complexity of disaster scenarios.

Although collaboration between multiple entities, including local governments, NGOs, the military and international private agencies is essential, it is also problematic. In spite all having the same target, that of providing assistance to the wounded communities, the diversity in operational commands from organization to organization and the variability in response capability levels complicate the establishment of a well-organized operational strategy (Ugwu & Onwuka, 2018). This disordered approach not only obstructs rapid action but also affects the strategic allocation of resources needed for both immediate relief and long-term recovery.

On the other hand, the size of the problem is also directly dependent on various physical factors such as the type of disaster, the weather conditions, and the damaged location. Having all the above in mind, particularly in the context of disasters in Greece, it can be said that the escalation of the frequency and intensity, has created unique difficulties for humanitarian logistics. Each year, emergencies in Greece are more frequent, serious, and unpredictable. Situations like these, require the use of local and national resources as well as functional cooperation mechanisms between all the various parties.

Due to the repetitive pattern of these crises, critical gaps in current Greek logistical and operational frameworks have appeared, underlining the need for improved strategies in the preparedness, response, and recovery phases of disasters. The development of a resilient, flexible and above all collaborative humanitarian supply chain could significantly mitigate the magnitude of the suffering on the affected areas, ensuring faster recovery and more efficient allocation of resources (Duong & Chong, 2020). Such a task is considered extremely difficult, as every region, every city and every economy have different capacities and availability of assets. Therefore, the choice of the logistical strategy to be followed becomes even more crucial, since it is necessary to maximise their utilisation, always in combination with a

simultaneous effort to achieve smooth cooperation between the entities involved. This calls for a thorough investigation into the obstacles that hinder the exploration of innovative solutions to address these challenges.

1.3 Purpose of the Thesis

The purpose of this thesis is to examine, within the context of supply chain and logistics, to what extent collaboration can enhance disaster response and recovery efforts. The study collects and analyses data from various actors from Rhodope, Greece, involved in humanitarian logistics operations in the wider territory of Thrace. Through the analysis, insights are intended to be delivered on how this network functions, elaborating on the measures taken before and throughout the disasters. It will also explore the resources utilized, identify existing deficiencies, and discuss the requirements to address them. To conduct the research and evaluate the current situation, the thesis will focus on three main questions:

Question 1: What is the present situation regarding cooperation between the actors involved in the field of humanitarian logistics in Rhodope, Greece?

Question 2: How can the main barriers faced by the humanitarian supply chain network be mitigated through better strategic choices and technology integration?

Question 3: In what ways can improvements in cooperation frameworks enhance the overall effectiveness of humanitarian supply chain management during disaster relief operations?

1.4 Limitations

The study is limited to the local level and the assessment of collaboration between specific actors, who are mainly active in Thrace regions that were affected by major incidents over the last years. Furthermore, given the quantitative nature of the research, the extent of the knowledge to be acquired relies heavily on the participation and contribution of the stakeholders in the study. If key stakeholders are not willing or able to provide the necessary information, the depth and accuracy of the analysis could be harmed. Finally, the limited time frame for conducting the research may not be sufficient to thoroughly obtain and analyse the data collected.

1.5 Thesis Outline

The thesis begins with an introductory chapter that highlights the increasing frequency and complexity of humanitarian crises, emphasizing the need for effective coordination among involved key actors in humanitarian logistics operations. The second chapter of the literature review explores global strategies and theoretical approaches in disaster management, focusing on logistical networks, facility optimization, and transportation planning.

Third chapter explains the methodology that used to gather insights for the research across four organizational categories. Data analysis in the fourth chapter reveals the current state of the humanitarian supply chain in the Rhodope region. The perspectives of the participants regarding critical issues they face are extensively explained, and the research questions posed at the beginning are comprehensively addressed. In the fifth chapter, is summarized the range to which the discussions and analyses in the study have practical relevance and can genuinely contribute to a district like Rhodope. Finally, practical implications are proposed, along with intriguing topics for future research.

2. Literature Review

In this section, is presented a review of the literature, based on papers that demonstrate efforts to address humanitarian logistics problems through various disaster response and recovery strategies. These are either currently being used, or have been used in the past, in various relief operations. Including them in the thesis helps in the subsequent research analysis, by first allowing the linking and highlighting of common elements between the strategies and the findings, and second, by helping in the deepening understanding of the extent to which the current local level of humanitarian logistics aligns with practices and standards in other regions of the world. The literature review is divided into three parts: logistics network and facility location problem, transportation planning and routing optimization problem, and theoretical approaches for better disaster management and more effective operation of the humanitarian supply chain.

2.1 Logistics Network and Facility Location Problem

Sheikholeslami and Zarrinpoor (2023), discussed the vital problem of disaster preparedness. They argued that the degree of preparedness and the subsequent overall performance of humanitarian activities, depends to a large extent on the design of an integrated logistics network. The bi-objective model developed, was derived from a fuzzy interactive programming approach and two meta-heuristic algorithms. From its application, the logistics costs were reduced, the reach and speed of response was enhanced, and the allocation and utilization of resources including personnel and fragile supplies was optimized, ensuring timely and adequate distribution during critical phases of disaster management. Verma and Gaukler (2015) stressed the critical issue of optimizing the pre-positioning strategy of disaster response facilities, responsible for storing relief supplies to mitigate the impact of large-scale emergencies. They employed both deterministic and stochastic modelling approaches, incorporating distance-dependent damages to critical facilities and population centres. Main findings revealed that the stochastic model significantly reduces the expected cost of delivering procurements and improves the placement of key facilities, especially in the budget constrained scenarios, compared to the deterministic model.

Yahyaee and Bozorgi-Amiri (2019), described the challenge of mitigating the adverse effects of natural hazards by structuring a relief logistics network under interval uncertainty and the risk of facility disruption. They proposed a robust mixed-integer linear programming model that is suitable for unpredictable environments and applied it by conducting experiments in real-world case scenarios. Results showed that, the model performs well under conditions of uncertainty, but it was underlined that the need to exchange even more accurate data on crucial locations and facilities during emergencies is great, for a more efficient handling of them. Working in the same context, Boonmee et al. (2017) analysed the issue revolving around optimizing the location of key infrastructures, such as distribution centres, warehouses, hospitals, shelters, etc., for disaster response. The methodology used was based on the separation of facility location problems into various types (deterministic, dynamic, stochastic, and robust) and the application of different models with exact and heuristic algorithms to each type. The results demonstrated a significant reduction in response times and expenses, highlighting its adaptability to different high-stress scenarios and improving overall logistical effectiveness.

Tofghi et al. (2016) dealt with the problem of designing a humanitarian logistics network with central warehouses (CWs) and local distribution centres (LDCs), preparing vulnerable urban areas specifically for potential earthquakes. The methodology involved a two-stage scenario-based possibilistic-stochastic programming model that integrates fuzzy and random data to manage uncertainties. Outputs showed a more cost-efficient network layout with improved response times and strategic positioning of supplies, strengthening the area's resilience to disasters. Apart from the part of preparedness and on-site confrontation, there is the part of recovery. This is where Sadeghi et al. (2021) focused, by studying the important challenge of locating the appropriate facilities to provide aid in the aftermath of natural calamities, which cause significant economic and human losses. To solve this problem, the authors developed a multi-objective mathematical model using an evolutionary meta-heuristic optimization algorithm. The main results demonstrated that the model effectively minimizes shortages in relief supplies, transportation costs, and the sum of constructing new distribution centres, yielding reliable solutions with reduced computation time for large-scale scenarios.

Mete and Zabinsky (2010) examined the issue of determining storage and distribution sites for medical supplies as well as the necessary inventory levels for each type of supply. They formulated a two-stage stochastic programming model, that incorporates specific disaster

information and potential impacts using real-life urgent scenarios. Its implementation revealed the model's usefulness in minimizing transportation duration and unsatisfied demand, providing reliable and cost-effective solutions for disaster preparedness and response. While Moeini et al. (2015) explored the benefits of the strategic placement and reallocation of ambulance fleets during emergencies. They proposed a dynamic model that adjusts ambulance locations based on real-time data, providing improved coverage compared to traditional static models. The study's numerical experiments demonstrated significant upgrades in coverage and responsiveness, which are crucial for effective emergency medical services during multiple crises. Continuing in the framework of medical logistics, Chen and Yu (2016) went one step further and dealt not only with the strategic location of ambulances in disasters, but with finding optimal temporary locations for Emergency Medical Services (EMS) facilities in the aftermath of a catastrophe to minimize travel distance for ambulances. The methodology involved formulating the problem as a capacitated facility location problem, utilizing integer programming, and a heuristic algorithm to handle large-scale instances efficiently. The main results demonstrate that the proposed network-based facility location method significantly enhances the effectiveness of EMS during disaster response, allowing for easier and more direct distribution of pharmaceuticals and other paramedical supplies to the affected people.

In an effort to find the optimal depot locations for humanitarian logistics service providers, in order to minimize transportation costs and response time during disaster relief efforts, Stienen et al. (2021) developed two different optimization models. A nominal optimization model that integrated historical data and a robust optimization model to better handle uncertainties in future sites and disaster scales. The results showed that both models function well, with similar performance in several cases. What made the difference, however, in favour of the robust model was its clear predominance in worst-case scenarios, where it ensured resilience and much lower transportation charges.

Table 1
Facility Location problem literature

Authors	Objective	Facility Location Type	Methodology
Boonmee et al. (2017)	Optimize the location of key infrastructures to reduce response times and expenses	Distribution centres, warehouses, hospitals, shelters	Exact and heuristic algorithms
Chen and Yu (2016)	Find optimal temporary locations for emergency medical services (EMS) to minimize travel distance for ambulances	Temporary emergency medical services facilities (hospitals, medical centers, pharmacies and drug stores)	Integer programming with Lagrangian Relaxation and a heuristic algorithm
Mete and Zabinsky (2010)	Select optimal storage locations for medical supplies and determine the required inventory levels for each type of medical supply	Warehouses	Two-stage stochastic programming
Moeini et al. (2015)	Strategic placement and reallocation of ambulance fleets during emergencies, to provide better coverage of demand points	Ambulance fleets service points	Integer linear programming
Sadeghi et al. (2021)	Locate the appropriate sites to optimize aid distribution	Relief distribution centres	Meta-heuristic and fuzzy algorithms
Sheikholeslami and Zarrinpoor (2023)	Design an integrated logistics network to reduce total costs and maximize network coverage	Distribution centers, shelters, hospitals, temporary care centers	Fuzzy programming with two meta-heuristic algorithms
Stienen et al. (2021)	Find the optimal depot locations to enhance the performance of humanitarian logistics service providers	Depots	Nominal and robust optimization
Tofghi et al. (2016)	Design a humanitarian relief chain to improve resilience and optimize cost efficiency and response times	Central warehouses (CWs) and local distribution centres (LDCs)	Possibilistic-stochastic programming with a differential algorithm
Verma and Gaukler (2015)	Optimize the pre-disaster positioning strategy to enhance the availability and efficiency of emergency supplies	Distribution centres, warehouses, hospitals, shelters	Deterministic and stochastic programming
Yahyaee and Bozorgi-Amiri (2019)	Facilitate the opening of new facilities pre-disaster, manage the transportation of relief items and minimize expected costs post-disaster	Shelters and distribution centers	Mixed-integer linear programming and robust optimization

2.2 Transportation Planning and Routing Optimization Problem

Vitali et al. (2017), highlighted the vulnerabilities in evacuation strategies for individuals without personal vehicles, during catastrophic events such as wildfires. They presented a model based on a metaheuristic algorithm for optimizing bus routes during evacuations, focusing on minimizing the total duration. It was proven that dynamic routing strategies can significantly reduce transportation times from collection points to shelters using public means, emphasizing on the importance of collaboration and communication through the exchange of real-time data. Further research on this section has been done by Hou et al. (2023), focusing on the traffic problem, which hinders the proper execution of humanitarian logistics operations during disasters and specifically wildfires. The Support Vector Regression (SVR) model that was developed, can forecast traffic conditions during wildfires by integrating traffic speed, flow data, and meteorological conditions. Its predictions enabled better management of evacuation and distribution routes, reducing congestion and facilitating quicker actions, thereby improving preparedness and response strategies during wildfires.

