



“School of Social Sciences”

“Master in Supply Chain Management”

Postgraduate Dissertation

**“The Role of AI in Decision-Making and Coordination in the
Humanitarian Logistics Sector”**

“Panagiotis Pantiris”

Supervisor: “Thomas Dasaklis”

Patras, Greece, January 2025

Theses / Dissertations remain the intellectual property of students (“authors/creators”), but in the context of open access policy they grant to the HOU a non-exclusive license to use the right of reproduction, customization, public lending, presentation to an audience and digital dissemination thereof internationally, in electronic form and by any means for teaching and research purposes, for no fee and throughout the duration of intellectual property rights. Free access to the full text for studying and reading does not in any way mean that the author/creator shall allocate his/her intellectual property rights, nor shall he/she allow the reproduction, republication, copy, storage, sale, commercial use, transmission, distribution, publication, execution, downloading, uploading, translating, modifying in any way, of any part or summary of the dissertation, without the explicit prior written consent of the author/creator. Creators retain all their moral and property rights.



“The Role of AI in Decision-Making and Coordination in the Humanitarian Logistics Sector”

“Panagiotis Pantiris”

Supervising Committee

Supervisor:

“Thomas Dasaklis”

Hellenic Open University

Co-Supervisor:

“Petros Pallis”

Hellenic Open University

Patras, Greece, January 2025

I dedicate this thesis to my wife and my daughter for their patience and support.

Moreover, I would like to thank my supervisor Mr Thomas Dasaklis for his valuable support.

Abstract

The integration of Artificial Intelligence (AI) in humanitarian logistics (HL) has emerged as a pivotal factor in enhancing decision-making and coordination during disaster relief operations. This dissertation looks at how AI can make supply chains run smoother, help us use resources more wisely, and bring different groups together more effectively during humanitarian efforts. It's about using AI tools and systems to respond better when crises happen. We want to figure out how these technologies can handle tough challenges like unpredictable situations, not enough resources, and the ever-changing nature of disasters. Methodologically, this qualitative research adopts Grounded Theory (GT) as a framework to generate theory grounded in empirical data obtained from humanitarian agencies and logistics professionals. These results will provide guidance on how AI can be used effectively for immediate and long-term disaster response in humanitarian logistics.

Keywords

Humanitarian Logistics, Artificial Intelligence, Decision-Making, Coordination

Περίληψη

Η ενσωμάτωση της Τεχνητής Νοημοσύνης (AI) στην ανθρωπιστική εφοδιαστική αλυσίδα (HL) έχει αναδειχθεί σε καθοριστικό παράγοντα για τη βελτίωση της λήψης αποφάσεων και του συντονισμού κατά τη διάρκεια επιχειρήσεων ανακούφισης από καταστροφές. Η παρούσα διατριβή εξετάζει πως η AI μπορεί να κάνει τις αλυσίδες εφοδιασμού να λειτουργούν πιο ομαλά, να μας βοηθήσει να χρησιμοποιούμε τους πόρους πιο αποτελεσματικά και να φέρουμε διαφορετικές ομάδες πιο αποτελεσματικά σε επαφή κατά τη διάρκεια των ανθρωπιστικών ενεργειών. Πρόκειται για τη χρήση εργαλείων και συστημάτων τεχνητής νοημοσύνης που βοηθούν στην αποτελεσματικότερη ανταπόκριση σε κρίσεις. Θέλουμε να καταλάβουμε πώς αυτές οι τεχνολογίες μπορούν να αντιμετωπίσουν βασικές προκλήσεις, όπως η αβεβαιότητα, οι περιορισμένοι πόροι και η διαρκώς μεταβαλλόμενη φύση των καταστάσεων καταστροφών. Μεθοδολογικά, αυτή η ποιοτική έρευνα υιοθετεί την Grounded Theory (GT) ως πλαίσιο για τη δημιουργία θεωρίας που βασίζεται σε εμπειρικά δεδομένα που λαμβάνονται από ανθρωπιστικούς οργανισμούς και επαγγελματίες της εφοδιαστικής. Τα αποτελέσματα αυτά θα παράσχουν καθοδήγηση για το πώς μπορεί να χρησιμοποιηθεί αποτελεσματικά η TN για την άμεση και μακροπρόθεσμη αντιμετώπιση καταστροφών στην ανθρωπιστική εφοδιαστική.

Λέξεις – Κλειδιά

Ανθρωπιστική Εφοδιαστική Αλυσίδα, Τεχνητή Νοημοσύνη, Λήψη Αποφάσεων, Συντονισμός.

Table of Contents

Abstract	v
Περίληψη.....	vi
List of Figures	ix
List of Tables.....	x
List of Abbreviations & Acronyms.....	xi
1. INTRODUCTION.....	1
1.1 Artificial Intelligence in Humanitarian Logistics	2
1.2 Research Problem and Objective	4
1.2.1. Research Problems	4
1.2.2. Research Objectives	5
1.3 Motivation	5
1.4 Structure of Dissertation	6
2. LITERATURE REVIEW.....	7
2.1 Humanitarian Logistics	7
2.2 Artificial Intelligence in Humanitarian Operations.....	9
2.2.1 Benefits	9
2.2.2 Challenges	10
2.3 Decision-Making and Coordination in Humanitarian Logistics	11
2.3.1 Decision-Making in Humanitarian Logistics	11
2.3.2 Coordination Among Stakeholders	12
2.3.3 Future Directions.....	12
2.3.4 Conclusion.....	12
2.4 Literature Gaps.....	13
3. METHODOLOGY	13
3.1 Grounded Theory	13
3.2 Expert Selection	15
3.3 Content Analysis	18
4. DATA ANALYSIS and FINDINGS	18
4.1 Overview of data collected.....	18
4.2 Thematic key areas.....	19
4.2.1. Balancing Experiential and Data Constraint in Coordination and Decision-Making	19
4.2.2. Challenges in Realizing Accurate and Timely Data for Real-Time Decision-Making in Humanitarian Logistics	20
4.2.3. The Critical Role of Coordination Mechanisms and Relationships in Managing Logistics Across Diverse Humanitarian Stakeholders.....	21
4.2.4. Enhancing Humanitarian Logistics Operational Efficiency Using AI-Enabled Optimization and Dynamic Planning.....	22
4.2.5. Maximizing AI's Impact on Coordination and Decision-Making by Focusing on the Mitigation and Preparedness Phases.....	23
4.2.6. Addressing Complex and Realistic Challenges to Integrating AI into Humanitarian Logistics Operations.....	24
4.2.7. Overcoming Human and Technological Barriers to Implement AI Effectively in Real-Time Humanitarian Logistics Operations.....	26

4.2.8.	Facilitating Collaborative AI Integration that Respects Cultural Nuances and Strengthens Coordination Among Humanitarian Actors.	27
4.2.9.	Beating Data and Information Management Challenges for efficient decision-making	28
4.3.	Thematic Synthesis	29
5.	DISCUSSION	31
5.1	Comparative Analysis	32
5.2	Synthesis of Findings	33
5.3	Implications for Practice	35
5.4	Limitations and Future Research	37
6.	CONCLUSION	38
	References	39

List of Figures

1. Figure 1. Humanitarian operation actors.....	1
2. Figure 2. Four phases of disaster management.....	2
3. Figure 3. The number of people in need of humanitarian assistance has more than doubled in the last five years.....	8
4. Figure 4. Funding gap.....	8

List of Tables

1. **Table 1.** Interview questions and their objectives related to exploring AI's role in decision-making and coordination within humanitarian logistics operations.....14
2. **Table 2.** Professional background and expertise of selected experts.....17
3. **Table 3.** Synthesis of Emerging Themes in AI for Humanitarian Logistics.....30

List of Abbreviations & Acronyms

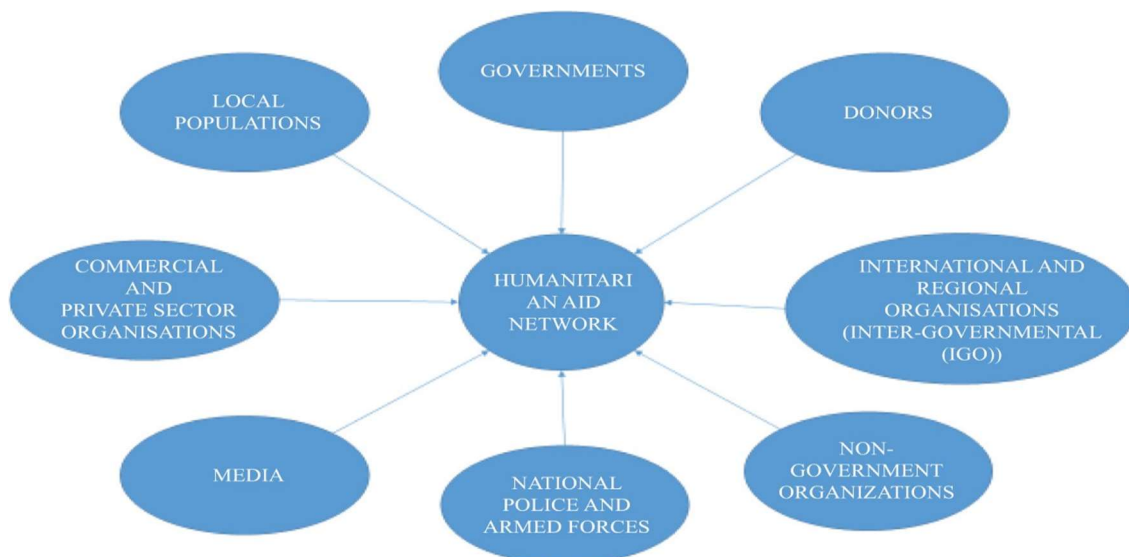
AI	Artificial Intelligence
HL	Humanitarian Logistics
GT	Grounded Theory
WEF	World Economic Forum
DRO	Disaster Relief Operation
NGO	Non-Governmental Organization
WFP	World Food Program
UN	United Nation
GHO	Global Humanitarian Overview
OCHA	(United Nations) Office for the Coordination of Humanitarian Affairs
HPC	Humanitarian Programme Cycle
ACAPS	Assessment Capacities Project
IoT	Internet of Things
PIROI	Indian Ocean Regional Intervention Platform
IT	Information Technology
WHO	World Health Organization
UNESCO	United Nations Educational, Scientific and Cultural Organization
ILO	International Labour Organization
WMS	Warehouse Management System
CEO	Chief Executive Officer
RFID	Radio-Frequency Identification
ICT	Information and Communication Technology
MSF	Doctors Without Borders

1. INTRODUCTION

The rising number and intensity of both natural and artificial disasters worldwide draw a great deal of attention towards Humanitarian Logistics (HL). In these events, whether disasters strike suddenly by nature or have long-lasting conflicts, well-timed and coordinated distribution is highly crucial to reduce human suffering in order to have the basic needs restored. Humanitarian logistics involves managing every part of this process, from planning and procurement of supplies to transport, storage and distribution of relief items and services, while facing complex and unpredictable challenges. Given that logistics can account for up to 80% of the total cost of disaster relief operations (DRO), it is one of the most vital aspects of effective crisis response (Khan et al., 2022).

Humanitarian logistics is inherently collaborative, bringing together government bodies, non-governmental organizations (NGOs), international agencies, and the private sector (**Figure 1**) (Paciarotti et al., 2021). Every player in this network operates with their own goals, rules, and ways of working, and that often makes it hard to get everyone on the same page. For example, the private sector provides many useful contributions that are often piecemeal and uncoordinated. Such a plan only leads to waste of resources. According to the World Economic Forum report for 2024, almost 80% of donations stay in storage, or it gets wasted due to a lack of solid plan to bring it all together (WEF, 2024). It identifies that there is a strong need for better mechanism and process so that the aid should reach the right beneficiaries at the right time.