Continuing in the wildfires’ framework, Das et al. (2020) focused on the logistical challenges in rescue, relief, and rehabilitation operations during such type of calamities, particularly in densely populated and traffic-congested areas. To tackle this problem, the authors suggested a mathematical model, through which they attempted to optimize the transportation and distribution of aid resources, factoring in traffic density and route suitability metrics. The primary results confirmed the authors' reasoning, demonstrating that response times and costs were minimized, and resource mobilization and distribution in urban disaster scenarios were significantly upgraded.

In 2019, Li and Chung posed the dilemma of choosing between Capacitated Vehicle Routing (CVR) and Split Delivery Vehicle Routing (SDVR) when delivering critical supplies to a population in need after a disaster. Both models were applied to large-scale problems using a robust optimization technique, employing identical objective functions and the same two-stage heuristic method. Researchers concluded that SDVR, manages uncertainties more effectively, reducing total travel time and costs while increasing the reliability of supply deliveries in periods of distress. Yin et al. (2023) sought to resolve the issue of resource transportation in post disaster phases due to routing problems, through the use of drones in cooperation with

trucks. They presented a robust optimization model designed for scenarios lacking accurate data on commodities needs and travel conditions. Findings showed that this collaborative approach reduces operational and penalty expenses, while expanding reach and productivity, as drones independently scout road conditions and deliver supplies on time.

Choosing the right routes is a significant challenge in designing transportation networks for crisis situations. Minimizing network length, travel time, and the number of routes through each link are crucial aspects that greatly affect the success of humanitarian logistics operations. Within this context, Nikoo et al. (2018), developed a multi-objective integer programming model that balances total travel time and the volume of emergency trips per network link. Results suggested that managing the distribution of route-links prevents bottlenecks, enhancing the robustness and efficiency of the transportation network during aid efforts. Sabouhi et al. (2019), featured a simultaneous routing and scheduling system of vehicles to transport individuals from affected zones to shelters and supply them with essential relief goods. They proposed a mixed-integer linear programming model to optimize these specific logistics procedures. This integrated approach proven superior in coordinating evacuations and commodity allocations, significantly reducing total arrival times of vehicles at affected areas, shelters, and distribution centres, augmenting total operational performance of aid supply networks.

Zhao and Wong (2021) addressed the weakness of government agencies and other stakeholders to make rapid and informed decisions, to avoid traffic troubles and ensure safer logistical procedures. They identified the problem of inability to decide in the lack of sufficient input data when conducting traffic simulations. Thus, they created a traffic simulation model, which included data from previous cases too, focusing on variables such as fire speed, departure time distribution, towing of items, transportation modes, Global Positioning System (GPS)-enabled rerouting, and phased evacuations. The results indicated that the effectiveness of recovery operations can be strengthened through the proper utilization of all available data and variables. This necessitates fostering communication and establishing partnerships for the collective benefit. As just mentioned, the existence of past data and their integration into strategic planning efforts for catastrophe response is of high importance. Thus, X. Huang & Song (2018) discussed the challenge of logistics delivery during unexpected events, emphasizing in the lack of historical data on key parameters such as demand and travel times. They proposed an emergency logistics distribution routing model based on uncertainty theory, employing a

cellular genetic algorithm for optimization. It was shown that this model provides reliability and optimizes routing plans since the total arrival time of the required material at the affected areas is reduced.

M. Huang et al. (2011), argued that the classic Vehicle Routing Problem does not adequately cover all humanitarian needs during calamities, as it focuses on specific issues. Thus, they brought to the spotlight another challenge that exist in humanitarian aid operations, that of providing fair and equitable service among recipients. The authors proposed performance metrics to quantify efficacy and equity, using analytical properties and computational tests to explore how these objectives influence routing structures and resource distribution. Their main findings showed that achieving a more equal distribution of services to the affected population requires detailed preparatory work, with multiple possible routes and scenarios, always prioritizing based on the objective and demand of the region concerned. Simple rules-of-thumb are considered necessary to give coordinators better control over the fleet and routes.

Table 2
Transportation Planning & Routing problem literature

Authors	Objective	Transportation Planning or Routing Method	Methodology
Das et al. (2020)	Minimize response time and cost in transporting relief items and resources to densely populated disaster-affected areas	Incorporating traffic density metrics and road conditions to select optimal routes	Novel mathematical modelling-based approach
Hou et al. (2023)	Predict traffic performance to develop better emergency traffic control plans and improve the effectiveness of evacuations	Intergrating real-time traffic and meteorological data	Support Vector Regression (SVR) method
Li and Chung (2019)	Plan vehicle routes for delivering critical supplies effectively and equitably to a population in need post-disaster	Comparing Capacitated Vehicle Routing (CVR) and Split Delivery Vehicle Routing (SDVR)	Robust optimization with a two-stage heuristic algorithm
M. Huang et al. (2011)	Achieve quick and sufficient distribution of relief supplies while ensuring equitable service to all aid recipients	Last-Mile delivery considering various performance metrics	Integer programming with heuristic algorithms
Nikoo et al. (2018)	Determine optimal routes for emergency vehicles to balance total travel time and facilitate response activities	Generate paths between origin-deistination considering length, travel times and number of paths	Multi-objective integer programming
Sabouhi et al. (2019)	Minimize vehicle arrival times for evacuating people to shelters and distributing relief commodities	Simultaneous routing and scheduling, considering capacity limitations and split delivery	Mixed-integer linear programming with a memetic algorithm
Vitali et al. (2017)	Optimize bus routes for evacuations, focusing on minimizing total duration from risks zone to safe shelters	Scheduling bus routes, considering the capacity of buses and shelters	Greedy Randomized Adaptive Search Procedure (GRASP) metaheuristic algorithm
X. Huang & Song (2018)	Minimize the total arrival time of needed materials at affected areas	Routing with uncertainty in demand, vehicle capacities and travel times	Cellular genetic algorithm
Yin et al. (2023)	Develop an efficient routing strategy to support humanitarian logistics in delivering relief resources to affected areas	Truck and drone method under uncertainty	Robust mixed integer linear programming with branch and price (BPC) algorithm
Zhao and Wong (2021)	Improve evacuation efficiency and ensure safer logistical procedures	Route mapping considering past data and multiple variables	Traffic simulation model and Dijkstra's Algorithm

2.3 Theoretical Approaches for Disaster Response

Sheppard et al. (2013) discovered significant gaps between management strategies and ground realities in disaster logistics, suggesting that decision-making and operational control need to be decentralized to municipal and city levels to integrate local capacities in a better way. Through semi-structured interviews with local responders in affected areas, they gathered insights, revealing the necessity of involving local NGOs and the private sector in emergency preparedness and response. The findings advocated for developing training centres and strategically placing warehouses to ensure the immediate availability of relief supplies, thus improving logistical efficiency and responsiveness. The role of local NGOs in humanitarian aid efforts was further explored by Miller and Mach (2021), as they analysed their actions in wildfire response and recovery, by examining the challenges of providing resources and immediate logistical support while simultaneously dealing with staff mental health and inter-organizational coordination issues. NGO representatives were interviewed about major wildfire incidents they were involved in 2017 and 2018. The main outcomes suggested that improved coordination and effective disaster response relies on pre-existing personal relationships, adaptable management, and prior disaster experience.

Moreover, Maon et al. (2009) spotlighted the collaborative challenges of disaster relief supply chains with commercial supply chains and underpinned that cross-sector collaborations between corporations and aid agencies have to be developed in order to improve the responsiveness and performance of humanitarian actions. The authors proposed a dual-cycle qualitative model of prevention, planning, reaction, and recovery, and suggested that the integration of corporate Supply Chain Management (SCM) capabilities into disaster relief operations could result in better operational results and service to affected populations. The study concludes that such integration could reduce costs and response times during crises.

Sharing both tangible (e.g. supplies, infrastructure) and intangible (e.g. skills, information) resources between stakeholders during humanitarian crises, has a huge contribution to the overall improvement of the coordination of relief logistics operations. On this topic, Pazirandeh and Maghsoudi (2018) analysed data collected from multiple humanitarian organizations through online questionnaires. The study found that resource sharing, particularly of intangible assets, and resource complementarity significantly boosts logistical operational performance

and inter-organizational cooperation. A few years later, L’Hermitte and Nair (2021) explored the innovative idea of implementing blockchain technology to improve the sharing of logistics resources during emergency operations by addressing inefficiencies such as fragmented processes and under-utilization of supplies. The research promotes collaboration and supports the need for increased participation from commercial entities and proposes a blockchain-based system to boost communication and asset sharing among stakeholders. Outcomes revealed that blockchain can streamline processes, offer complete transparency, and guarantee faster reaction times during emergencies.

In the context of healthcare logistics, VanVactor (2012) underlined the crucial role of strategic planning and efficient resource allocation in ensuring that medical facilities are prepared to handle disaster situations. In his methodology is included detailed planning to consider different scenarios, involving potential supply line disruptions, to maintain an uninterrupted flow of medical supplies. The study brings attention to the integration of logistics planning with broader emergency management strategies to create a holistic response, leveraging shared resources and skills. Additionally, Heaslip and Barber (2016) examined the role of military involvement in humanitarian logistics, with a focus on improving civil-military coordination during disaster reaction. They proposed a logistical model, based on interviews with core personnel, describing the phases of military contribution from immediate aid delivery at the first moments of a catastrophe to long-term recovery. The findings highlighted the importance of gradual involvement and the need for clear transitions between different stages of disaster response and recovery, to enhance humanitarian logistics procedures.

Leadership challenges in collaborative multi-organizational settings during relief efforts are also discussed, emphasizing the conflict between traditional intra-organizational leadership styles and the needs of inter-organizational cooperation. Under the occurrence of catastrophic events, Uhr (2017) suggested that leaders need to balance between authoritative decision-making within their organizations, and cooperative consensus-driven approaches across entities to achieve the desired recovery results. The proposed framework calls for re-evaluation of leadership qualities and traits like adaptability and confidence, to support effective collaboration in critical occasions and high-risk environments. Dubey et al. (2022) studied the impact of agility in humanitarian supply chains, focusing on information sharing and supply chain visibility to create swift trust and commitment, elements which are crucial for amplifying efficiency in disaster aid efforts. The study used a theoretical modelling approach and survey

data from NGO respondents to confirm that these factors significantly strengthen agility. It successfully links the foundational theories with practical implications, providing a thorough understanding of how relational dynamics and information processes influence agility in relief logistics.

Over the years there have been several studies, such as the one just mentioned, that have been undertaken to underline the usefulness of the agile strategy in the humanitarian supply chain. Cozzolino et al. (2012) though, analysed when and how to embrace agility in combination with lean principles. Utilizing a case study approach focused on the United Nations World Food Programme's operations, they proposed an original conceptual framework to identify in which specific stages of the humanitarian logistics are these tactics more effective. The findings indicated that agility is essential in the immediate response phase for rapid aid delivery, while leanness is crucial in the reconstruction phase for cost-efficient, long-term recovery efforts.

Table 3
Theoretical approaches for disaster response literature

Authors	Objective	Theoretical Approach	Methodology
Cozzolino et al. (2012)	Identify when and how to embrace agility with lean principles in humanitarian logistics	Develop a conceptual framework that proposes a correlation between agile and lean principles	Employing a real case study of the United Nations World Food Programme to apply the conceptual framework
Dubey et al. (2022)	Understand how relational values can enhance the agility of humanitarian supply chain networks	Investigate the role of swift trust, commitment, and collaboration in building agility	Organizational information process and relational view theories with survey data from NGO respondents
Heaslip and Barber (2016)	Examine the role of military involvement in humanitarian logistics to improve civil-military coordination	Interviews with key personnel involved in military and humanitarian logistics	Proposed a logistical model describing military involvement in three phases, from immediate aid to long-term recovery
L'Hermitte and Nair (2021)	Increase the participation of commercial organizations and improve the sharing of logistics resources during emergency operations	Implementation of blockchain technology in humanitarian logistics	A blockchain-based system for communication and sharing based on Social Exchange Theory
Maon et al. (2009)	Spotlight the collaborative practices, gaps and challenges of disaster relief supply chains with commercial supply chains	Propose integrating corporate SCM capabilities with disaster relief operations, considering financial and capability	Dual-cycle qualitative model encompassing prevention, planning, reaction, and recovery
Miller and Mach (2021)	Improve coordination and effective disaster response among NGOs through pre-existing personal relationships and adaptable management	Interviews with NGO representatives involved in major wildfire incidents	Analysis of the interviews and proposal of new practises related to resource provision, mental health, and coordination
Pazirandeh and Maghsoudi (2018)	Examine the link between resource sharing and the operational performance of humanitarian organizations	Data analysis from multiple humanitarian organizations through online questionnaires	Analysis of the quantitative and qualitative data from the questionnaires using Structural Equation Modeling-Partial Least Squares
Sheppard et al. (2013)	Identify how local populations can enhance their capacity to prepare and respond more effectively to the logistic challenges after a disaster	Semi-structured interviews with local responders in affected areas.	Recommendations for decentralizing decision-making and involving local NGOs and private sector
Uhr (2017)	Discuss leadership challenges in collaborative multi-organizational relief efforts	Developing an analytical framework that proposes balance between authoritative and cooperative leadership	Proposed constant re-evaluation of leadership qualities to support effective collaboration during disasters
VanVactor (2012)	Upgrade the crucial role of strategic planning and efficient resource allocation in healthcare logistics	Employment of a conceptual approach through a review of existing literature, involving potential supply line disruptions	Integration of logistics planning with emergency management strategies for a holistic response

3. Methodology

In the quest to accomplish the purpose of the research, the selection of the appropriate methodology is of paramount importance. The method serves as the backbone of the thesis, providing a systematic plan of how, where and when the data were collected but also elements and arguments for why the research is trustworthy. A well-structured methodology ensures that the research process is transparent, reproducible, and adheres to academic standards.

3.1 Research Design

The present research falls within the quantitative spectrum. Due to the difficulty in conducting comprehensive interviews, it was decided the creation of a structured questionnaire, a type that is mostly used in quantitative research. Most of the questions, despite being of a closed type, have very detailed suggested answers. This ensures more focus and depth in the examination of the efforts and techniques of the agencies involved in humanitarian logistics operations, aiming to better understand the extent to which their collaboration boosts their actions, rather than providing one-word or brief answers that would simply compile the quantitative results. At the same time, through the detailed suggested responses, the chances of misunderstanding the meaning of the questions by respondents due to a lack of direct communication with the researcher are minimized. As a result of the previous, the research does not require the collection of a large amount of data that would ultimately lead to the acceptance or rejection of a specific existing assumption or theory. It maintains an independent path, concentrating on its own findings rather than just analysing records from previous studies in the field and depending solely on them. Existing literature and earlier studies provide a good supportive base for better understanding and deconstruction of the problem.

Nevertheless, as previously mentioned, the methodology on which the research is based is quantitative. Online questionnaires were preferred, not only because of the difficulties in conducting extensive interviews but also for other reasons. First, because the research deals with a sensitive issue. When there are questions related to the capabilities, the compliance or non-compliance to regulations by the involved organizations, and other such internal matters, respondents often hesitate to answer. Therefore, with an online survey, their anonymity is

guaranteed. At this point, it should be noted that the participants were informed through the following text that all their data is subject to the General Data Protection Regulation (GDPR).

Purpose of Data Collection: *The collection of contact information is intended for potential clarification needs or additional questions related to the research.*

Use of Data: *Your contact information will be used exclusively for the completion of the research. It will not be shared with third parties without your explicit consent.*

Data Protection: *We are committed to ensuring that your data is securely stored. All data will be processed in accordance with the General Data Protection Regulation (GDPR).*

Retention Period: *Your contact information will be retained until the completion of the study, after which it will be securely deleted.*

Your Rights

You have the right to:

- *Access your personal data*
- *Correct any inaccuracies in your personal data*
- *Request the deletion of your personal data*
- *Object to the processing of your personal data*
- *Withdraw your consent at any time*

Furthermore, as is well known, many people, despite receiving a questionnaire, do not complete it for various reasons. By targeting a specific group of organizations and individuals, this phenomenon is reduced. Setbacks in completion are considered certain, but at least the response rate is increased comparatively to the number of people it was sent to. Finally, such platforms as Google forms allow the questionnaire designer to control the number of responses through the IP address and thus the participants cannot enter the survey for the second time (Kurzahls, 2021).

With regard to the humanitarian supply chain field and given that is still developing, many ideas and concepts require exploration to establish optimal practices and models. This fact, allows considerable flexibility in collecting, comparing, and correlating data to identify commonalities. Specifically, the present thesis, focuses at a local level on the broader region of Rhodope dealing with a population, the majority of which, is not familiar with such kinds of expertise knowledge and information. Thus, it gives the opportunity to examine different

entities, collect a respectful range of data, and interpret behaviours, where the analysis of all these in the future may offer a different viewpoint on addressing humanitarian supply chain issues in the area. The importance of relief operations should not be overlooked, as all parties involved always aim at the development of current practices to be more adaptive and handle any situation. Consequently, the research can potentially serve as a helpful tool in overall improvement.

3.2 Timeline

Given the restricted academic schedule linked to this paper, conducting an extended study within the designated timeframe for the thesis was nearly impossible. Consequently, a cross-sectional approach has been adopted. This indicates that the research is limited to a specific period allocated for the master's thesis, concentrating on the present state of humanitarian logistics, especially at a local level. To be more precise, the questionnaire remained open for completion on the online platform for the selected population from 24 of July until 30 of September 2024. During this particular time horizon of the research, a cross-sectional study offered a clear overview of the significance of collaborative actions among humanitarian organizations and various local actors, emphasizing in current practices and areas for immediate improvement.

3.3 Data Acquisition

3.3.1 Data Acquisition Set up

The data gathering process was conducted using Google Forms questionnaires. This approach allowed the author to guide the overall direction of the topics and gave the participants the chance to express anonymously their personal perspective on the performance of the organization to which they belong for each topic asked. The participants were the ones who, voluntarily through their responses, attached importance to specific points and details of the survey, while at the same time an opportunity was given to them, by providing their contact details, to have further communication and follow-up questions at a later stage if it was deemed

necessary. The questionnaire was written and then completed by the participants in their native Greek language. Yet, the questions utilized in this study are available in English in the Appendix after the References section and are categorized into four main parts.

- The first part concerns introductory questions for the participants, covering which agency they belong to and what is its general role and main responsibilities in relation to humanitarian logistics.
- The second part explored how the organization is prepared before an emergency arises. If there is a general response plan, the appropriate resources, infrastructure and a proper network of communication and cooperation ready to deal with any situation.
- The third part focused on on-site disaster supply chain coordination and communication. The questions in this part aimed to gain a deeper understanding of how operations are managed, examining the current state of communication within the involved parties, the role of Information Technology (IT) and which are the main challenges faced in the response phase during the efforts of immediate service and delivery of all necessary commodities to the beneficiaries.
- The last part aimed for the participants’ personal opinions, on general context questions regarding the functioning of humanitarian supply chain at a local level.

Delays in the collection of the results were relatively long, as a result of the busy summer period schedule during which the participants were asked to complete the questionnaire. The organizations involved in humanitarian actions, to which the participants belong, face every year in the summer months many incidents of natural disasters due to the heatwave. Hence, since delays were expected, a great deal of emphasis was placed on trying to keep regular communication with the participating organizations, to obtain the valuable insights needed.

3.3.2 Data Acquisition Participants

As noted earlier, this paper explores the necessity and importance of cooperation among stakeholders in humanitarian logistics operations, in order to raise awareness of the issue and mobilize efforts for necessary improvements.

The study used a non-probabilistic, judgmental sampling technique for data gathering, an approach that is applicable on both quantitative and qualitative investigations. It enables a

thorough analysis of a carefully chosen small group of participants with certain traits from certain actors. By employing judgmental sampling, the researcher can decide which actors and individuals are most likely to offer relevant and valuable insights to help in the completion of the research (Campbell et al., 2020). As this research focuses on actors at the local level of a specific geographical area, the sample came from participants such as municipal and district elected officials who hold positions in the relevant councils, NGOs such as the Red Cross, the army and from the health sector from National Emergency Aid Centre (NEAC) employees that are involved in crisis management situations, like the transport of people in need and delivery of medical supplies. It is understood that due to the specific characteristics of the participants sought for the sample, the total population was naturally limited, but all necessary efforts were made to obtain a reliable result.

The people who are best equipped to provide in-depth knowledge are those who are directly engaged in relief efforts. However, various practical challenges, most notably, as mentioned above, time constraints, and increased workloads due to the environmental conditions of the summer season made it extremely difficult to access these individuals. Setting up direct online or telephone interviews was not only difficult but could also interfere with their duties at that time in assisting people in need. Hence, this was one of the main reasons why it was decided to carry out the research through an online survey.