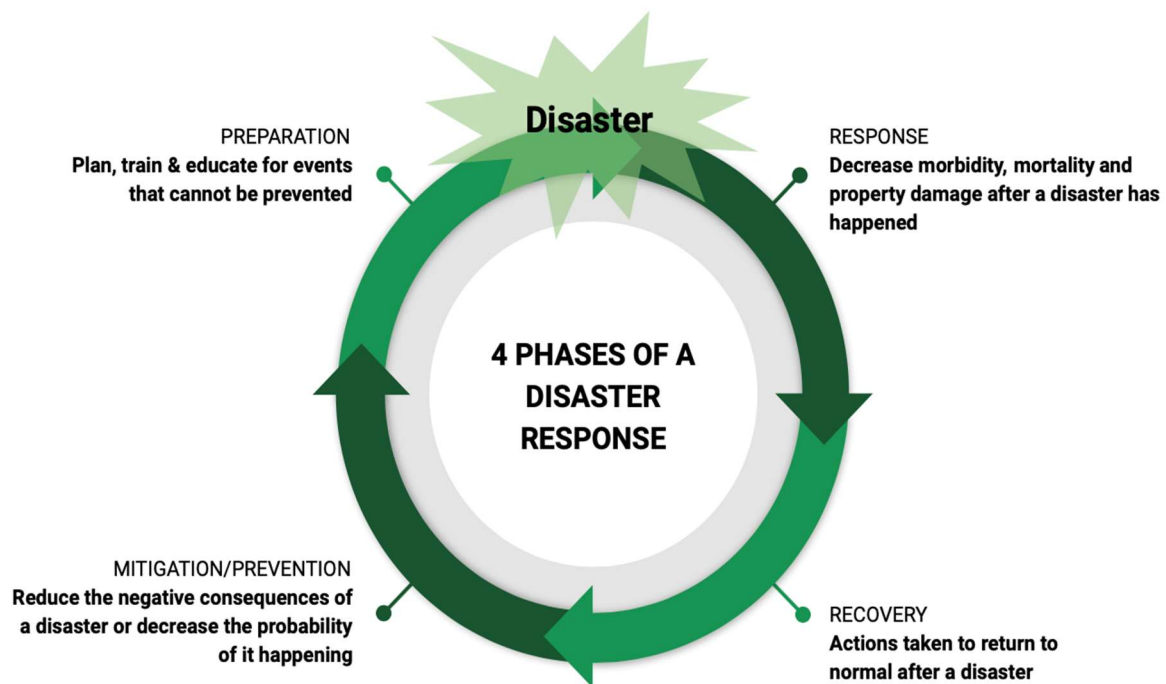
Figure 1 Humanitarian operations actors (*Claudia Paciarotti, 2021*)



The various phases of humanitarian logistics—mitigation, preparedness, response, and recovery—each demand strategic focus on logistics and supply chain elements (**Figure 2**). When disaster hits, getting help to people fast means making quick decisions and keeping everyone on the same page. However, you’ve got to figure out what’s needed, get supplies, and move them—often while facing damaged roads, fragmented information, and high-pressure schedules (Guo & Kapucu, 2020). In these scenarios, making decisions is critically relies on organizations sharing information and resources quickly. Inefficiencies or delays can slow down the process and leave people waiting even longer for the help they need. (Mohammed Zain et al., 2023).

Figure 2. Four phases of disaster management

(<https://disastermedicine.wordpress.com/four-phases-of-disaster-management/>)



1.1 Artificial Intelligence in Humanitarian Logistics

The field of humanitarian logistics is now turning to advanced tools such as Artificial Intelligence (AI) to address difficult problems, especially in uncertain and high-stakes situations (Nguyen et al., 2023). The last few years have seen the advent of a major transformation that has brought along faster disaster responses and sector efficiency through the adoption of new technologies (Płaczek & Świtalska, 2023). One such technological advancement includes Artificial Intelligence. It has made a difference between the old

decision-making process and the new coordination of efforts across different teams involved (Zarei et al., 2024).

AI tools, machine learning algorithms, and predictive analytics are deployed to use AI for the mainstream operation of supply chains aimed at disaster forecasting and resource allocation within humanitarian logistics (Singh, 2024). AI-based techniques involve predictive models that generate results by interpreting big data for predicting what occurs during a natural disaster like a cyclone or flood so that organizations can preserve supplies in advance and provide them wherever it's urgently needed (Tahla, 2024). The aid application drastically shortens response time and guarantees that relief is directed to high-need populations in a timely manner.

The UN World Food Programme optimized food distribution routes in crisis zones by harnessing machine learning as a practical illustration of artificial intelligence in humanitarian logistics (WFP, 2023). The AI algorithms analyse many different factors, including road conditions, security risks, and climate conditions, to determine the safest and fastest routes for delivering assistance. This minimizes risks to personnel and resources but also speeds up the delivery process.

Another remarkable example is the use of drones with AI to deliver medical supplies to remote or inaccessible areas (AI for Humanitarians: Introducing the Innovations - Elrha, n.d.). Zipline works in countries, such as Rwanda and Ghana, hand in hand with governments and health organizations by developing autonomous drones that deliver critical medical supplies, including blood and vaccines, to health facilities in need. Such innovation in technology has reduced delivery time from hours to minutes, saving numerous lives (Seelos et al., 2024).

It enhances decision-making using better data analysis and real-time visualizations. For example, in the humanitarian industry, AI is being utilized by organizations in the processing of satellite imagery as well as information on social media, which assists organizations to immediately make judgments regarding the consequences of disasters (Aryatwijuka et al., 2024). Thus, in the case of earthquakes or hurricanes, AI identifies damaged infrastructure and areas where people are at risk, enabling faster and more targeted actions. Moreover, platforms like Humanitarian OpenStreetMap facilitate quicker and more accurate disaster mapping and aid delivery (Fernandez-Luque & Imran, 2018).

These innovations show how AI is transforming humanitarian logistics. By automating time-consuming processes and providing detailed information, organizations are gaining the ability to respond quickly and effectively to crises (Zarei et al., 2024). As emergencies become increasingly complex, influenced by climate change and geopolitical instability, the use of AI in logistics and supply chain management is emerging as a necessity.

However, the introduction of artificial intelligence does not come without obstacles. Problems such as data protection, requirements for robust technological infrastructure and the risk of algorithmic biases are issues that cannot be ignored (Singh, 2024). We need to ensure that AI systems act transparently and that their development follows ethical rules. If the trust in such systems is compromised, humanitarian efforts will be irreparably damaged.

In conclusion, Humanitarian logistics is risky and requires rapid, coordinated action to save lives. AI is entering dynamically into Humanitarian logistics, giving us tools to help make decisions and coordinate actions. The fact that it can handle huge amounts of data with incredible speed means that actions can be timelier and more targeted. The bottom line is that when it works well, it makes a difference to those who need immediate help. We haven't seen the limit of what technology can do. As it advances, so does our ability to use it for humanitarian purposes. In the future, responses to crises can be not only faster but also more rightful. This work investigates how AI can change the face of decision-making and coordination of humanitarian operations with better resource allocations for more effective action. Sections below will discuss how AI can solve some of these complex problems of an operational nature and related issues of coordination.

1.2 Research Problem and Objective

In recent years, humanitarian logistics has faced serious challenges as disasters—whether natural or man-made—have become more frequent and more intense. These crises require immediate and highly coordinated logistical actions to meet the needs of the people affected. Yet, the sector struggles with problems that reduce its effectiveness: from the inability to predict demand to the management of limited resources, the complex coordination between multiple actors, and the need for quick decisions that make a difference. Where it really gets interesting is this: the main research question will be how Artificial Intelligence enhance decision-making process and improve coordination within this sector. How could we use the capabilities of AI to overcome obstacles and make more focused interventions in the effort to save lives?

1.2.1. Research Problems

1. Unpredictability and Demand Forecasting: Humanitarian logistics operates in an extremely volatile environment whereby resource needs are abruptly changing according to each type and the size of any disaster. It is where many conventional forecasting methods often fail and result in situations of shortage or oversupply, therefore wasting the extremely critical resources of time and money. That's where artificial intelligence comes in, analysing historical data, weather forecasts, and real-time situations for more accurate predictions of the needs that may arise.
2. Coordination Among Stakeholders: The humanitarian world is a network that comprises so many players, from NGOs and governments down to international organizations to companies. Every actor has its operational structures, its prioritized lists, and ways of operations. This fragmenting is, in fact, creating serious problems in collaborations. With the AI tools in place, the chances will be there for us to come out with generally useful coordination platforms-putting into place all missing jigsaw puzzle pieces, improved communications, avoidance of overlaps or gaps.
3. Time Sensitivity in Disaster Response: Every second counts in a disaster condition. The longer it takes to make the decision or to coordinate the action, the more lives are lost,

and with every passing moment, the condition of people in need deteriorates. Under these assumptions, AI provides support in analysing real-time data and giving suggestions based on a close scrutiny of what is going on. This would result in quick decisions and speedier mobilization.

4. AI Integration: The AI's hybridization with humanitarian logistics will pose enough challenges to face. Inadequate data, lack of interoperability among systems, extremely limited technical training, and above all, ethical considerations are some issues that one can hardly afford to bypass. These problems must be understood so we will be able to devise functional and responsible solutions suitable for such a demanding field.

1.2.2. Research Objectives

The objectives that the research seeks to achieve are as follows:

1. Mapping the Future Decision-making and Coordination Practices: How are humanitarian organizations functioning? What works? What does not work? Identify the gaps and shortcomings that cognitive agents can fill in operational logistics. Such an action illustrates peak moments when AI can give better results.
2. Discuss how AI can strengthen Humanitarian Logistic Networks: Discuss ways in which some AI tools, like predictive and optimization algorithms, promote logistics efficiency through better forecasting of needs, better allocation of resources, and smart routing.
3. Identify and Examine the Challenges to AI Integration: Try to determine what problems will surface in the practical world. Address issues related to access, technical limitation problems, and moral dilemmas. Focusing only on the benefits provides a wrong picture; examining the pitfalls is equally important. All of this will help to balance things out and help in taking an even more realistic approach toward the usage of AI in various fields.
4. Construct a Theoretical Model for AI in Humanitarian Logistics: Using Grounded Theory, develop a framework that explains how AI can improve decision-making and coordination. The model should be practical and useful for organizations that want to integrate these technologies, whether to respond immediately to disasters or to prepare for the future.

Finally, this research will help contribute to humanitarian logistics with meaning. Also, the idea is to provide concrete ideas on how AI might help improve speed and efficiency in critical situations. With smarter management and better decisions, the organizations will be able to reduce human suffering in difficult times.

1.3 Motivation

The decision to go ahead with this dissertation on the role of artificial intelligence in decision-making and coordination in humanitarian logistics is not incidental. It is based on one growing concern: global crises are increasing in number and intensity. From earthquakes and floods to protracted conflicts and pandemics, millions of people are

affected every year. This is not theory; this is grim reality that requires immediate, concentrated responses. And this is where logistics becomes so important. In the distribution of aid to vulnerable groups, speed and precision may be the difference between life and death. However, it is also a field marked by lots of deficiencies: shortage of resources, problems of coordination, and inability to make real-time decisions.

AI provides an opportunity to which we can't say no. The possibility of breaking old limitations is at the front door, supported by analytics models, decision support systems, and optimization tools. What means more than a theoretical hypothesis for me is how AI can work in an environment full of uncertainties where decisions are needed instantly and informed. At moments when resources are few and risks gigantic, such technologies become even more important.

Moreover, humanitarian logistics allows a field where the capabilities of AI are not only useful but decisive. It is not about gains in efficiency or improvement in operational indicators; it is about setting the frame for collaboration between different actors where technology can join to reduce human suffering. In presenting this research, I aim to go more than pure academic curiosity; I make certain to provide results of applicability and validity in actual practice. Thus, my key objectives would include providing clarity in the understanding of knowledge and what instruments could aid not just present-day practitioners but bring new shifts in the way humanitarian action is carried out with AI acting as a potent transformation enabler.

1.4 Structure of Dissertation

The dissertation is structured into six chapters. We begin with the Introduction, where I define the problem and objectives of the research. Here I analyse the current difficulties of humanitarian logistics, while examining how artificial intelligence (AI) can improve decision-making and coordination during crises. This section highlights the potential of AI to provide solutions with greater accuracy and speed. Chapter 2: Literature Review focuses on the fundamental concepts of humanitarian logistics, describing its importance in providing aid. At the same time, I examine how AI has begun to change the way humanitarian interventions are carried out. I focus on the benefits, such as better coordination and increased efficiency, while also discussing the challenges, such as data access problems and ethical issues arising from the use of technology. Chapter 3: Methodology explains the research strategy. I use Grounded Theory to create a solid framework for analysis, detailing data collection through interviews with logistics professionals and document analysis. My goal is to highlight the applications of AI and reveal how it impacts humanitarian logistics practice. In Chapter 4: Data Analysis and Findings, the study will present key themes and categories that emerged from the data, summarizing how AI influences decision-making and coordination in humanitarian logistics. Chapter 5: Discussion will interpret these findings considering the research objectives and existing literature. This chapter will discuss the implications of the findings for improving humanitarian logistics, addressing practical strategies for organizations to adopt AI technologies effectively. The final chapter, Conclusion will summarize the main findings of the dissertation, synthesizing the study's insights into AI's role in enhancing humanitarian logistics.

2. LITERATURE REVIEW

2.1. Humanitarian Logistics

Humanitarian logistics (HL) is, essentially, the management of the transfer of goods, information, and resources from donors to people who need them, usually in crisis conditions. This means handling everything from needs assessment to procurement, transportation, storage, and distribution of aid. Unlike commercial logistics, which pursues efficiency and profit, here the goal is speed and efficiency in supporting people in immediate danger. We are talking about activities such as providing food, medicine, water, and shelter in areas that often resemble chaos. Speed literally saves lives, something recent studies consistently emphasize (Khan et al., 2022).

Ten years ago, this work seemed important; today it is crucial. The number of crises-natural disasters, conflicts, and more-has multiplied, leaving millions of people dependent upon humanitarian assistance. UN reports are clear: humanitarian needs have more than doubled in the past decade and in 2024 reached levels no one had predicted. Within the first six months of 2024, demands have increased even more, with the estimated cost of global humanitarian aid increasing from \$46.4 billion in January to \$48.7 billion. The pressure, both on resources and on the people working in the field, is immense and shows no sign of abating. Yet, despite rising needs and harrowing decisions made by humanitarians about who, and what, to include in 2024 appeals, funding is dire. Some \$7.9 billion had been received against the Global Humanitarian Overview (GHO) requirements by the end of May 2024, which is 18 per cent lower than the amount received at the same time in 2023 (\$9.8 billion), and just 16 per cent of the requirements for this year (OCHA, 2024). **Figure 3** shows clearly the alarming increase in humanitarian needs around the world. This places immense pressure on logistics systems, which struggle to keep pace with the ever-growing demands. At the same time, **Figure 4** indicates yet another critical problem: shortages in funding. The gap between what is needed and what is available keeps increasing, adding one more obstacle that needs to be taken care of.

Figure 3. The number of people in need of humanitarian assistance has more than doubled in the last five years. Trends in people in need over the last decade, 2013–2022.

(Development Initiatives based on UN Office for the Coordination of Humanitarian Affairs (OCHA) Humanitarian Programme Cycle (HPC), ACAPS and historic people-in-need figures extracted from Global Humanitarian Overview (GHO) reports.)

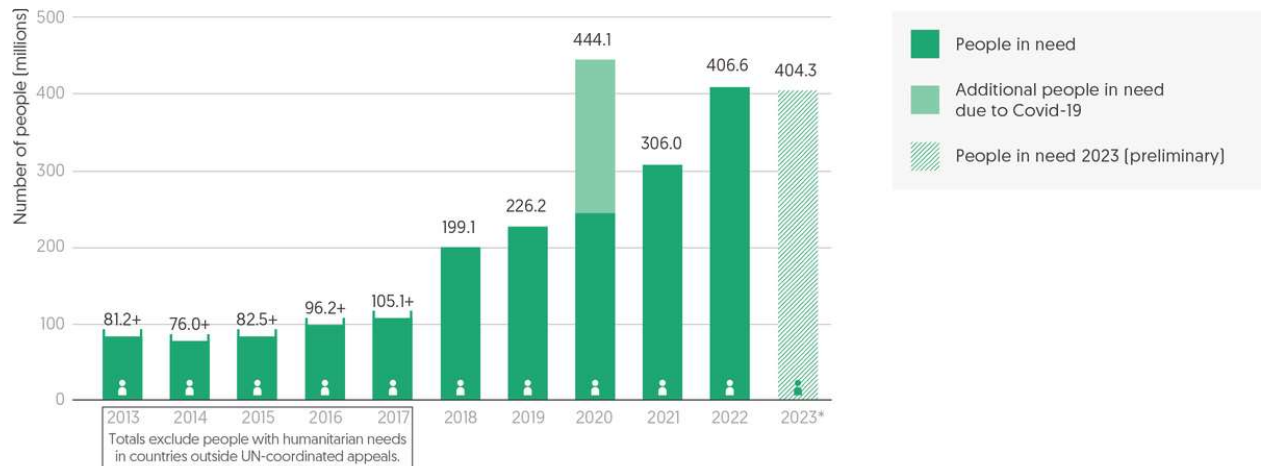
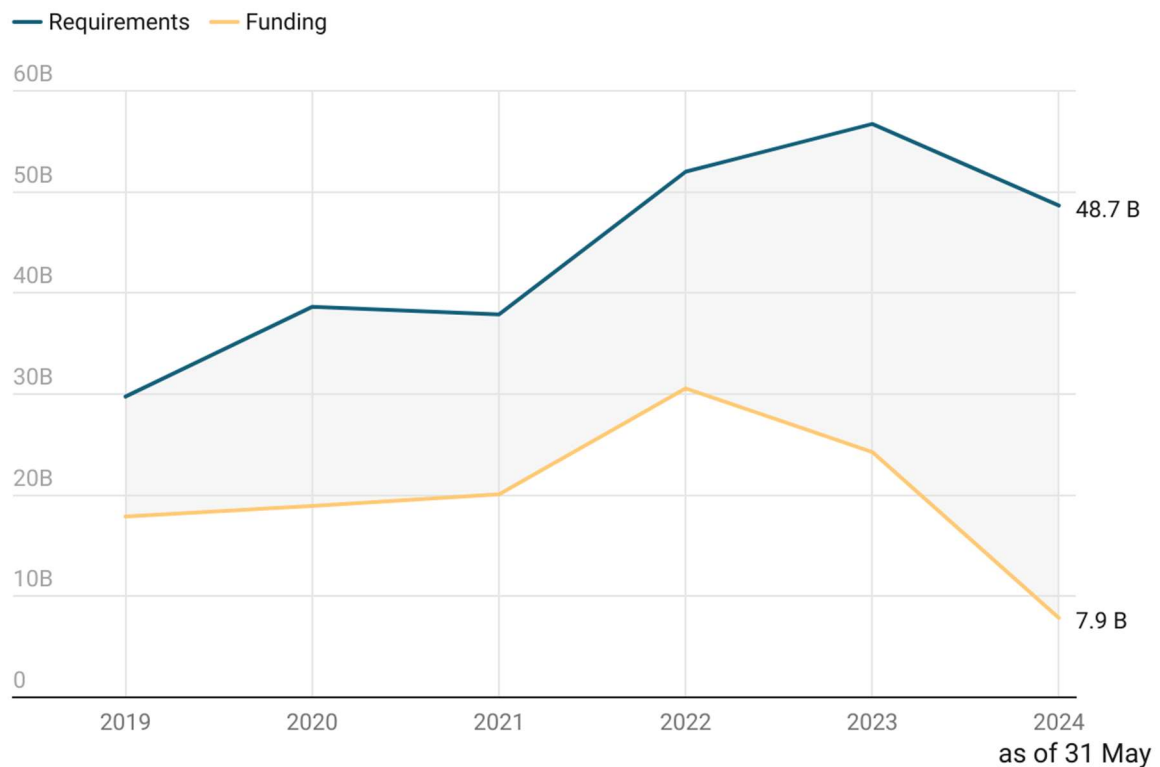


Figure 4. Funding gap. (Global Humanitarian Overview 2024 – Financial Tracking Service)

Appeals Funding Gap (2019-2024)



Humanitarian logistics take place in a complex environment, calling for coordinated interventions by government, non-government organizations, and private partners and/or international agencies. This complex environment could be bedevilled by unpredictable demand, unyielding logistical constraints, and often limited access to critical infrastructure (Schiffling et al., 2022). An overview of key metrics within humanitarian logistics, including response times, funding levels, and beneficiary coverage, highlighting the logistical obstacles that can hamper effective disaster response and underscores the necessity for strategic resource allocation to ensure adequate support for those most in need (OCHA 2024).

2.2. Artificial Intelligence in Humanitarian Operations

AI represents the game-changing difference because it now developed itself into a tool that has huge bearings on humanitarian logistics, enabling responses to be much quicker, better coordinated, and more effective. It represents a set of technological solutions aimed at replicating cognitive functions, where its scope is limited by its design, purpose, and dependency on human-defined values and inputs (Dzyaloshinsky, 2022). I see how AI systems can provide real-time updates, predict spikes in demand, route improvements, and help stakeholders exchange information immediately. These are not just technical details. They are tools that save lives when crucial decisions need to be made quickly. AI also makes easier the deep data analysis, unprecedented forecasting and time-saving automation. In humanitarian logistics field, where every minute and every decision counts, these kinds of technologies are not optional – they are essential. Of course, it is not all straightforward. There are obstacles and questions that arise with the application of AI in this field. The following sections examine both the benefits and the challenges, because nothing comes without a price or difficulty (Kahn et al., n.d.).

2.2.1 Benefits

Artificial intelligence in humanitarian logistics can offer solutions that plug the most critical gaps within conventional response systems. For example, with AI using predictive analytics enables estimates of a disaster outcome to compute the necessary relevant resources by integrating historical and real-time data (Guo & Kapucu, 2020). This will give decision-makers a chance to fast-track resource allocations and reduce instances of bottlenecks while ensuring relief reaches where it most needs to reach (Louis & Hubert, 2024).

On the other hand, the optimization algorithms make efficiency in logistics a whole different story. They also calculate the most efficient and economic routes within the complex model of emergency situations in which the most valued thing is every minute and every second; likewise, the data from AI-based decision support systems combines in various ways and builds a real overview of the real-time situation of actual status conditions for better, quick response through policymakers (Paz-Orozco et al., 2023; Khan et al., 2022). Conversely, AI facilitates the simulation of various catastrophic scenarios to test and improve supplier selection and reduce unmet demands and operational costs, while ensuring that suppliers remain profitable, thus enhancing disaster preparedness and response (Hu et al., 2024).

Furthermore, AI tools have the ability to predict trends and risks, thereby easing preparations and hastening responses to crises (Nguyen et al., 2023).

Against this backdrop, AI technologies such as face-tracking software (Trace the Face) and chatbots help reconnect families and offer critical communications to affected communities (Fernandez-Luque & Imran, 2018). Likewise, with the AI support of the camera network as well as its smart facial recognition, behaviour tracking, etc., it's possible to track and detect insurgency and to opine on early and timely reactions mitigating the violence (Swasdee et al., 2020).

One of the strong points of AI lies in improving coordination between humanitarian organizations. Systems collate data from myriad sources to build a common operating picture that helps them to prioritize their responses. Prioritizing the most vulnerable populations during the preparation phase and focusing on the most affected individuals during the response, avoids redundancy and maximize the effectiveness of available resources (Haak et al., 2018). At the same time, obstacles to collaboration between organizations are eliminated, even when there are differences in their priorities or operational values (Chin et al., 2024).

Lastly, such systems as 'cogSolv and cogResolv' have also been devised to use advanced artificial intelligence in conceiving dilemmas in conflict resolution and humanitarian response, so that the analysis context can include cultural, psychological, and pragmatic perspectives. They thus produce simulations of the cultural and psychological dynamics that help in conflict resolution acceptable to the parties involved, helping reduce biases in negotiation processes. It provides culturally sensitive mission design, reducing tensions and increasing engagement with local communities in peacekeeping operations. With reduced risks of conflict escalation, response efforts will be more effective, and it challenges old processes in order to bring about more equitable outcomes in complex, high-stakes situations (Olsher, 2015).