In conclusion, we can infer that people who work and are present on a daily basis in the decision-making environment are considered the most suitable to provide accurate information. The first participants with whom communication was established, were the elected councillors of the municipality, as they were more accessible because of their nature, since one of their main duties is to communicate with the people who have placed their trust in them. Therefore, through their offices, their telephone and email addresses are available for the convenience of the citizens. The other entities approached were selected based on their known involvement in humanitarian operations during periods of disasters and emergencies. The efforts to approach were numerous, either through e-mails or by visiting the workplaces of the participants to promote the questionnaire. Given the heavy workload due to the time of year when they were approached, there were also people who politely declined to participate. The fact that in the broader region of Thrace, where the research was being conducted, incidents requiring

immediate response and aid delivery to those affected occur quite frequently, especially during the warmer months, made finding the required sample size even more challenging.

3.3.3 Data Evaluation

After the required number of questionnaires was collected, the evaluation and analysis of the responses could begin. The answers provided by the participants, delivered information regarding the main responsibilities in the humanitarian logistics field of the organization to which they belong, their readiness, and the action plans that exist. Additionally, they highlighted the challenges they are called to face, and of course, how they assess the current level of collaboration and communication among the involved entities and how this affects the performance of operations.

The possibility provided for the evaluation and analysis of responses as a whole with numerical data, as well as for each individual completed questionnaire, allows for comparisons not only between the organizations themselves but also among the different perspectives held by individuals belonging to the same involved party. This reveals very important information regarding the current situation and the level of collaboration within the field of humanitarian supply chain at a local level. Finally, due to the different sizes, capabilities, and responsibilities of each involved agency, it is understandable that each participant may perceive potential issues or challenges differently.

3.4 Trustworthiness of the Research

In the effort of conducting any study of any kind, especially where human behaviours, past experiences, and personal opinions are examined, trustworthiness should be ensured. While there might be limitations to a study, particularly when executed within a specific time frame, securing its trustworthiness increases the accuracy while simultaneously provides greater transparency, allowing readers to have a more effective evaluation (Ahmed, 2024).

3.4.1 Validity

One of the key pillars of a research's trustworthiness is validity, a concept that can be directly linked to other related terms such as credibility. Validity is assessed through the data collected from the questionnaires. The questionnaires were designed with the purpose of gathering insights from the involved stakeholders that would reflect the current state of their overall operation when faced with issues linked to humanitarian logistics. Hence, by targeting individuals with relevant expertise and experience, the research secures that the information collected is both relevant and reliable. The anonymity of the respondents was maintained to encourage honest and unbiased responses, thereby increasing the authenticity of the data. Finally, this particular research falls under an investigative nature, meaning that it is open to all of them for any further information that cannot be obtained through the questionnaire.

3.4.2 Generalizability

Generalizability refers to the extent to which the findings of this research can be applied to other contexts or situations. In this study, the data were collected through questionnaires distributed to individuals that are elected and actively involved in the local municipal and regional committees, to military officials, the local Red Cross branch, and EMS personnel. While the research is focused on specific organizations within a particular region, the principles of collaborative humanitarian logistics and operations are broadly applicable. The knowledge gained can potentially act as a driving force for the update of disaster response and recovery strategies in other regions with similar organizational structures and operational challenges. However, some unique characteristics of the study, such as geographical and meteorological should be taken into account when applying these findings elsewhere. The detailed explanation in this chapter of the process followed in carrying out the research enhances generalizability, as it allows potential researchers or casual readers to determine the relevance and applicability of the findings to other situations.

3.4.3 Reliability

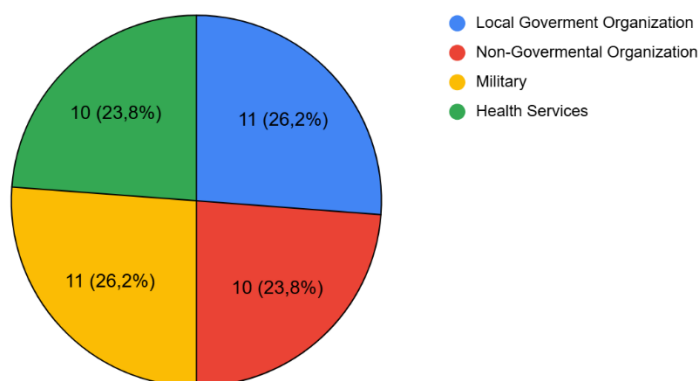
The reliability of this thesis is ensured through a consistent and systematic documentation of each move of the research process. The paper employed questionnaires with standardized questions for all participants, which ensures uniformity in the information gathered across different participants. This consistency allows for reliable comparisons and analysis, as everyone's responses are based on the same set of needs. The reliability is further strengthened by the structured design of the questionnaire, which minimizes the risk of variability in the data. By maintaining a standardized method throughout the whole process, the study guarantees the smooth collection of results, thus contributing to the overall trustworthiness.

4. Data Analysis

In this chapter, the 42 responses collected through the online survey will be analysed and subsequently interpreted, always considering the pre-existing theoretical and operational framework presented in the second chapter. For the readers' convenience and for a deeper and clearer understanding of the topic, the analysis will be conducted by isolating and illustrating each questionnaire question individually. Out of the 15 questions, the first 2 are of an introductory nature, questions 3 through 6 relate to the preparedness phase, questions 7 through 10 are about the response phase (on-site), and questions 11 through 15 are more general questions that cover broader aspects of humanitarian logistics. At the end of the chapter, the research questions posed in the first section will be addressed based on this analysis.

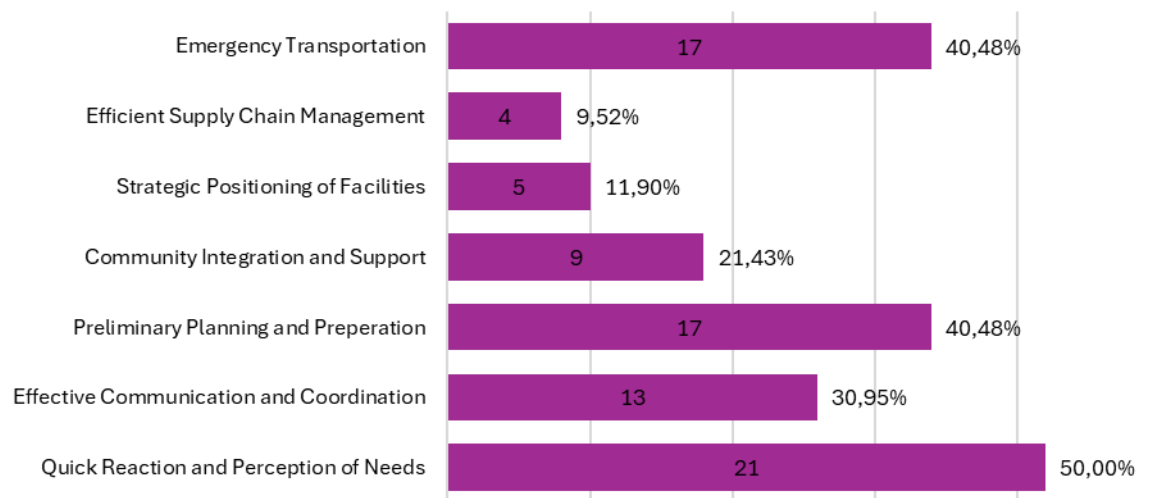
4.1 Findings

Graph 1. Which of the following organizations do you belong to?



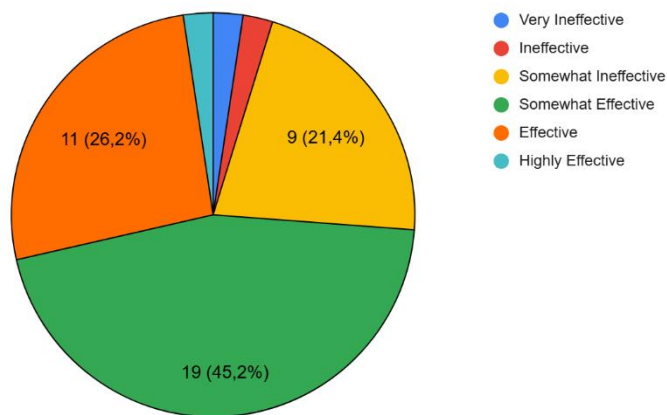
Earlier at some point in Chapter 3 of the thesis, it was noted that due to the specific characteristics required for participants to qualify for the research, the overall population was limited. The questionnaire was sent to a total of more than 100 people living and working to one of these four parties in Rhodope, Greece, of both genders, electronically via email and social networking platforms, as well as through arrangements with specific participants by visiting their workplaces and having them complete it on the spot. As it was mentioned earlier, a total of 42 individuals constitutes the final sample collected, with the exact number from each organizational category depicted in the pie chart. By gathering data from four different stakeholders involved in humanitarian supply chain operations, a variety of perspectives is obtained. This is very important as it forms a holistic view of the current practices, challenges, and opportunities in humanitarian logistics.

Graph 2. What are the main responsibilities and capabilities of the organization you belong to during disaster periods? (Up to 3 answers)



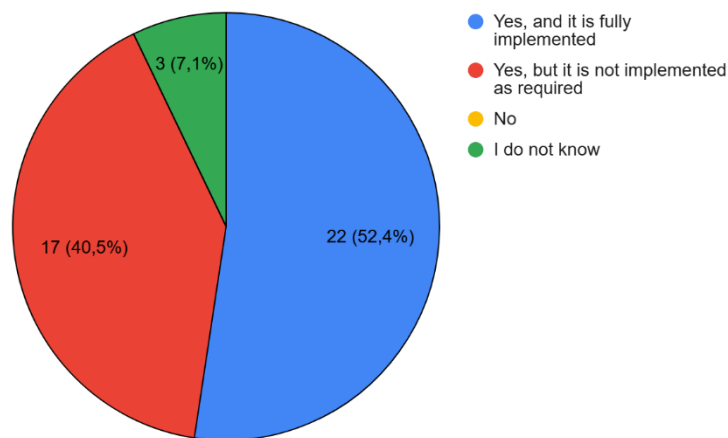
From this specific bar chart, we can identify the significant part that the assignment of responsibilities and clear roles of involved organizations play during humanitarian logistics operations. All possible answers were available to everyone, regardless of the involved party to which they belong, and participants had the opportunity to choose up to three. Thus, some responses from individuals from different organizations included the same choices. On the one hand, this indicates that different parties may share common priorities in disaster response and recovery operations. This could foster improved interaction between different entities when they work together during emergencies. On the other hand, however, it is important to clarify or delegate roles to avoid duplication of efforts and to ensure that all critical aspects of humanitarian logistics operations are adequately addressed. As shown, the involved parties in the Rhodope region place the greatest emphasis on ‘Quick Reaction and Perception of Needs’ of the existing situation, followed by ‘Preliminary Planning and Preparation’ and ‘Emergency Transportation’. The priority given to these three choices by the respondents, highlights first, the need to explore advanced technologies and real-time decision-making tools, second, the value of having detailed and rehearsed emergency plans and training programs, and third, the importance of advanced vehicles, as well as routing and tracking tools that enhance emergency transport efforts. Nevertheless, the other options should not be underestimated. Responsibilities such as ‘Efficient Supply Management’ and ‘Strategic Positioning of Facilities’ are critical for relief operations and should be given appropriate attention to ensure holistic and comprehensive actions that cover all areas of need.