2.2.2 Challenges

The integration of AI in humanitarian operations management presents several challenges, which cannot be ignored despite the advantages. One major problem is that in this field, high-quality and decent data are lacking, since often reliable and available data in real time are hard to find. Without extensive and well-organized datasets, AI systems can't perform properly. Schiffiling et al. (2022) note that damaged infrastructure, security issues and a lack of technological resources are common barriers to data collection and accuracy during crisis situations.

Another major hurdle is technical incompatibility. Most humanitarian organizations still operate on outdated and antiquated systems that usually do not easily interact with modern AI platforms, which raises profound technical ground concerns that are tremendously expensive in terms of infrastructure and training (Vhikai et al., 2024). At the same time, another crucial problem is ethical implications. Many concerns are arising because we cannot ensure data privacy and accountability, especially when AI is called upon to make critical decisions (Beduschi, 2022). Ensuring the above mentioned problems is critical in order to avoid severe ethical and legal implications (Tiwari, 2023). Furthermore, the use of AI may result in ethical questions regarding independence and a potential bias in judgment (Shrivastav & Bag, 2024). Human over-reliance on machine-generated results, may lead to errors in judgment or decision-making (Milaninia, 2020). Moreover, there are many

concerns that AI could deepen societal inequalities, facilitate surveillance and authoritarian control, and influence human behaviour and decision-making (Dzyaloshinsky, 2022).

In the end, financial constraints pose another layer of complication. This adds further complications as humanitarian agencies often work with little budgetary allocation. AI solutions require resources that are hard to commit, especially in instances where funding is based on external sources (OCHA, 2024). If the money is available, then lack of technical competencies makes the roll-out complicated as most organizations lack specialized staff or adequate training to utilize AI. Here, collaborations with tech companies/ universities and other institutions would give us the solutions needed by giving access to infrastructures and tools such as training and technological support (Kouhizadeh et al., 2021).

Nevertheless, the incorporation of altruistic work with AI is not an easy task. This is a path that individually holds both challenges and opportunities. The way forward will require pragmatism, partnership, and a clear understanding of our strengths and weaknesses.

2.3. Decision-Making and Coordination in Humanitarian Logistics

Humanitarian logistics plays a critical function in disaster management and emergency response, where the quality of the response in terms of timeliness and coordination takes precedence over many other issues in the survival and sustainment of any vulnerable group. Indeed, the increase in the frequency and intensity of natural disasters, conflicts, and health crises has dictated the need for robust logistical frameworks that can respond aptly within such complex and constantly changing environments (Besiou & Van Wassenhove, 2020). Logistics applied to this emergency are limited because of the uncertainty and dynamic character of the crises; thus, the application of advanced technologies, such as artificial intelligence, could be a factor in improving decision-making and coordination.

2.3.1 Decision-Making in Humanitarian Logistics

Effective decision-making in humanitarian logistics is about planning, allocation of resources, and operationalizing activities under conditions of uncertainty, in most cases under very strict time constraints. A decision-maker, therefore, has to conduct needs assessment, prioritize interventions, and optimize the use of scarce resources with maximum value (Kovács & Falagara Sigala, 2021). The classic approaches heavily rely on historical data and human expertise, which might not be sufficient considering the unprecedented, fast-developing situations in case of disasters.

AI has the potential to be transformative because it offers tools that can analyse large volumes of information with ease and accuracy. Likewise, machine learning algorithms can process data from multiple sources, including satellite imagery, social media, and IoT devices in real-time to construct actionable insights (Papadopoulos et al., 2017). For example, this would allow the pre-emption of disasters through weather pattern modelling and geographical vulnerability. Prediction analytics hence can predict demand for relief items by prepositioning supplies and helping to cut response time (Dubey et al., 2022).

Routing decisions are bettered using artificial intelligence-powered optimization algorithms for the distribution of supplies against scenarios that could potentially be degraded through infrastructure damage, security threats, or alterations in environmental conditions. The most crucial point here has to do with the last legs of delivery to the most difficult-to-reach and

the most-affected areas (Kouhizadeh et al., 2021). Hence, AI also helps in a way to improve the response to humanitarian crises by improving the accuracy and speed of decision-making processes.

2.3.2 Coordination Among Stakeholders

Humanitarian logistics requires, in many cases, urgent calls for coordination—from the governmental, non-governmental, international agency even local community levels. It blocks the duplication of efforts, allows for the best utilization of scarce resources, and covers all the stricken areas effectively (Baki & Abuasad, 2020; Tatham et al., 2017). On the other hand, coordination faces some challenges related to fragmented information systems, different operation procedures, and gaps in communications.

AI can significantly enhance coordination in that it allows for effective sharing of information and the interoperability of completely different systems. AI-enabled platforms help NGOs, humanitarian agencies, and local stakeholders to work together, paint a comprehensive operational picture, and concurrently support planning and operation (Baki & Abuasad, 2020). Natural language processing and AI-enabled communication tools help smooth over language barriers, further sharpening international teams' understanding of each other.

Further, it can support the surveillance of the mechanisms for real-time monitoring and feedback, thus leading to dynamic plan adjustments as situational contexts develop. Such flexibility is paramount within disaster response—situational conditions may evolve rapidly, while effectiveness in planning requires timeliness (Kovacs & Moshtari, 2019).

2.3.3 Future Directions

Having fully realized the potential influence of AI on logistics in humanitarian operations, it has also called for a painful transformation of concurrent infrastructural changes. Context-specific AI applications need to be developed for very concrete challenges that can be faced in humanitarian settings. The applications should have user-friendly interfaces and tools usable by personnel and workers without advanced technical training (Papadopoulos et al., 2017).

Investment in data infrastructure and promotion of data sharing among various stakeholders will boost the quality and availability of data for AI systems. Setting standards and regulatory frameworks will ease the concerns over issues of privacy, security, and bias (Tiwari, 2023).

Collaboration among humanitarian organizations, governments, academia, and the private sector is critical. Such collaboration could help drive innovation, share best practices, and pool resources to overcome common challenges (Tatham et al., 2017).

2.3.4 Conclusion

AI can radically change our thoughts on decision-making and coordination of humanitarian logistics. For now, its strengths are its ability to process data, make predictions, and optimize resources; that appears to open the way to efficiency and effectiveness. However, that is really the hard part, as the million-dollar question remains how to unshackle those benefits for good. Poor quality data, ethical dilemmas, and lack of organizational readiness are some

of those substantial barriers that simply cannot be styled away. These need to be solved one by one—data quality comes in first. AI must be fed clean, reliable, and timely data for it to develop foresight and recommendations (Tatham et al., 2017). Most humanitarian efforts are forced to make use of incomplete or outdated data. Such a mismatch causes even the most promising AI tools to fail spectacularly. Ethical concerns form another major obstacle. Algorithm-driven decisions must be compatible with values and principles that respect life and human dignity. No one organization can do this alone. It's going to require ongoing research, collaboration, and an acceptance of failure. The bottom line? AI can make a real difference in humanitarian work, but only if we address the messy, human problems that stand in its way. Ethical considerations relating to data privacy, consent, and the risk of algorithmic bias must be firmly put into place in order to protect very vulnerable populations (Tiwari, 2023). This therefore calls for equally urgent capacity building among humanitarian organizations in terms of investments in the relevant technical competencies that would be required to implement and manage these AI technologies effectively. Future research and practice should be more geared toward developing context-specific AI solutions to enhance existing data management practices, and toward fostering partnerships between humanitarian organizations and technology providers.

2.4. Literature Gaps

Notwithstanding the growing literature on humanitarian logistics and the potential of AI, there are still several research gaps. First, while there have been some discussions of the theoretical benefits, few empirical studies have been conducted that analyse the actual impact of AI on decision-making and coordination within humanitarian logistics. Khan et al. (2022) suggested a case study and practical evaluation of how the AI tools perform when facing specific challenges that occur during disaster response operations.

Second, while much has been said about the role that AI plays in logistics optimization, little has been discussed about its ability to strengthen cooperation among humanitarian organizations. It calls for research to show how AI can close the information-sharing gap to enable different stakeholders to work harmoniously. Additionally, ethical and legal issues of using AI in humanitarian contexts need more research, especially in regard to privacy and accountability (Bedushi, 2022).

Lastly, although advances in technology occur, the reality of dependence on donor funding still prevents the humanitarian sector from easily accessing the most cutting-edge AI tools. In addition, cost-benefit ratio studies related to investment in AI within humanitarian logistics could further yield insights for resource-constrained organizations. The presence of all these gaps will be injurious to the goal of full transformation of AI in decision-making and coordination in the humanitarian sector.

3. METHODOLOGY

3.1. Grounded Theory

This paper explores AI use in decision-making and coordination for humanitarian logistics operations using the Grounded Theory (GT) methodology through structured interviews.

Logistics experts and humanitarian actors currently operating in these areas are the sample of interviewed professionals. In-depth interviews will be carried out that shall delve into exploring the status quo of practices involving AI integrations, plausible benefits, and challenges. Interviews that were structured to investigate a wide range of aspects regarding the use of AI for supply chain planning and coordination were structured but enabled unique opinions and experiences.

Following the data collection, we conducted an extensive GT coding. In particular, we carefully analysed the interview transcripts so as to identify key themes and patterns with respect to the impact of AI on decision-making and coordination as well as the perceived barriers to the integration of AI in humanitarian logistics. We conducted the analysis by using qualitative analysis software, namely MAXQDA 2022. In the sections that follow, we present our methodological approach in detail, while the list of interview questions used can be found in **Table 1**.

Table 1. Interview questions and their objectives related to exploring AI's role in decision-making and coordination within humanitarian logistics operations.

No.	Question	Objective
Q1	How do you currently approach decision-making and coordination in humanitarian logistics within operations?	To understand current methods for decision-making and coordination in humanitarian logistics operations.
Q2	How can AI assist in optimizing humanitarian logistics networks, specifically in the planning and coordination of supply chains?	To investigate ways AI can enhance planning and coordination in humanitarian supply chains.
Q3	How do you perceive the possible challenges of integrating AI into humanitarian logistics operations?	To understand the perceived challenges of incorporating AI into humanitarian logistics operations.

GT is one of the significant qualitative research methodologies that emphasizes the generation of theory directly from data, rather than testing pre-existing hypotheses typical in quantitative research (Allan, 2003; Turner 1981). It identifies meaningful words or phrases in interview data and summarizes them into codes; this process is repeated with a view to developing a coherent understanding of the underlying themes. GT sifts through data, bringing to light the important issues and setting aside less relevant information (Turner 1981; Cho 2014).

The coding process in GT enables the coherent development of a theory that helps the researcher manage the complexity arising from a large volume of qualitative data. It enables the researcher to identify relevant themes and patterns, which is quite useful for the researchers who are using this methodology for the first time (Allan 2003). GT, focusing on theoretical sampling, constant comparison, and theoretical saturation, offers a very robust framework for deep understanding of such complex phenomena as decision-making processes in humanitarian logistics. For maintaining high standards of research, critical is the mastery of intricacies related to GT, as well as its application accordingly (Charmaz 2021, Martin 1986, Chun Tie 2019). In addition, GT is adaptable to various research contexts and allows flexibility with regard to rigorous qualitative analysis (Cho 2014, Walker 2006).

Despite these strengths, most scholars have observed a number of challenges in using GT. One major challenge has been data saturation, especially among inexperienced researchers. Saturation of data, as defined by Reference (Aldiabat 2018), is a point at which no new data emerges from the data. This definition is crucial yet usually hard to understand, especially in establishing whether saturation has taken place in a study.

Besides, references Turner (1981) and Walker (2006) refer to cognitive difficulties in organizing and processing qualitative data. They emphasize that effective data management and interpretation strategies are needed in order to systematically develop GT. The iterative nature of GT involves constant comparison and theoretical sampling, which is yet another layer of complexity. Reference Charmaz (2021) underlines the importance of these elements in maintaining the quality of research and stresses that empirical grounding should be maintained throughout the study.