Graph 3. How do you evaluate the humanitarian aid and supply network in your area, particularly in terms of its readiness for disaster situations?



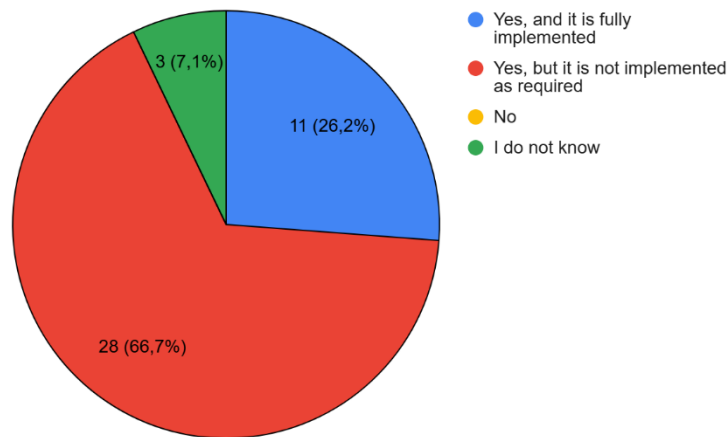
Looking at the pie chart, it is immediately apparent that nearly half of the participants, specifically 47.2%, have chosen a particular option: 'Somewhat Effective'. Additionally, 26.2% believe that the humanitarian aid and supply network functions effectively in terms of disaster preparedness. It's clear, then, that the majority of participants, people active in relief operations in the Rhodope region, indicate partial satisfaction with the network's performance, as they also leave significant room for improvements to better address and manage larger-scale issues. On the other hand, it should not be overlooked that a total of 21.4% of respondents chose to rate the humanitarian aid and supply network as either 'Somewhat Ineffective', 'Ineffective' or 'Very Ineffective'. While this group may be in the minority, their responses highlight considerable concerns regarding specific aspects of the network's disaster readiness. These respondents likely perceive issues with infrastructure, resource distribution, or coordination among organizations. Insights from the chart reveal a general perception that the local humanitarian aid and supply network is moderately effective regarding preparedness, while simultaneously pointing to the need for targeted enhancements, particularly in inter-organizational cooperation and inventory management. Integrating strategies such as those examined in the '*Logistics Network and Facility Location Problem*' subsection of the literature review, namely the pre-positioning of critical facilities and dynamic adjustments based on real-time data, could be the starting point for these targeted enhancements. This approach would potentially enable Rhodope's logistics network to evolve into a more resilient and effective system, ultimately strengthening disaster response and recovery capabilities for the community.

Graph 4. Does your organization have a predetermined plan for the management and utilization of resources, supplies, facilities, technologies, etc., during emergencies?



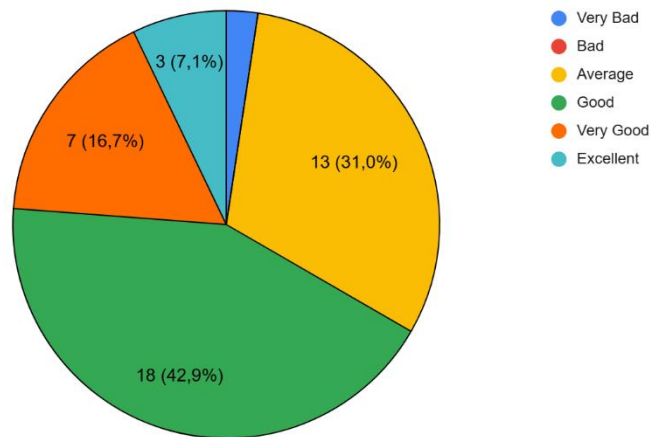
Through their responses to this particular question, 52.4% of respondents believe their organization's plan is fully implemented, or at least significant effort is being made towards its full implementation. This reveals their self-confidence, belief in their capabilities, level of preparedness, and, above all, the determination of each organization to fulfil its duties and handle emergency situations. They recognize not only the importance of having a plan in place but also the value of its proper execution. However, nearly 4 out of 10 participants highlight existing gaps between planning and execution. Despite good intentions, some organizations struggle to turn their plans into fully functional actions, potentially leaving them vulnerable in real disaster scenarios. These operational and logistical challenges could stem from various issues, such as limited resources, inadequate training, or difficulties in coordination among different departments or agencies. An additional, small but not unimportant percentage of 7.1% stated that they 'Do not know' if their organization has such a plan. This indicates a lack of internal communication or awareness within certain actors. Among the members of each involved entity in managing the humanitarian supply chain, there should be clarity. Otherwise, when disaster management plans are not fully communicated, it is likely to reduce the organization's overall readiness, especially if key personnel are unaware of procedures or protocols in place. In summary, the graph reflects a mixed state of preparedness among humanitarian logistics stakeholders in Rhodope. While more than half feel confident in their plans, a notable portion faces obstacles in achieving their desired goals.

Graph 5. Regardless of whether your organization has a separate plan, is there a common cooperation plan followed by all involved parties to ensure the best possible preparation and coordination of humanitarian operations?



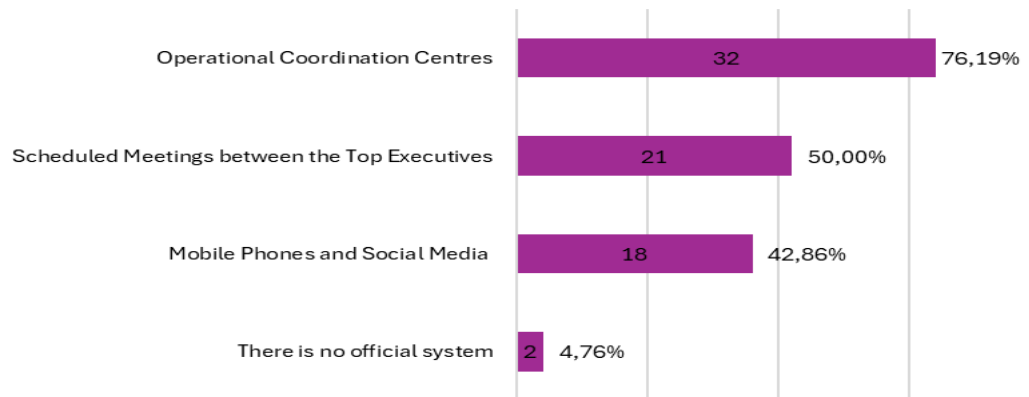
Following up the previous question, participants were asked whether, beyond the individual plans of each organization, there exists a unified plan for coordination, collaboration, and execution among the involved entities. A plan that aims primarily to clarify the responsibilities and duties of each participating organization. A notable 66.7% acknowledged the presence of such a plan but identified that it is not fully implemented. This figure marks a considerable gap between the theoretical framework and actual execution, revealing practical barriers that hinder the effective implementation of logistical relief operations. However, the key finding from this question is the significant decline in the response 'Yes, and it is fully implemented'. When asked about their own organization's predetermined plan, 52.4% of respondents stated it was fully implemented. In contrast, for this question about a common collaborative plan, only 26.2% believe it is totally carried out. This highlights the complexity of inter-organizational cooperation in humanitarian logistics. The substantial decline shows that while entities may be relatively effective in managing their own internal strategies, they encounter challenges with coordination and alignment when multiple bodies are involved. Additionally, this change may also reflect broader issues related to organizational culture, mindset, and trust. Lastly, the consistent 7.1% of respondents who stated 'I do not know' in both questions underscores a recurring lack of awareness or communication regarding these plans. This points to potential gaps in the exchange of information and training among stakeholders, which could weaken the overall response capability.

Graph 6. How would you evaluate the level of communication and collaboration between your organization and other local entities involved in humanitarian logistics operations in the pre-disaster phase?



Reviewing this chart, it appears that nearly 43% of the respondents assessed the level of communication and collaboration as 'Good'. This implies that, for the majority, the fundamental requirements for cooperation and information sharing are met, allowing operations to proceed without extreme issues. However, the 'Good' rating falls short of 'Excellent', suggesting that while major complications may not typically arise, further refinement and improvement of practices in this area, is desirable. Another prominent and significant detail is the 31% of respondents who rated the level of communication as 'Average'. This group likely experiences functional yet inconsistent communication, where information is conveyed but not always in an optimal or reliable manner, implying potential gaps or challenges that should be addressed to streamline operations. A positive aspect is the combined total of 23.8% who opted for 'Very Good' or 'Excellent'. Although this represents a minority, it is a meaningful proportion, indicating that some stakeholders enjoy effective and seamless communication that meets or even exceeds expectations. The lone response in the 'Very Bad' category, along with the absence of responses in the 'Bad' category, indicates that significant breakdowns in communication are not prevalent. Overall, the responses reveal a marginal adequately satisfactory level of communication and collaboration within stakeholders in the region of Rhodope. However, steps toward progress should still be taken to strengthen collective strategies, implement standardized protocols, enhance transparency, and foster stronger relationships among them.

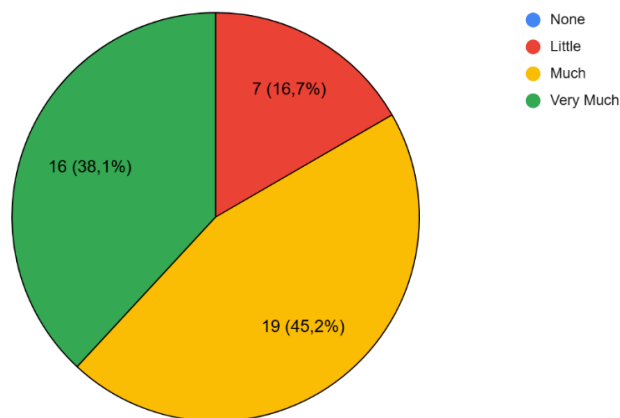
Graph 7. During a disaster, how is information regarding needs and the progress of operations shared among the various involved parties and participants? (At least 1 answer)



The participants in this question had the right to select at least one answer, as it is possible for multiple methods of information exchange to be used during a disaster. Based on the total responses, 76.19% agreed that there is a dominant method of knowledge sharing, which is through operational coordination centres. Hence, they expressed a clear reliance on formal, centralized systems where information is gathered, analysed in detail by experts in the field, and distributed among stakeholders and their leaders. This highlights the importance of structured communication frameworks during emergencies. Half of the respondents (50%) chose scheduled briefings and meetings among top executives, emphasizing in the value of having a communication system based on principles, with organized discussions, that respect the existing hierarchy for strategic decision-making and updates in challenging situations. Additionally, 42.86% of the participants indicated that they use mobile phones and social media as part of their communication approach. This significant percentage suggests that, despite the presence of formal systems, many respondents rely on quicker and more flexible channels for real-time updates, possibly due to their accessibility, especially in dynamic and rapidly evolving disaster scenarios. Only a small fraction (4.76%) reported the absence of an official system and felt disconnected from the established processes. While this may point to gaps or inconsistencies, it is worth noting that the percentage is low, suggesting that these individuals might not be making themselves the necessary steps to become more active members of this community. Overall, in Rhodope region the findings suggest a balanced use of both formal and informal interaction methods during disaster response. This combination illustrates the need for a robust central system complemented by flexible and diverse communication tools, ensuring that all relevant parties can collaborate effectively and adapt to immediate needs.

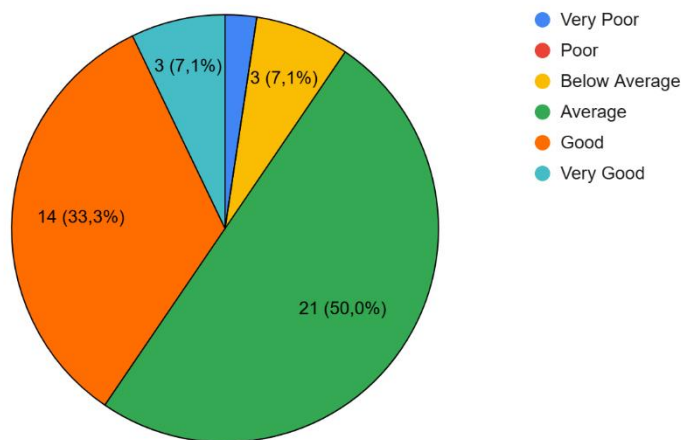
Finally, as discussed in some papers in subsection 2.3 of the Literature Review, these results remind us that each individual involved in humanitarian logistics operations, particularly the leaders, must be adaptive and agile in their approach to information sharing and, consequently, decision-making. If this is achieved, they will be able to maintain a balance between cooperative and authoritative practices and reinforce the strength of relational values among the involved organizations, significantly boosting relief logistical procedures.

Graph 8. How dependent is the course of humanitarian aid logistics operations on information technology?



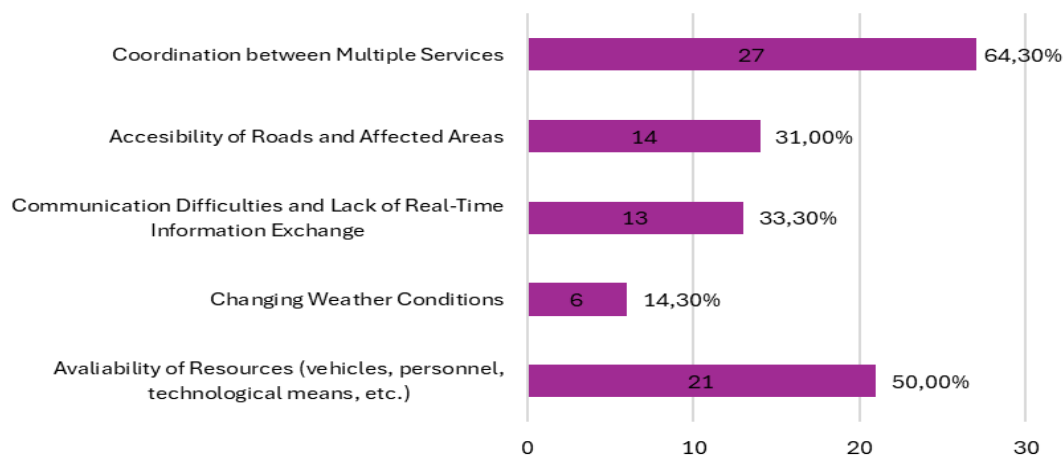
The chart serves as a common acknowledgment of the vital importance of integrating IT into humanitarian supply chain aid operations. A total of 83.3% (45.2% for 'Much' and 38.1% for 'Very Much') recognized a high dependency on IT. It is evident that most respondents appreciate the value of advanced systems, such as real-time data analytics and integrated communication networks, in enhancing the efficiency and speed of disaster response and recovery efforts. The 'None' category is absent, and only 16.7% of respondents selected 'Little', suggesting that a small proportion of participants still view traditional methods as predominant, with limited reliance on technology. The dominance of responses in the 'Much' and 'Very Much' categories implies that traditional, non-technology-based methods are becoming less relevant as organizations increasingly adopt advanced technological solutions to optimize their logistics capabilities. Sophisticated systems like AI and blockchain in humanitarian logistics are perceived as essential for improving forecasting, coordination, and secure supply chain tracking. All of the above show a desire, and perhaps even a demand, from the engaged parties in the region of Rhodope for further investment in modern and innovative IT systems.

Graph 9. Evaluate the level of collaboration and effectiveness in the planning and routing of transportation during disasters



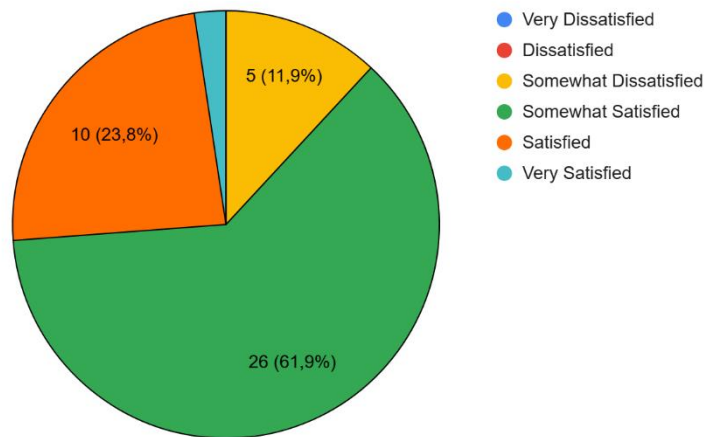
Analysing the pie chart, it is apparent that the superiority of the 'Average' response compared to the others demonstrates that, while the current transportation planning and routing efforts in disaster scenarios in Rhodope are functional, they fall short of achieving optimal efficiency. The relatively high percentage of 'Good' ratings reflects a positive perception among many stakeholders, suggesting effective collaboration in certain scenarios. An important finding is the fact that the smaller segments of 'Below Average' and 'Very Good' responses, although they represent completely different opinions, constitute the same percentage in the pie chart (7.1%). This reflects inconsistencies in collaboration, likely influenced by varying levels of preparedness and resource availability, which lead to uneven performance perceptions across the different groups involved in such activities. Only one participant chose the 'Very Poor' response, which may be due to this individual having less experience than the others, with his or her most recent involvement in this field perhaps not being that positive. Generally, transportation planning and routing during emergencies are of vital importance for the overall direction of logistics processes. As discussed in sub-section 2.2 of the Literature Review, proper designing in this area and the integration of advanced tools that assist in its implementation can provide significant results. If sufficient attention is given to the unique geographical, infrastructural, and organizational challenges, then the responses of 'Below Average' and 'Average' could shift to 'Good' and 'Very Good'. This would enable the Rhodope region to progress in this sector, creating a more unified and collaborative structure with more consistent outcomes, ultimately benefiting the affected communities.

Graph 10. What are the main challenges faced by the humanitarian supply chain during the response phase? (Up to 2 answers)



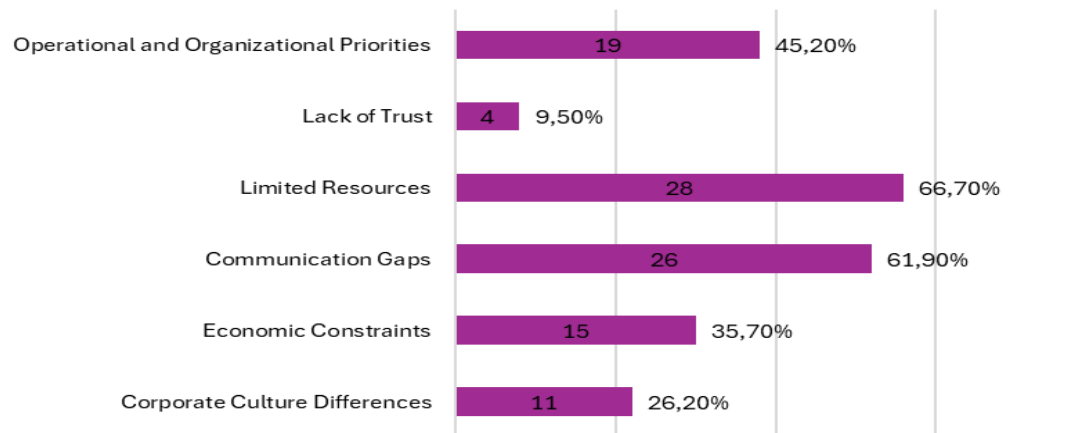
Individuals responding to this question could select up to 2 options. The bar chart shows a clear depiction of the perceived challenges in the disaster response phase among organizations operating in Rhodope, Greece. As identified, the main obstacle is the coordination between multiple services, with 64.3%. Synchronizing efforts across various bodies in order to maximize the effectiveness of logistical actions is complex. This high percentage reflects issues such as fragmented communication channels, misalignment due to diverse objectives and priorities, or problems related to trust. The second most cited challenge is the availability of resources, with half of the respondents highlighting this concern. Here is implied a shortage of critical assets, which may affect the timeliness and efficiency of response operations. Communication difficulties and lack of real-time information exchange, that noted by 33.3% of those surveyed, underlines problems in sharing timely and accurate information between the different services engaged, which is essential for decision-making during the response phase. Similarly, 31% reported the accessibility of roads and affected areas, reflecting, on one hand, the physical barriers faced due to damaged facilities or difficult terrain, and on the other hand, the importance of creating robust routing plans and resilient infrastructure. Finally, while weather can impact logistics, it is not perceived as the most pressing issue in this context, as it garnered only 14.3% of the responses. This may hint that the organizations are relatively well-prepared for common weather challenges, or that other logistical and organizational hurdles take precedence. The direction provided by the responses to this question is obvious. Although there are several areas of concern, the primary focus in the local community of Rhodope should be on improving the coordination among involved stakeholders, followed by better management and utilization of the existing resources used in the response phase.

Graph 11. How satisfied are you with the existing frameworks of cooperation regarding the functioning of the humanitarian supply chain in the overall approach across all phases of disaster management?