It is also important to understand the philosophical underpinnings of GT. Reference Cho (2014) explains the underpinnings, which help the researcher to choose the correct methodological approach. Reference Chun Tie (2019) is a practical guide through the methodologies of GT and thus makes the process easier for those who just begin working with GT. Reference Kelle (2005) discusses the basic principles of GT-especially how theories are developed from data-from both historical and philosophical points of view. Moreover, reference Martin (1986) has indicated that GT is fit for analysing complicated organizational structures. It also puts great emphasis on the feature of GT to provide contextually grounded insights. Finally, reference Timonen (2018) tackles some common challenges and provides an explicit, practical roadmap for novice researchers by covering the basic principles and variants of GT.

GT is effective when combined with structured interviews from practitioners; these are sources of primary data. The study utilizes structured, in-depth interviews in which insights provided by logistics professionals and humanitarian workers are analysed using GT's coding and comparative methods to identify patterns, themes, and relationships in qualitative data. This approach lets the theory be deeply rooted in participants' specialized knowledge and experiences, hence enriching the qualitative analysis and making sure that the resulting theory is well grounded in data and reflects real-world perspectives.

For the interviews, sample size is an important consideration. The literature suggests that one works better with a relatively small number of cases. This approach leads to a much more deeply embedded study of social phenomena and gives rise to depth and a deeper understanding than what appears or lies on the surface and obvious meaning. Qualitative research methods do not stress the statistical representative sample, neither the proportional relation among its constituent parts to capture the situations' dynamic quality (Crouch 2006).

3.2. Expert Selection

Our selection of experts sought to capture diverse knowledge and experiences from humanitarian logistics thus, participants would include strategic policy decisions and grassroots practitioners. In this regard, due to a more specialized focus again of the role AI is playing and can play both in decision-making and coordination concerning humanitarian logistic operations, we decided to use a nonprobability form, more precisely purposive sampling. In this respect, logisticians and humanitarian workers were to be selected as they took an active part in these operations, which, based on an analytical investigation, had a place in providing in-depth details not possibly feasible from adopting the probabilistic

sampling techniques, for this agreed with the in-depthness the qualitative research design emphasized more than the statistical generalization.

Five experts were chosen to take part in our structured interviews:

- **Expert A** is a Regional logistic coordinator for the French Red Cross in the southwest Indian Ocean. He holds responsibility for logistics management, procurement processes, supply chain oversight, and inventory control within the Indian Ocean Regional Intervention Platform (PIROI). Through active involvement with a number of emergency operations over recent years, he has accumulated substantial practical experience in humanitarian logistics. He brings a very high level of practical experience combined with a strategic role within the emergency response to provide valued insights into current good practice in decision-making and coordination. His view is even more relevant to our research on the integration of AI in humanitarian logistics, as he will be able to provide insights into the potential benefits and barriers to implementation of this technology.
- **Expert B** has been assigned to a new team Community Solutions Team. His job entails aligning, enhancing, smoothing, and seamless community-facing IT solutions. He works with six clusters; about 1,000 partners and stakeholders around the globe, mainly in operations but also on global projects that run the gamut of activities from reverse logistics, preparedness, anticipation and information management. His team is also currently working on different solutions and innovations in artificial intelligence and language models, among others, in using AI to improve information management and decision-making processes in the humanitarian sector. The huge amount of experience in the integration of advanced IT solutions, including AI, within a complex network of humanitarian partners, his leading role in managing information systems in emergencies, and his focus on innovation are great assets for discussing the place of AI in decision-making and coordination.
- **Expert C** started working in 2005 with the Lebanese Red Cross and took up a specialty in humanitarian logistics for close to ten years, along with huge direct involvement in work with both the Lebanese Red Cross and the Swiss Red Cross, and currently the Lebanese Red Cross search and rescue team. His extended involvement includes around seven deployments on several international missions assigned concerning logistic activities and humanitarian logistics activities. He has also provided logistician training in over eight Arabic-speaking countries, building knowledge and capacity in the region. He was selected based on his extensive practical experience related to humanitarian logistics in several countries around the world. His dual role in operational logistics and training places him in an advantageous position to bring insight into both the practical challenges and nuances of decision-making and coordination on the ground. Leadership in search and rescue operations, along with work within multilingual and multicultural environments, brings special value to how AI could be integrated to enhance humanitarian logistics. Firsthand knowledge of this will be especially applicable to our research objectives because it will further enrich our understanding of the possible benefits and obstacles linked with the application of AI technologies in humanitarian action.
- **Expert D** is a humanitarian logistics professor who has been working with projects in this field for various different organizations for over 15 years. At the moment, she is working as an Academic Director for the Research Centre at her university, undertaking work on humanitarian logistics and regional development. She is uniquely capable of amalgamating her work between academic scholarship and involvement with project work

to marry theory and practice in humanitarian interventions. The professional experience of Expert D resonates volumes with humanitarian logistics while leading in a dedicated research centre offers a particular view on the recent developments and challenges, such as the integration of AI technologies.

- **Expert E** is the chief executive officer of Relief Applications, a company he founded some decades ago, which is dedicated to the development of IT systems and solutions for humanitarian workers and organizations. Under his guidance, Relief Applications has collaborated with international bodies such as the World Health Organization (WHO), United Nations Educational, Scientific and Cultural Organization (UNESCO), International Labour Organization (ILO), various Red Cross societies, and a large number of NGOs, operating exclusively in the humanitarian and development sector. A notable achievement of his organization is the development of a Warehouse Management System (WMS) designed to help organizations manage their inventory and warehouse operations more efficiently. Before establishing Relief Applications, he gained extensive experience as a humanitarian worker and was frequently deployed with the Red Cross as the head of emergency operations. His background combines practical field experience with technological innovation, providing a unique perspective on the intersection of humanitarian work and IT solutions.

Together, these experts offer a comprehensive perspective on the role of AI in decision-making and coordination within humanitarian logistics, encompassing policy and operational viewpoints, which makes them highly suitable for interviews on this subject. In **Table 2** we provide a detailed description of the experts’ professional background and expertise.

Table 2. Professional background and expertise of selected experts.

Expert	Professional Background and Expertise
Expert A	Regional logistic coordinator for the French Red Cross in the southwest Indian Ocean. Expertise in logistics management, procurement processes, supply chain oversight, and inventory control.
Expert B	Head of Preparedness and ICT Community Solutions Team. He is harmonizing, improving, streamlining, and optimizing community-facing IT solutions.
Expert C	Volunteer with the Lebanese Red Cross since 2005, specializing in humanitarian logistics for nearly a decade. His extensive experience includes deployment on over seven international missions focused on logistics and humanitarian logistics.
Expert D	Professor specializing in humanitarian logistics. She currently leads a research centre at her university as the academic director, focusing on humanitarian logistics and regional development.
Expert E	CEO of Relief Applications, an organization that specializes in developing IT systems and solutions for humanitarian workers and organizations.

3.3. Content Analysis

The material analysis relies on MAXQDA 2022, a qualitative tool for analysis supported at each particular step regarding how to conduct the GT analysis on this tool. The analysis process will go in the following way:

1. *Coding the Data:* Coding The data in this study were qualitative, involving interviews that were already transcribed. These were subsequently coded. Guided by GT principles, the process was divided into two main phases:

- *Open Coding:* We approached the data first with open coding, that is, developing new codes for specific segments without any preconceived categories. This will enable us to note a wide range of concepts freely without any limit on the number of codes generated.
- *Selective Coding:* After this, more emphasis was given to the identification of significant higher-level codes and the structuring of the lower-level codes into these. Refining and consolidating codes in this phase were done to underline the most pertinent themes in the data.

2. *Customizing the Code System:* Successive rounds of selective coding have helped us refine our coding scheme. Organization of codes in a hierarchical structure of parent code and subcode helped explain the relationships among various concepts and develop coherence within the code system.

3. *Categorization through Creative Coding:* Concepts standing for similar ideas were grouped under categories, which gave way to the later stages of selective coding. Categories are very important because they represent the skeletal framework upon which the emerging theory is built and through which the theoretical relationships between many of the concepts delineated in the data can be uncovered and demonstrated.

4. *Constructing the Theory:* Once the categories were defined, we had a clearer view of the theoretical relationships among them. This brought us to the stage of theoretical sampling, where we further developed the emerging theory by exploring and depicting the relationships among the identified categories.

These steps define how the qualitative data were analysed systematically to develop a theory grounded in the experiences and insights of logistics professionals and humanitarian workers. In so doing, this approach enabled us to develop a deep understanding of the role of AI in decision-making and coordination within humanitarian logistics operations while embedding our findings firmly in the data collected.

4. DATA ANALYSIS and FINDINGS

4.1. Overview of data collected

This chapter synthesizes findings from in-depth qualitative interviews with five professional respondents who had rich experience working in humanitarian logistics. Professionals working in different jobs such as logistics coordination, supply chain, field operations, and strategy provided in-depth insights on the integration of AI within humanitarian logistics operations. These data were gathered through structured interviews, where in three overall guiding interview questions related to current approach, potential AI-driven optimization of

logistics networks, and challenges to integrating AI within humanitarian effort decision-making and coordination.

Based on the GT approach described in detail below, 9 thematic key areas have been identified. The use of a grounded theory methodology enabled the development of a theory inductively from the data. More particularly, we utilized the following four steps of coding that are applicable to any approach to GT: (1) Coding the data, (2) Customizing the code system, (3) Category building with creative coding and (4) Constructing the theory. The findings highlight that while AI holds significant promise for enhancing humanitarian logistics, successful integration necessitates a holistic, human-centric approach that addresses the identified challenges. This chapter aims to provide a comprehensive understanding of these complexities, contributing valuable insights for developing effective strategies to integrate AI into humanitarian logistics operations.

4.2. Thematic key areas

4.2.1. Balancing Experiential and Data Constraint in Coordination and Decision-Making

Focusing on experience and data constraints, the interviewees provided valuable insights into how the humanitarian logisticians navigate decision-making and coordination by balancing their reliance on experience with the limitations posed by data challenges and technological constraints. This complex interplay of experience and data, reveals that humanitarian logistics decision-making and coordination is a multifaceted and complicated procedure. Three main sub-themes have emerged, namely the decision-making approaches and information management, the technology utilization and the importance of human factors:

- *Decision-making approaches and information management:* Issues in data collection result in pivotal experience-based strategies. Humanitarian logisticians have used experience in disasters and local-level networks to make timely decisions with a lack of reliable data. Data-driven decisions are preferred, but technology limitations and issues of standardization in data stand in the way. Besides the challenge of real-time data gathering and lack of organizational standards for data, language and culture barriers further impede this process. These barriers affect making informed decisions directly, hence always forcing the system to rely back on experience.
- *Technology Utilization:* Software applications and technological tools exist in humanitarian logistics operations but are not utilized fully due to barriers in adoption and a need for training. The absence of automated systems like RFID, added to manual processes, reduces efficiency and effectiveness. The full potential of various existing solutions for warehouse management and information exchange is seldom realized because of resource limitation, lack of skills, or resistance to changes from traditional systems. These factors impede shifting from experience-based to data-driven decision-making and hence limit

improvement in logistics operations and timely humanitarian assistance. Addressing these barriers and investing in training will lead to better data management, hence timely data-driven decision-making for better disaster relief efforts.

- *The importance of Human Factors*: The most important assets in humanitarian logistics operations are the human factors. Most often, human experience bridges gaps left by the challenges of data; hence, this is a very critical aspect in decision-making. There is a pressing need for comprehensive training and capacity-building processes as far as wide technology adoption is concerned. These, however, face challenges in training in data systems and resistance to change by older members of staff who would prefer to rely on traditional methodologies. This unease reduces the effective use of technological tools and, in a self-feeding circle, returns to relying on experience. Human factors are of paramount importance in taking full advantage of technological improvement and enhancing efficient operations in humanitarian logistics.

4.2.2. Challenges in Realizing Accurate and Timely Data for Real-Time Decision-Making in Humanitarian Logistics

In discussing the subsequent theme, the respondents identified a number of major obstacles that stand in the way of getting accurate and timely data to make real-time decisions in humanitarian logistics. Their overall contribution sheds light on how several challenges, related to data, impede effective immediate decision-making in this field. Overcoming these challenges requires a multi-layered approach, which involves investment in intuitive and user-friendly technological solutions, improvement of data collection methods, training on a wide range of skills for staff, and encouraging a culture of data sharing and standardization across organizations. Such a holistic approach would align data management and pave the way toward informed, quicker, and better decision-making in humanitarian operations. Based on these, two important sub-themes have emerged, the time constraints and urgency and data collection and processing challenges:

- *Time Constraints and Urgency*: The urgency of disaster response significantly amplifies reliance on the experience of seasoned practitioners as there is often no time to actually conduct thorough data analysis, especially when confronted with large volumes of information. In such high-pressure situations, the need for rapid action precludes anything but a pragmatic approach where the expertise and established networks of experienced decision-makers compensate for the lack of reliable real-time data. Time constraints force swift decisions to be made in haste, often with incomplete or unreliable information, which underlines how utterly crucial prior experience is to handle uncertainties and ensure effective responses.
- *Data Collection and Processing challenges*: Among the most inhibiting factors toward real-time decision-making in humanitarian logistics are obstacles related to data collection and processing. The accuracy and reliability of the data reduces active information when most needed. Political and security issues, especially in conflict zones, further restrict access to vital data, adding layers of complexity to the collection effort. Adding to these challenges is the limitation in staff capacity. In most instances, there is a

lack of sufficiently trained personnel to collect and process data efficiently. The reliance on field volunteers for assessment introduces other problems: during disasters, the workloads for volunteers make it unrealistic for them to put in the much-needed time for inputting and analysis of data; this results in many errors and inaccuracies. Paradoxically, logisticians must face both an overload of unprocessed data and a lack of actionable insights, therefore making it one of the tricky paradoxes that complicate the decision-making process.

4.2.3. The Critical Role of Coordination Mechanisms and Relationships in Managing Logistics Across Diverse Humanitarian Stakeholders

The analysis of the interview identified that the coordination mechanisms and relationships were vital in managing logistics across diverse humanitarian stakeholders. This will become of paramount importance for multi-party collaboration to avoid duplication of effort and to improve efficiency in general for humanitarian operations. Various problems such as political interferences that could reduce cooperation, complex systems with aspects of decentralization, organizational incentives and their translation to priorities, differences in capacities, and authorities result in poor coordination. It hence remains a challenge-and requires the ideal combination of mechanisms along with good relationships-to thrive and consequently work within humanitarian logistics contexts where complexity abounds. The three important emergent sub-themes include coordination mechanisms, resource management, and political and cultural context:

- *Coordination Mechanisms*: Through stakeholder involvement and through direct communication with local governments and NGOs, and also international partners, coordination in humanitarian operations can be done in an effective and flexible manner. Cluster meetings can also be organized on a regular basis to achieve it. For coordination in logistics, building and sustaining trust will be very crucial, and open communication should be done. These methods help overcome political and cultural barriers and bridges gaps. However, information-sharing practices, though essential, are usually made complex with challenges related to data confidentiality and transparency. The reluctance of organizations to share data further exacerbates difficulties in achieving effective coordination.
- *Resource Management*: Good stock management is dependent on good data; however, inventory inaccuracy issues force reliance on past inventories, including contingency stocks, and experience. Lack of finance influences how resources are allocated and forces decisions to be made with limited data and professional judgment, using prioritization based on needs. Mechanisms that enable shared resources, such as warehouses and transport, improve coordination but require agreement on liability and standardization.
- *Political and Cultural Context*: Political and cultural contexts are some very strong influencers that affect coordination in humanitarian logistics operations and require the practitioners to hold just that correct blend of experience and adaptability. This necessitates effective interfacing with governments and sensitivity to cultural nuances. The strength of local governments becomes an influential issue: where government presence is stronger, this typically means clearer leadership and hence unified efforts. In most scenarios where governments remain weak or unstable, there is an end to scattered initiatives and responses.

Political interest and objectives worsen coordination in collaborations and may damage neutrality. These political dynamics influence everything-from beneficiary validation to data sharing-and, therefore, the overall effectiveness of humanitarian logistics operations. Moreover, coordination effectiveness is really hampered by challenges in diverse cultures and languages, since understanding and respecting local customs and practices requires a lot of caution and poses major obstacles. The ability to manage the interaction of political landscapes and cultural diversity effectively is hence imperative for successful coordination and decision-making within humanitarian contexts.

4.2.4. Enhancing Humanitarian Logistics Operational Efficiency Using AI-Enabled Optimization and Dynamic Planning

According to expert interviews, there is vast potential for AI applications in humanitarian logistics: supply chain optimization, planning enhancement, and enhanced coordination. AI improves operational efficiency through network flow optimization, improving distribution coverage, better inventory management, and resource planning with predictive analytics. Real-time "what-if" simulations enable dynamic route planning and better decision-making. By focusing investments on the most impactful areas of application of AI, building human capacities, enhancing good practice in data, and assuring human oversight, the benefits of AI can be leveraged while trying to keep the risks low. Based on the analysis, three overarching sub-themes emerge, including potential benefits, stimulating real-time "What-If" scenarios, and adaption of AI models:

- *Potential Benefits:* AI has immense potential for transforming humanitarian logistics through operational optimization, enhanced information processing, and multi-stakeholder coordination. Generally, AI increases operational efficiency in logistics networks via inventory management, resource allocation, scheduling, and modes and methods of transport. Furthermore, it updates information about shipping lines and schedules automatically, thus minimizing errors and delays. Besides, it increases the preliminary awareness of the stock to position the appropriate supplies for distribution when a crisis arises. Furthermore, AI processes and structures enormous amounts of data effectively; hence, addressing the problem of information overload, which leads to an improvement in the decision-making process. Regarding coordination improvement, AI enables effective collaboration based on real-time data analyses, instant language translation, and simulations aimed at the better preparation of organizations against eventualities. Advanced pattern recognition algorithms allow for more accurate forecasts and anticipation of future needs, thus allowing stakeholders to act proactively against emergent situations. Realizing that the effects of AI will increase with each improving stage of technology and data, one may easily deduce that the inclusion of AI into humanitarian logistics is bound to go a long way in making humanitarian responses more effective and timelier.
- *Stimulating Real-Time "What-If" Scenarios:* In dynamic route planning, AI simulations look at real-time information about traffic patterns, weather forecasts, and infrastructure status to bring into view the best roads that must be taken to reach destinations with aid. Real-time analysis allows resources to reach faster and safely. Moreover, it allows

organizations to prepare for possible challenges by investigating several types of ‘what-if’ scenarios. Modelling such scenarios allows them to make proactive changes in plans by mitigating the risks before materialization. Additionally, AI provides powerful decision support through data-driven suggestions for operational decisions. It particularly includes predictive analysis regarding resource needs through which organizations are capable of making appropriate estimations of demand and efficient use of resources. Furthermore, AI may include adaptive changes in ground circumstances, which allow the operation to be flexible and responsive. This helps an organization make the right decisions by foreseeing the probable consequences of a variety of strategies. All these capabilities eventually allow them to upgrade their planning and preparedness and build resilience with agility in humanitarian logistics.

- *Adaption of AI Models:* Such adjustment is necessary due to the requirement of AI models to be tuned to specific demands made by humanitarian operations, depending on dynamics that are quite different from those of commercial logistics, which can use extensive data with relatively stable conditions. Humanitarian logistics would often involve limited data availability along with difficult and differing environmental scenarios under severe time conditions. Therefore, AI models need to be suitably aligned with these unique conditions, constraints, and uncertainties. Hence, AI models need to be adapted to these particular conditions, limitations, and uncertainties. In summary, there is a huge gulf in scale, complexity, and above all, data availability between humanitarian and commercial logistics. To this aim, this approach will provide a better way of tailoring technically sound yet practically relevant AI solutions to enhance decision-making and coordination under severe humanitarian situations.

4.2.5. Maximizing AI's Impact on Coordination and Decision-Making by Focusing on the Mitigation and Preparedness Phases.

Focusing on the next theme, the interviewees underscored that AI offers significant tools to enhance coordination and decision-making in humanitarian logistics, particularly during the mitigation and preparedness phases. Pressing challenges present in the response phase have again balanced with human experience. The issues related to the complete exploitation of AI also concerned investment in training and questions about trusting the technology. Three main sub-themes have emerged, namely the phase-specific application of AI, improving coordination and decision making and personnel-related aspects.

- *Phase-Specific Application of AI:* AI is particularly effective in the preparedness and mitigation phases, given the availability of abundant data and the luxury of time to make an in-depth analysis. It helps anticipate and optimize resource allocation in these phases through scenario modelling of disasters that could occur. This allows an organization to plan ahead and place its resources at strategic locations. During response and recovery, on the other hand, an unfolding situation and factors that impede available data reduce any potentially improved capability of AI. The urgent for immediate action, coupled with chaotic conditions typically results in minimal good-quality data, which impedes AI systems from delivering their full range of capabilities. Integrating AI at all phases bridges these

gaps, ensuring continuity of data management and decision support. It links mitigation and preparedness to response and recovery through a flow of information that enhances coordination and general effectiveness in humanitarian efforts.

- *Improving Coordination and Decision-Making*: AI enhances coordination and decision making in humanitarian logistics through information access, improvement in analysis, and efficiency in communication. In the first place, AI helps in real-time translation and the dissemination of information between the stakeholders. This removes potential barriers in languages and ascertains that crucial information is at the disposal of all concerned parties. This greater access provides important decision support during the planning phase, hence quicker and more knowledgeable decisions. Second, AI assimilates and enhances evidence-based decision-making through better data analysis such as pattern recognition and predictive analytics. Structuring the data from the narrative reports, AI shows trends and insights that are easy to miss in manual analysis. Third, AI streamlines the channel of communication by filtering and organizing information simultaneously. It hence reduces information overload across various teams and stakeholders. The efficiency accorded to information communication enables quicker responses and more coordinated performances during crisis situations.
- *Personnel-related aspects*: Whereas AI has the best capabilities, there remains one critical and fundamental reason involving human beings in ensuring accuracy, ethical acceptance, and appropriateness of AI generated outputs. Experience in personnel is necessary to review and validate results into accuracy and making the AI systems free from errors and biased outputs. For solving all these issues, training and capability building shall be required, which means that staff must be able to use the tools of AI. For example, this includes understanding of how the algorithm of AI works, how its results must be interpreted, and its limitations. However, human judgment would also, very importantly, play a critical role in creativity, flexibility, and adaptability in situations which are unpredictable and may not be amenable to any AI. Resoundingly, human inputs are what will remain vital, and AI will result as support machinery. While implementing AI systems, organizations may be used to improving processes of decision-making, ensuring all technology advancements augment human roles rather than replace them.

4.2.6. Addressing Complex and Realistic Challenges to Integrating AI into Humanitarian Logistics Operations

In researching this theme, an in-depth examination of the views of the respondents shows that while AI holds huge potential in bringing humanitarian logistics networks closer to optimum levels, the integration of AI in humanitarian logistics operations is a complex challenge on several dimensions: securities, ethics, adoption, and applicability. Overcoming these issues will require a holistic approach: addressing limitations of adoption and applicability, data security, and maintenance of ethical practices. The major underlying sub-themes that have emerged are data security, ethical concerns, limited adoption/barriers and their applicability in humanitarian context:

- Data Security: The critical issue about humanitarian logistics bears upon the aspect of ensuring data privacy and confidentiality, good observation of restriction imposed by a donor on information utilization and the protection of sensitive data. These are critical restrictions for donor trust and adherence to the spirit of the law and ethical considerations and protecting individuals - especially the employees are working in conflict zones like Doctors Without Borders (MSF). Additionally, they safeguard proprietary information for all stakeholders involved. Beyond prevention of potential breaches and misuse of sensitive information, protection also involves maintaining the integrity and reputation of humanitarian organizations in complex and often vulnerable environments.
- Ethical Concerns: Ethics have become critical considerations at all levels in integrating AI technologies within the humanitarian logistics sector. It is warranted that organizations permit themselves to follow set regional regulations like the AI Act in Europe, targeted toward setting bounds to protect users' privacy and ensuring more transparency, and prevent the misuse of AI systems. Besides that, the environmental impact of AI, due to vast water usage in data centres and computational processes utilized in operational work at AI with cooling towers and air mechanisms, has to be countered. They have to be compliant not only legally, with the complex set of regulations, but also to demonstrate a commitment to sustainability and responsible innovation. A balance of these requirements is crucial in creating trust and accountability in their operations.
- Limited Adoption / Barriers: The enormous integration of AI into humanitarian organizations, on the contrary, presents quite a number of challenges despite the great potential of its impact. The budgetary restrictions and the donor limits presuppose the insufficiency of investment to develop such technologies like AI. The limitations are also aggravated with organizational constraints of technology such as lack of infrastructural base, along with not enough technical skill that would reject effective implementation of the AI solution. There is also some scepticism among donors regarding the efficiency and suitability of AI in humanitarian contexts, which adds to the reluctance to fund such initiatives. Beneficiaries may also appreciate the human element of things over an automated process due to the associated empathy and interpersonal connection provided by an aid worker. Outside of the economic barrier and barriers due to technology, perceptions among donors and beneficiaries are barriers in themselves to furthered adoption in AI for humanitarian needs.
- Applicability in Humanitarian Context: While AI has the potential to be truly transformative in the humanitarian sector, its current applicability is rather limited, especially for small to medium-sized organizations. Most of these organizations have limited access to data, which is one of the important ingredients in training and implementing any effective AI model. Without very large datasets, AI algorithms cannot perform optimally, hence bringing about minimal improvements in operations. Besides, most of them are of small scale, hence the gains to be obtained by adopting AI technologies can be marginal, and hence, difficult to justify the investment needed for implementation. In this respect, AI has a very limited impact on improving decision-making and coordination in humanitarian logistics. To address this, solutions considering data scarcity and scalability issues typical of smaller organizations should be provided.