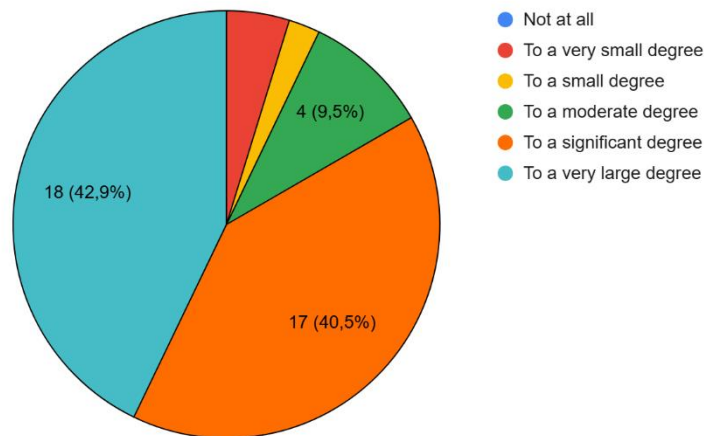
Observing the chart, it is easy to detect which category dominates the others. The largest segment of the pie chart, comprising 61.9% of respondents, falls under the 'Somewhat Satisfied' category. Men and women who are part of the humanitarian supply chain see some positive aspects and successes in the current systems, however, they also recognize that there is considerable room for development. While there are achievements, there are also times when the frameworks fail to meet the ideal standards expected by these stakeholders. Continuing, the second-largest segment of the chart belongs to the 'Satisfied' category. Although one in four respondents chose this option, the difference from the dominant category is substantial. Clearly, the presence of this percentage is valuable because it highlights the existence of positive elements and examples of strong cooperation within the existing frameworks. The small but noticeable percentage in the 'Somewhat Dissatisfied' category indicates that there are individuals who perceive more negatives than positives. They acknowledge that that serious efforts are being made to achieve the objectives, but these are often insufficient. There may be occasional successes, but overall, these frameworks present critical gaps that hinder effective disaster handling. A positive aspect is the absence of answers in the 'Very Dissatisfied' and 'Dissatisfied' categories, suggesting that even the least satisfied individuals acknowledge some degree of effectiveness in the system. Finally, the very small percentage of 2.4% who replied 'Very Satisfied' implies that significant corrections and progress need to be made for the stakeholders in the Rhodope region to feel a high level of satisfaction with the humanitarian logistics operations in which they participate. The feedback points towards a system that is not failing but one that requires strategic improvements.

Graph 12. In your opinion, what are the major barriers to effective cooperation in overall disaster management? (Up to 3 answers)



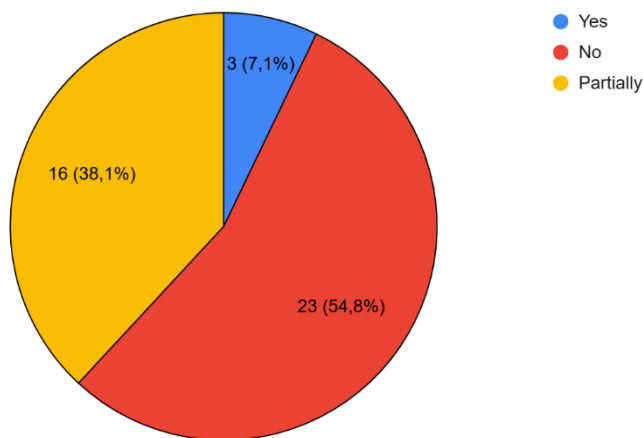
Here, participants had the option to choose up to three responses. Like question number 10, which focused on the main challenges during the response phase, the top two choices in overall disaster management are the same but appear in a different order. Specifically, limited resources ranked highest at 66.7%, followed by communication gaps, which lead to coordination issues, at 61.9%. This reversal in order in the two questions is likely because the greatest difficulties in collaboration and coordination typically arise during high-pressure situations, particularly in the response phase, and is also where dissatisfaction tends to peak. But this question encompasses all phases of disaster management, which is why limited resources stand out as the most critical barrier overall. Operational and organizational priorities, selected by 45.2% of respondents, underscore the challenges and the lack of alignment in collective disaster response strategies, leading to difficulties in harmonizing efforts and making unified decisions. It is encouraging to note that economic constraints, identified by 35.7%, were not ranked as highly compared to the previously mentioned barriers. This suggests that, in general, the necessary funding for humanitarian logistics operations appears to be available. However, the high percentage for limited resources may indicate that the available capital is not being utilized or allocated in the most efficient manner. The case of corporate culture differences, selected by 26.2%, arises from varying organizational norms, practices, and values. Consequently, misunderstandings can occur when attempting to collaborate across sectors. Therefore, addressing these contrasts is essential for building a more cohesive response framework where diverse entities can work together smoothly. Finally, lack of trust was reported by only 9.5% of participants as a barrier, showing that while trust issues do exist, they are not seen as a primary concern compared to the other barriers identified.

Graph 13. To what extent do you believe that improving cooperation can enhance the effectiveness of humanitarian logistics operations?



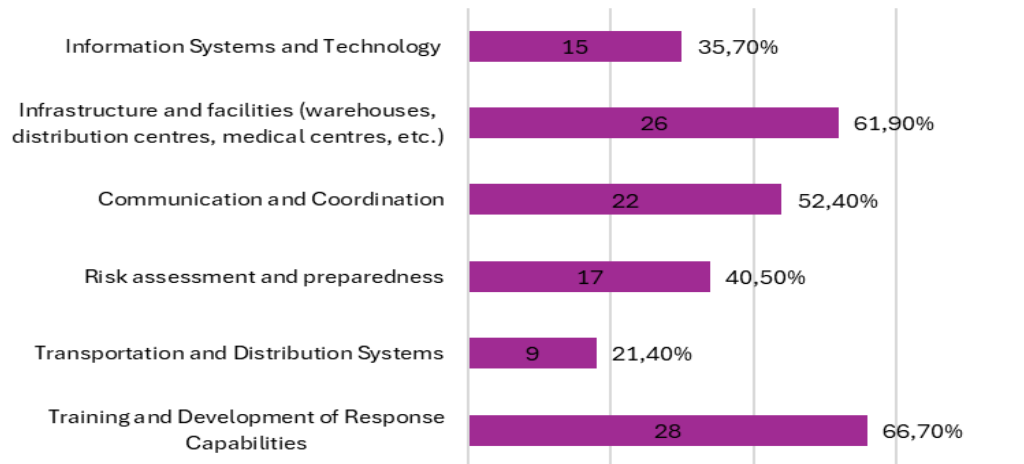
In this graph, the data is clear and leaves no room for doubt, as 42.9% by selecting the option 'To a very large degree', strongly believe that improving cooperation can significantly enhance the effectiveness of humanitarian logistics operations, while 40.5% chose 'To a significant degree'. This means that nearly 83.3% of the respondents marked the need to prioritize the building of long-term relationships, improvement of communication, and the of fostering resource-sharing mechanisms to optimize disaster response and recovery. To achieve these goals, it is crucial first to address inequalities between larger and smaller entities in terms of influence and decision-making and to promote greater balance in information exchange, always without risking the protection of sensitive data. Improvements in this area will automatically benefit and enable involved parties to maximize their impact, reduce inefficiencies, and ensure that aid reaches those in need promptly and equitably. The other three categories selected, which collectively account for 17.7%, may indicate an awareness that other factors, such as infrastructure, resource availability, and technology, also play a role in determining the success of these actions.

Graph 14. Do you consider the training and education provided regarding the functioning of the humanitarian supply chain sufficient for disaster management?



These findings highlight several important conclusions about disaster response and recovery in the region of Rhodope, Greece. The overwhelming consensus of 92.9% (54.8% 'No' and 38.1% 'Partially') among survey takers points to deficiencies in the current educational framework for humanitarian supply chain operations. This suggests that the existing training programs may be either too theoretical, generic, or not tailored to the specific incidents faced by individuals in disaster management roles in this region. Given that responses came from a diverse group of stakeholders, including the military, local government councillors, NGOs, and health service workers, underscores the need for a more collaborative and comprehensive approach to training. By pooling knowledge and resources across these sectors, training programs could be designed to better reflect the operational realities and challenges of disaster management. The minimal percentage of people who consider the education and information sufficient (7.1%), indicates that existing efforts have had limited impact, or perhaps lacked widespread implementation. To address this, local entities involved in humanitarian logistics should prioritize investment in practical, scenario-based training and continuous skill development. Enhancing the quality and scope of educational programs is essential to improve disaster preparedness and response. Overall, the data marks the critical need for targeted improvements in the education and training provided for humanitarian logistics operations in Rhodope. Strengthening these aspects through collaboration and adapted approaches will likely lead to enhanced disaster response and recovery in the area.

Graph 15. Based on your experience, which aspects of the humanitarian supply chain require immediate improvement? (Up to 3 answers)



In the final question of the questionnaire, the aspects of the humanitarian supply chain that require immediate improvement in this specific local region are underlined. The participants ranked the ‘Training and Development of Response Capabilities’, as the area that needs the most immediate improvement with 66.7%. This aligns with the overwhelming response to the previous question regarding the adequacy of training, where participants were very clear. It underscores the huge need for developing and improving both individual and collaborative skills, practices, and strategies aimed at minimizing human suffering. Also, it seems that the belief in the importance of resources and their utilization appears to persist, as the second area for improvement ranked with 61.9%, is the enhancement of infrastructure and facilities. Upgrading this field would directly reduce the negative impact of the barrier of limited resources, as with more, newer, and more modern facilities, resource management would improve even if those resources remain somewhat quantitatively insufficient. The top three areas requiring immediate attention in the Rhodope region are completed with the issue of ‘Communication and Coordination’. Aligning the mindset and efforts of various stakeholders must be set as a top priority to ensure that relief operations are not inadvertently undermined. Risk assessment and preparedness was also identified from many, with 40.5% emphasizing the need for better pre-disaster planning and risk management frameworks. Furthermore, as noted in question number 8, nearly all participants (83.3%) agreed on how crucial IT is for advancing aid logistics actions. However, in the overall management of disasters across all phases, they placed IT systems and technology lower, at 35.7%. This reveals that while they recognize IT as a significant aspect requiring improvement, they believe that if the other, higher-priority

areas (based on the percentages) improve, can compensate for any weaknesses that might arise due to this. Finally, the percentage for transportation and distribution systems (21.4%) reflects the answers from question 9, where 80.5% of the participants evaluated the level of collaboration and effectiveness in planning and routing transportation during disasters as either 'Average' or 'Good'. It appears to be functioning relatively well compared to other areas or is seen as less critical in the current context. All of the above indicate that Rhodope faces systemic challenges that may hinder the considerable efforts being made during emergencies. Therefore, responsible authorities must prioritize investments in these critical areas to upgrade human logistical mechanisms and strategies.

4.2 Research Questions Outcomes

Based on the above findings from the online survey questions, the summaries of the three research questions posed in subsection 1.3 will be discussed. These summaries will help readers to better understand the findings and to answer some of the logical questions that arise, while keeping in mind the existing limitations mentioned earlier. These questions may be whether or not other empirical studies and research such as those in the Literature Review match or not with the findings of this thesis, to what extent these findings strengthen or weaken the theory on which the thesis is based, or which of the existing statements in chapter 2 that stated previously can be justified by this study (Nenty, 2009).

4.2.1 Outcome of Research Question 1

What is the present situation regarding cooperation between the actors involved in the field of humanitarian logistics in Rhodope, Greece?