4.2.7. Overcoming Human and Technological Barriers to Implement AI Effectively in Real-Time Humanitarian Logistics Operations.

The next theme, in the perspective of the interviewees, is that humanitarian logistics operations in real-time cannot be performed without addressing human and technological challenges while implementing AI. This can be overcome by proper training and involvement of personnel in order to overcome the resistance of the staff. Besides, such challenges can also be overcome holistically considering infrastructure limitations and impossibility to replace human touch at work completely. AI tools should be user-friendly and designed to work within typical infrastructure constraints in disaster zones. Besides, effective data management strategies will help to avoid overloading the system and ensure that relevant information is readily available to support rapid decision-making. Five key sub-themes have emerged: technological limitation, infrastructure limitation, impact of human interaction, trust and reliability concerns, and urgency and time constraints:

- *Technological Limitation:* Some key difficulties with the integration of AI in humanitarian logistics have indeed been a lot of dimensions of technological incompetence, which exist at each level of the industry. Moreover, the people suffer from a competency gap-different comfort levels and familiarities with using new technologies- which prevent the adoption of AI tools. This is exacerbated by the problem of software usability with mobile devices commonly used in the field, most of which may not support more complex AI applications. There is, therefore, a dire need for an easy-to-use AI tool that can easily be adopted for use by any personnel irrespective of technological exposure.
- *Infrastructure limitations:* Poor infrastructure, like roads, electricity, and internet connectivity in disaster and resource-constrained environments, affect the real-time updating and overall effectiveness of applications that make use of AI. Weak or limited connectivity affects not only data transmission but also access to important cloud-based services required to handle big data in real-time. Furthermore, high-quality, abundant data is needed for effective AI optimization, as well as robust technological infrastructure, which is usually lacking in humanitarian contexts. These infrastructural deficits make it impossible to guarantee the accessibility of AI tools to all partners regardless of resource endowment; hence, the collaborative potential of AI-driven solutions under crisis conditions is further limited.
- *Impact of Human Interaction:* Integration of artificial intelligence into humanitarian logistics presents one of major difficulties since it will influence organizational culture and human interaction. Usually, especially for seasoned employees who might worry about losing their jobs or those connected to conventional ways of working, like Excel spreadsheets, resistance to change occurs. That fuels a sort of anxiety about the acceptance of artificial intelligence technologies. In this regard, staff training and capacity-building initiatives become crucial since they equip team members with the necessary skills and help them to be included into the integration of artificial intelligence. As the employees vary in

degrees of competency in technology, the training program will have to be customized for individuals. Furthermore, it is imperative to maintain the human touch to ensure people do not trust artificial intelligence above human relationships. The balance of AI intelligence with human judgment and emotional understanding will have to be enabled by user-friendly interfaces and collaborative approaches where insights are derived from the staff.

- *Trust and Reliability Concerns:* The trust and reliability issue are one of the major obstacles in embedding AI in significant decision-making activities, coupled with the danger of depending too heavily on AI outputs without human oversight. Blind trust in AI recommendations can be troubling since they could become biased or false outputs due to the original data being incomplete or erroneous. Indeed, during critical times, this trepidation can find increased weight since reliance on only AI for validation now could lead to ineffective or even disastrous actions. Therefore, it is essential to maintain human judgment in these processes, emphasizing the importance of human creativity and flexibility that AI cannot fully replicate. Building trust in AI outputs goes through adding human verification into its process to take away some fears about possible errors and biases. The reliability of AI systems would also have to be built on robust and dependable technologies that could perform consistently in high-stakes situations.

- *Urgency and Time Constraints:* Decisions must be made swiftly to address immediate needs, which leaves little time for extensive AI analysis. With such high pressure, it is often a challenge to believe in the outcomes provided by AI because there is little time to confirm the recommendations. This scepticism could be detrimental to the use of AI tools since decision-makers might rely more on instinct or proven traditional methods when rapid responses are required.

4.2.8. Facilitating Collaborative AI Integration that Respects Cultural Nuances and Strengthens Coordination Among Humanitarian Actors.

Moving forward to the next theme, it was pointed out by the interviewees that in an effort to enhance the coordination among humanitarian actors through AI integration, overcoming challenges related to data sharing, cultural sensitivity and trust, and differences in technology will be very important. With collaboration and by developing these tools specific to cultural nuances and language differences, the organizations will help facilitate more effective coordination. Three emerging sub-themes can be identified, namely coordination challenges, collaboration and data sharing challenges, and cultural and cross-cultural considerations:

- *Coordination Challenges:* Efficient coordination in the humanitarian logistics sector often encounter challenges, particularly in stakeholder engagement and the navigation of cultural and language barriers. Effective humanitarian work requires government and local authority acceptance and involvement. NGOs must also work closely and effectively with governmental actors and private partners. In turn, this may involve consultation and cooperation between a number of stakeholders to align objectives, gain access and permission, and develop collective resources where possible. In addition to that, there are cultural differences, as well as language differences, that add further difficulty. Building trust within teams, as well as having sound communications among diverse teams, as with affected communities, depend a whole lot on mutual cultural awareness and respect. A

language barrier could often lead to misunderstandings or misinterpretation of information that may affect professional performance at this critical time. Those cultural and linguistic variables, therefore, necessitate consideration, with various techniques involving local interpreters, cultural competency training, and multilingual communication channels. The way forward is to put more effort into improving coordination, building relationships with the stakeholders, and, subsequently, enhancing the performance of humanitarian interventions.

- *Collaboration and Data Sharing Challenges*: Standardization is also a problem-the different systems and types of data create obstacles in true collaboration as well as exchanging information. This fragmentation makes it difficult to integrate AI solutions effectively across various platforms. Moreover, there is the issue of confidentiality and trust in that organizations may be reluctant to share sensitive information, sitting on the fence due to privacy concerns and the futility posed by possible misuse of data. Overcoming this reluctance is crucial for AI systems that rely on very extensive data inputs to reach top functionality. Building and maintaining trust with all stakeholders is imperative, particularly since AI integration may disrupt existing personal relationships and workflows. Preserving these relationships will rely on continuous transparency in communication and showing employees how AI can complement human efforts rather than substituting them. Moreover, there is huge variability in technological capabilities and resources across the organizations.
- *Cultural and Cross-Cultural Considerations*: Language barriers can create situations that make it difficult for effective communication to take place among the diverse population, aid workers, and local authorities. Enhancing the language translation capability of AI is important but quite challenging, as it has to correctly interpret a wide range of languages and dialects, including idiomatic expressions. Besides, cultural subtlety is complex. For artificial intelligence systems to recognize and respect cultural variations requires deep knowledge and careful programming, in order not to commit misinterpretation or cultural insensitivity. It has to understand the customs, social norms, and values of the community it's serving. These challenges highlight the necessity of developing culturally aware AI systems to ensure interactions are appropriate and sensitive, thereby fostering better cooperation, building trust, and ultimately enhancing the effectiveness of humanitarian efforts.

4.2.9. Beating Data and Information Management Challenges for efficient decision-making

The interviewees have pointed out that proper data and information management ensures that the system does not get overloaded and that information has the role of supporting speedier decision-making. Two main sub-themes have emerged, namely challenges in data quality and information management:

- *Challenges in Data Quality*: Poor or incomplete data may affect the outputs of an AI system considerably, hence laying the ground for ineffective decisions or even decisions that are counterproductive. To make AI function effectively and generate meaningful insights, there has to be good-quality and reliable data inputs. Besides, flawed data inputs

have a high potential for biases and inaccuracies. If the data fed to AI algorithms is biased or incorrect, then AI generates biased or incorrect outputs, thus aggravating the existing problems or creating new problems in humanitarian operations.

- *Information Management*: Major issues to be conquered include avoiding system overload; without adequate filtering mechanisms, AI can become overwhelmed with data it does not need, slowing performance and complicating decision-making. It is crucial to use strong methods of filtering and prioritizing data, which is challenging in itself since it needs a balance between the inclusion of critical information and exclusion of irrelevant inputs. Moreover, given the scarce amount of data from most disaster situations, further improvement of AI's support for decision-making becomes a very hard task. Indeed, making AI algorithms function well with limited information is one of the tricky tasks that has been a symptom of the larger challenge in information management in this field.

4.3. Thematic Synthesis

As can be underlined from the above analysis, the potential of integrating AI into humanitarian logistics could be related to enhancing efficiency, coordination, and decision-making processes. Yet, this is interdependent with a complex set of challenges emanating from human factors, technological limitations, data management issues, and ethical considerations. Humanitarian logisticians often rely heavily on personal experience and established networks due to data availability, quality, and standardization constraints. Ineffective utilization of the technological tools that already exist is due to lack of training, resistance to change, and overall resource limitations, which underlines the need for urgent investments in adoption of technology and staff capacity-building initiatives in order to support a shift toward data-driven decision-making. **Table 3** summarizes the emerging themes with a brief description.

Effective collaboration among a variety of humanitarian stakeholders is the backbone of any successful operation; however, this is usually well hindered by challenges in coordination, including political influences, lack of standardization of data practices, and cultural and language barriers. These make it really complex to avoid duplication and effectively allocate resources. AI provides huge value in the solution of these challenges through operational optimization, enhancement in information processing, and stakeholder coordination. The phases of mitigation and preparedness may be raised to considerably higher levels by the large volume of data processed, the facility for real-time communication, and the "what-if" scenarios simulated by AI. However, during urgent disaster response scenarios, the limitations of AI become more pronounced due to time constraints, data scarcity, and the critical need for swift, experience-based decision-making, highlighting the need to balance AI use with human expertise.

This integration of AI into humanitarian logistics brings a set of challenges: data security concerns, ethical considerations, and limited adoption due to funding constraints, technological disparities, and skepticism from donors and beneficiaries. Security of data is of prime importance for adhering to the restrictions imposed by donors and the protection of sensitive information, which is critical for building trust and meeting legal and ethical expectations. Further adding to the complexity of AI integration are the ethical considerations of compliance with regional regulations, such as the AI Act in Europe, to environmental impacts of AI, like high water consumption. The AI applicability problems

are very high for small and medium-sized organizations, while the organizations lack data for training AI models, technological infrastructure, and minor gains relative to the invested effort. Consequently, this is limiting the effects of AI on decision-making and coordination. The effective application of AI in humanitarian logistics operations will require overcoming not only technological but also human barriers, that is, overcoming the resistance of staff to change through comprehensive training and active involvement of personnel in the process of integrating AI, usually motivated by fear of job displacement and a preference for 'how things have always been done'. It is important that the AI tools are user-friendly and designed to work within the typical infrastructure constraints of disaster zones, including unreliable electricity and internet connectivity. Moreover, the human touch should not be lost in order not to lose trust and effectiveness in interaction, since AI cannot fully reproduce emotional understanding and empathy inherent in human relationships. Building trust in AI systems through human oversight and validation mitigates concerns over AI errors and biases, which is particularly important during high-pressure situations where rapid decision-making is critical.