By its very nature, humanitarian supply chain necessitates collaboration among numerous individuals and consequently organizations, to achieve optimal performance (Wisetjindawat et al., 2014). Rhodope, like other regions, includes multiple entities in this collaborative effort, each contributing with their own capabilities and resources. However, true cooperation requires the synthesis of these diverse characteristics and elements into a unified system for the effective execution of relief operations. An overview of the results reveals that cooperation in Rhodope's humanitarian logistics reflects a system that is functional but fragmented. During the pre-emergency phase, organizations demonstrate higher levels of internal trust and relatively

satisfactory completion of their individual plans. However, inter-agency cooperation is blocked by pivotal execution gaps and coordination challenges. The overall supply chain network, particularly in terms of disaster readiness, falls short of being considered sufficiently effective, highlighting issues such as infrastructure inadequacies and inefficiencies in resource distribution. In the response phase, the collaboration required for transportation planning and routing remains below the desired level. Key concerns identified, include difficulties in coordination and limitations in resource availability. Dealing with these issues entails a re-evaluation of existing training programs. Greater investment of time, and more attention to detail in disaster-specific training is essential to bridge skill gaps, enhance interaction among stakeholders, and thereby improve task execution during emergencies. Overall, although the foundation for achieving better performance exists, there are vital deficiencies in key areas of planning and organizing which hamper the efforts made. There is a need for targeted interventions to create a more cohesive and resilient humanitarian logistics system in the region.

4.2.2 Outcome of Research Question 2

How can the main barriers faced by the humanitarian supply chain network be mitigated through better strategic choices and technology integration?

The first step towards a change in handling the barriers that arise and affect the functioning of the humanitarian supply chain must be taken long before the critical moment arrives. In every country, city, or region, and likewise in Rhodope, strategic decisions must be made at an early stage with the aim of achieving the best possible functionality of the entire chain and, resultantly, serving the affected communities. The present research highlighted problems for this specific local area, which have been studied and discussed for other regions, as described in Chapter 2. For example, literature such as Verma & Gaukler (2015) and Tofighi et al. (2016) stress the issue of strategic pre-positioning of essential facilities and supplies. Having identified resource availability and utilization as a key problem in the overall disaster management by the participants, the integration of advanced predictive analytics using artificial intelligence could further refine pre-positioning strategies by forecasting demand and enabling real-time adjustments. Furthermore, the participants largely recognized the inadequacy in training methods. Improved cross-sector training programs, tailored to local disaster contexts, which

will mandate the presence of all involved organizations, can improve preparedness and operational efficiency both during disasters and in the recovery phase. As also pointed out by VanVactor (2012) the sharing of resources and skills creates a holistic approach that ensures better handling of emergency situations and maintains an uninterrupted flow of critical supplies. Once thorough studies are conducted and collective decisions that are widely accepted by all are made, then common plans, protocols, and procedures can be developed that will bring real benefit to the region of Rhodope.

4.2.3 Outcome of Research Question 3

In what ways can improvements in cooperation frameworks enhance the overall effectiveness of humanitarian supply chain management during disaster relief operations?

By stressing the value of collaborative frameworks within the context of the humanitarian supply chain, it becomes possible to highlight ideas and systems that were previously unknown or undervalued. As a result, their implementation or use was either delayed or entirely neglected. Respondents, as evidenced by the very high percentage in the corresponding survey question, strongly agreed with the idea that enhancing cooperation can improve the effectiveness of humanitarian logistics operations. Their opinions align with the existing literature presented in Chapter 2, which underscores the importance of collaboration. Hence, by focusing on improving the interaction among involved stakeholders, not only are the immediate challenges of coordination and resource management addressed, but overall, a more resilient and efficient system is created, better equipped to respond to future disasters with greater agility and impact. Foundations are also laid for building strong bonds of trust, coupled with an increased sense of solidarity. Furthermore, aligning responsible entities by setting common goals provides an opportunity for smaller regions, such as Rhodope, to seamlessly integrate the best possible practices used on a global level and to harmonize with them. In conclusion, strengthening collaborative frameworks supports both the theoretical and relational aspects through the development of solid relationships, and the practical aspects through the application of upgraded practices. These improvements can also lead to the reduce of the impact of barriers and ultimately serve as essential pillars for the continuous enhancement of disaster response and recovery outcomes.

5. Conclusions

As mentioned in the introductory chapter of this work, humanitarian supply chains operate under extremely high levels of uncertainty, particularly in our times due to climate change and wars. Given the diversity of disasters (fires, earthquakes, floods, typhoons, etc.) and the unique characteristics of each region where they may occur, many factors must be considered to provide the best possible assistance to the affected societies. This implies that thorough preliminary work is necessary to maximize the readiness of the involved organizations. At the same time, this entire process places critical burdens and responsibilities on their shoulders, as the essence of relief operations ultimately lies not only in their proper execution but also in the protection of human lives.

Across all the existing literature, it is emphasized that, due to the complexity and unpredictability prevailing in this field, the mechanisms for confronting challenges must be continuously revised and updated. New methods must emerge to ensure the smoothest possible execution of humanitarian logistics processes and to reduce related struggles. Achieving these goals requires proper collaboration and coordination among the participating entities, within the framework of creating a unified front. This entails setting aside disagreements and personal interests while promoting collaborative practices and policies. However, as previously noted, each region has its own characteristics and capabilities, which makes the securing of these objectives even more challenging.

In the region of Rhodope, Greece, based on the research conducted for the thesis, the state of humanitarian logistics appears to be at a moderate level. On one hand, there are certain aspects where the prerequisites and foundations for the proper management of disasters are in place. On the other hand, there are many areas that require immediate improvement, as they prevent the effectiveness of logistical relief procedures from reaching optimal levels. Undoubtedly, in such a complex operational environment, it would be very ambitious to describe the improvement of all these aspects as easy. It is extremely difficult, if not impossible, due to the unforeseeable nature of disasters, and under such pressure, for any system to operate at 100%. What can be done is to collectively establish and constantly adjust priorities based on the specifics of each case, guaranteeing the best possible handling.

Within this framework, the participants in the study consider collaboration to be a fundamental pillar of success. The foundation of this pillar strengthens as major issues that already exist or

arise are resolved or substantially mitigated. For example, poor resource allocation and utilization, limited infrastructure, training programs not adapted to current conditions, or the replacement of outdated IT systems with more modern ones. Enhancing the collaborative framework among stakeholders is imperative for making progress. By achieving progress in this field, Rhodope could potentially serve as a model and operate as an example for other regions with similar geomorphological characteristics and organizational capabilities.

5.1 Practical implications

It is clear that not every issue identified through the research can be resolved or have its countermeasures implemented within the same timeframe, at the same speed, and with identical results. Some issues are more complex, while others are simpler. Perhaps the most applicable implication emerging from the research, which was also identified by the respondents as the aspect requiring the most immediate improvement, is the investment in training and education. As noted by Sheppard et al. (2013) in the literature review, the establishment of training centres where individuals from all involved stakeholders participate and practice simultaneously in realistic disaster scenarios will enhance collaboration and understanding of conditions. This, in turn, will significantly improve responsiveness to affected areas.

Additionally, another feasible solution is the creation of new infrastructure or the upgrade of existing ones. In the broader area of Rhodope, there are underutilized buildings and land that could serve as strategically positioned points. Actors involved in humanitarian logistics operations should exploit their knowledge of the region and its peculiarities to make the best possible use of these elements. For instance, placing warehouses stocked with essential items for disaster victims near areas particularly vulnerable to disasters, such as wildfires during the summer months, will not only enhance immediate response and recovery efforts but also help entities maintain a clearer and more structured overview both before and during their operations.

At the same time, these two interventions could potentially result in money savings, which could then be allocated to other areas in need of improvement, such as communication and information technologies. Gradually, this would not only lead to improvements but also foster a robust collaborative culture and mindset, laying the foundation for a resilient humanitarian supply chain.

5.2 Future Research

Since the paper focuses solely on the region of Rhodope, one direction for future research could be a comparison with neighbouring areas such as Xanthi and Evros, as well as other regions. To what extent can these findings be generalized, adapted, or implemented in other regions with differing or similar demographics, geomorphological characteristics, and disaster profiles? On the one hand, it would be valuable to examine how collaborative humanitarian logistics strategies evolve in different environments (urban versus rural), providing a broader understanding of regional dynamics. On the other hand, if the characteristics of the regions being studied are similar to those of Rhodope but the outcomes of the applied practices differ significantly, what might be the underlying reasons for this discrepancy?

Moreover, the research did not focus on specific policies related to relief operations, which may vary by region depending on the individuals or entities in charge. Hence, future studies could explore the role of policy involvements and governance structures in enhancing disaster readiness and inter-agency coordination, offering insights into systemic improvements. Finally, beyond the role of the involved organizations, the participation of the affected communities themselves could be studied. How can local communities engage and collaborate with the relevant authorities in the planning and implementation of disaster logistics operations? This could lead to the development of frameworks for incorporating real-time feedback from affected populations into the disaster response processes.

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Appendix – Survey Questionnaire

Purpose of Data Collection: *The collection of contact information is intended for potential clarification needs or additional questions related to the research.*

Use of Data: *Your contact information will be used exclusively for the completion of the research. It will not be shared with third parties without your explicit consent.*

Data Protection: *We are committed to ensuring that your data is securely stored. All data will be processed in accordance with the General Data Protection Regulation (GDPR).*

Retention Period: *Your contact information will be retained until the completion of the study, after which it will be securely deleted.*

Your Rights

You have the right to:

- *Access your personal data*
- *Correct any inaccuracies in your personal data*
- *Request the deletion of your personal data*
- *Object to the processing of your personal data*
- *Withdraw your consent at any time*

Questionnaire structure

Introductory questions

1. Which organization from the following do you belong to?
2. What are the main responsibilities and capabilities of the organization you belong to during disaster periods?

Preparation before the disaster

3. How do you evaluate the humanitarian aid and supply network in your area, particularly in terms of its readiness for disaster situations?
4. Does your organization have a predetermined plan for the management and utilization of resources, supplies, facilities, technologies, etc., during emergencies?
5. Regardless of whether your organization has a separate plan, is there a common cooperation plan followed by all involved parties to ensure the best possible preparation and coordination of humanitarian operations?
6. How would you evaluate the level of communication and collaboration between your organization and other local entities involved in humanitarian logistics operations?

Coordination and cooperation during humanitarian logistics operations at the disaster site

7. During a disaster, how is information regarding needs and the progress of operations shared among the various involved parties and participants?
8. How dependent is the course of humanitarian aid operations on information technology?
9. Evaluate the level of collaboration and effectiveness in the planning and routing of transportation during disasters.
10. What are the main challenges faced by the humanitarian supply chain during the response phase?

General content questions

11. How satisfied are you with the existing frameworks of cooperation regarding the functioning of the humanitarian supply chain in the overall approach across all phases of disaster management?
12. In your opinion, what are the most significant obstacles to effective cooperation in disaster management?
13. To what extent do you believe that improving cooperation can enhance the effectiveness of humanitarian logistics operations?
14. Do you consider the training and education provided regarding the functioning of the humanitarian supply chain sufficient for disaster management?
15. Based on your experience, which aspects of the humanitarian supply chain require immediate improvement?