Improving coordination using artificial intelligence calls for respecting cultural quirks and language variations and overcoming data sharing obstacles. Such culturally sensitive and accurate language translating AI systems would help humanitarian actors-NGOs, governments, and corporate sector partners-to cooperate better. Technological discrepancies among companies, data confidentiality issues, and the absence of any form of standardization in systems and data formats, however, remain major hurdles. Solutions to these challenges include collaborative approaches among stakeholders, trust-building, and the development of common platforms or standards for data sharing and integration of AI solutions. Furthermore, effective decision-making depends on addressing data quality issues and employing effective information management techniques to avert system overload and ensure that relevant data supports quick responses during emergencies.

The implication is that, while AI holds great promise for the transformation of humanitarian logistics operations, most of the benefits are realizable only when considered in a holistic perspective against the complex play of technological advancement and human elements. That would include investment in personnel training, capacity-building processes, the spirit of collaboration, data sharing, adherence to ethical considerations on handling data, compliance issues, and adapting AI tools to the particular conditions and limitations which may be required in such a humanitarian context. By doing so, AI capabilities can be leveraged to improve operational efficiency and effectiveness without sacrificing those key human values of empathy, trust, and adaptability that underpin any form of humanitarian endeavor.

Table 3. Synthesis of Emerging Themes in AI for Humanitarian Logistics

No.	Emerging Themes	Description
1	Integration of AI into Humanitarian Logistics	Enhancing efficiency, coordination, and decision-making through AI integration, despite existing challenges.

2	Challenges in AI Adoption	Barriers like lack of training, resistance to change, resource limitations, and funding constraints.
3	Coordination and Stakeholder Collaboration	Importance of collaboration among stakeholders, hindered by political, cultural, and technological barriers.
4	Limitations of AI in Disaster Response	AI struggles in urgent disaster responses due to time constraints, data scarcity, and reliance on human expertise.
5	Ethical and Security Considerations	Concerns about data security, regulatory compliance, and environmental impacts of AI.
6	Overcoming Human Resistance to AI	Fear of job displacement and preference for traditional methods require comprehensive training and involvement.
7	Infrastructure and Design Considerations	Designing AI tools for disaster zones, accounting for unreliable electricity and internet connectivity.
8	Data Quality and Management	Addressing issues like data availability, accuracy, standardization, and overload.
9	Building Trust in AI Systems	Establishing human oversight and validation to mitigate AI biases and errors.
10	Cultural Sensitivity and Language Barriers	Respecting cultural nuances and using AI for accurate language translation to enhance cooperation.
11	Standardization and Data Sharing	Challenges in creating standardized systems and formats for seamless data sharing and AI integration.
12	Balancing AI and Human Expertise	Maintaining empathy, trust, and adaptability alongside AI-driven operational improvements

5. DISCUSSION

The integration of Artificial Intelligence into humanitarian logistics is both a dynamic and complex environment characterized by opportunities and challenges. Based on the interviews with the logistics professionals, this analysis creates a grounded theory that underlines the complex nature of the adoption of AI in this domain, highlighting its great potential to increase operational efficiency, coordination, and decision-making while the barriers to the effective implementation are unraveled. The interaction of technological, human, ethical, and organizational factors forms a rather complex ecosystem when it comes to AI integration in humanitarian logistics.

The interdependencies regarding such areas have to be approached holistically for successful integration. Alongside technological advances, human capacity building should be enhanced to empower the staff in the use of AI tools, reducing resistance to change and increasing the likelihood of its adoption. Ethical concerns and strong data security would go a long way in building confidence among its stakeholders, thereby facilitating data sharing and coordination. Apart from that, the design and deployment of AI systems should be integrated with cultural sensitivity and political contexts to ensure acceptance and relevance across diverse environments. Lastly, good quality data and information management is the backbone for valid AI outputs and better decision-making.

Recognition is the first step toward understanding and tackling the interconnectedness of such themes, in order to devise strategies for integrating AI in humanitarian logistics. There is a need for the realization that technological solutions will have to be complemented with alignment in human and organizational dimensions.

5.1 Comparative Analysis

This comparative analysis examines the implications of the findings based on grounded theory research into AI adoption for decision-making and coordination in humanitarian logistics, grounded in insights from the extant literature. These juxtaposed cases provide a comprehensive overview of how empirical findings supplement or disagree with theoretical arguments. Grounded theory identifies, and literature reinforces the availability of a strong technological infrastructure and the proper management of data (Schiffling et al., 2022). On the other hand, the empirical findings discuss unique aspects, such as data scarcity-overload paradox, which has not received explicit discussion in prior literature.

Furthermore, it places into context the practical relevance of AI tools that can operate offline—a factor rarely discussed in theoretical studies. Whereas literature generally acknowledges human factors (Kouhizadeh et al., 2021), the findings from the grounded theory provide richer insights into organizational resistance, including tensions between senior staff supportive of traditional methods and younger personnel who are more open to the integration of AI. Ethical concerns are broadly acknowledged in the literature (Bedushi, 2022; Tiwari, 2023), but the empirical data links these concerns to tangible challenges like donor skepticism and reluctance to share data.

Regarding coordination, theoretical perspectives emphasize AI's potential (Tatham et al., 2017; Baki & Abuasad, 2020), while grounded theory findings illuminate practical barriers, such as confidentiality concerns and competitive dynamics impeding data sharing. Both sources address cultural factors (Baki & Abuasad, 2020; Shrivastav & Bag, 2024), with the study extending this discussion to include broader implications, such as respecting local customs and norms. Regarding financial constraints, the literature (OCHA, 2024) identifies funding issues; however, the grounded theory reveals its operational implications, such as ignoring long-term technological investment for short-term immediate needs.

According to the literature, there is a need to integrate AI capabilities with human expertise (Besiou & Van Wassenhove, 2020; Kovács & Falagara Sigala, 2021). Grounded theory findings contribute by showing real-world scenarios, such as balancing AI recommendations with local knowledge during crises. While both sources point out the common challenges: technological limitations, data quality, ethical considerations, human factors, coordination complexities, cultural sensitivities, and financial constraints, the grounded theory provides evidence of practical manifestations of these issues.

The study juxtaposes theoretical insights with practical realities in the development of a more nuanced understanding of immediate challenges in humanitarian logistics, including

reliance on experience because of data constraints and the phase-specific relevance of AI tools. These will help organizations in the crafting of strategies that effectively integrate AI, and enhance decision-making, and coordination while upholding the human and ethical dimensions so vital to humanitarian efforts.

5.2 Synthesis of Findings

Based on the analysis, the integration of AI into the Humanitarian Logistics sector is not a linear process but rather a multifaceted journey requiring a nuanced understanding of various interrelationships. The following are derived from the initial research questions and from what the results of our analysis showed:

Q1: Humanitarian logistics operates within highly dynamic and at times volatile contexts where data is very often scarce, unreliable, or fast evolving. Indeed, interviews with logisticians showed that decisions based on personal experience and a well-established network are common due to the fact that there are still widespread data availability and quality issues. Data-driven decision-making is recognized as potentially very valuable, yet in practice, access to technology is limited, standard practices for data are lacking, and different languages are spoken. Besides this, some technological tools available are being underutilized because of poor training and resistance to change, which further solidifies reliance on experiential knowledge. Overcoming these barriers involves targeted investment in technology, staff training, and organizational change management toward more systematic and data-informed strategies

Disaster response is urgent, adding to the difficulties of data-limited environments. In a number of situations, decisions are needed quickly in the context of incomplete, outdated, or unreliable data. Interview findings show other critical barriers that include limited capacity of staff and external factors such as political instability and volunteers in the field being overworked. These challenges lead to a proliferation of raw, unprocessed data and a deficit in actionable insights, making real-time decision-making relies highly on experienced practitioners. Better collection and processing of data in humanitarian logistics could be advanced through investments in a robust data management system that will be able to generate timely, actionable insights to guide response efforts and achieve better outcomes.

Another cornerstone for effective humanitarian logistics is coordination with a diverse number of stakeholders-a very challenging feat. Political pressures, cultural differences, and lack of standardization for data sharing practices significantly hamper attempts at duplication avoidance and optimization of available resources. Moreover, building trust and free flow of communication are recognized, yet often destroyed by concerns on confidentiality of data or conflicting organizational priorities. These will be overcome through the development of robust coordination mechanisms that inspire confidence and open communication. This results in increased collaboration among stakeholders and, hence, assurance of better efficiency in operations with less duplication and a more effective distribution of resources.

Overall, addressing the challenges of data scarcity, enhancing technological integration, and fostering stakeholder collaboration are critical steps toward strengthening humanitarian logistics. By overcoming these barriers, organizations can shift from reactive, experience-based approaches to proactive, data-driven strategies that improve the timeliness and effectiveness of disaster response.

Q2: AI has the potential to revolutionize humanitarian logistics by offering a solution for supply chain optimizing, better planning, and coordination. By further use of AI for the processing of large amounts of data, including continuous updates and real-time simulations, operational efficiency can be significantly improved. Moreover, the use of AI in humanitarian contexts entails some distinct challenges, including limited data availability, highly variable environments, and, most importantly, a critical need for rapid adaptation. Customizing AI solutions to address these complexities is crucial for their effective deployment.

AI finds its perfect expression during the mitigation and preparedness stages of humanitarian operations. The respective phases usually allow for ample data collection and deeper analysis, which AI can use for anticipatory planning, resource allocation, and scenario modelling. Integration of AI into these two stages enables organizations to respond pre-emptively to possible logistic challenges; thereby, they may shorten response time and hence improve overall readiness.

On the other hand, action brings a phase with imposing constraints that diminish AI's applicability. The urgent nature of decision-making, constantly changing data and unpredictable situations, present flexible maneuvers that do not allow total dependence on AI. In those cases, the need becomes obvious for the human worker to verify AI outputs and change schemes when necessitated by the living situation. This underscored the great need for complementarity of a human expert and the capabilities of AI.

For AI to make any meaningful contribution to humanitarian logistics, the emphasis must be on phase adoption just as AI gains a good footing in accordance with computational ability and predictive modeling. With this sort of collaborating system, there will be dual appropriateness between the AI system and human judgment; hence the operations remain flexible and sensitive to temporal response initiatives. This sort of integration achieves operational efficiency while maintaining flexibility within the humanitarian operation.

Q3: It involves complexity at the integration of AI into humanitarian logistics from all three levels: technical, organizational, and cultural. Major challenges include but are not limited to data security issues, ethical dilemmas, strained budgets, and even trust from donors and beneficiaries alike. Side effects arise from regulatory requirements at regional and national levels demanding compliance and minimizing the negative effects on the environment. Particularly smaller organizations-with limited data and resources-deeply suffer in optimally leveraging AI, which deprives them of enormous advantages. To do so is to build up trust and confidence in a community of stakeholders, coping with constraints and limitations imposed by funding sources and ensuring some degree of compliance with legal and other ethical frameworks.

Ethical, Legal, and Trust-Building Considerations

There should always be fixed measures taken to address the ethical and legal side and also to build a trust environment among stakeholders. This involves a habit of hard data security, regulatory compliance, and transparency in approaches, which form the very backdrop of deploying responsible AI. There should also be an investigation into the ethical problems to avoid bias of any type within the AI systems to promote equal results. Donors and beneficiaries are often sceptical because of the opacity of how AI works and their risks of not achieving what had been promised. Trust can only be built by the clear articulation of the promised benefits, the limits of AI, and the risk safeguards. Staff resistance and gaps in technological proficiency further hinder adoption, underscoring the importance of investing in capacity-building initiatives. Training personnel, integrating them into the process, and designing user-friendly AI tools with the matching of organizational capacities can reduce

resistance and increase trust. Human oversight and interaction become very essential for making AI systems reliable and accountable.

Technological and Infrastructure Constraints

Technological constraints, including unreliable electricity and internet connections, are severely challenging for the use of AI in the humanitarian settings. AI tools thus need to be designed to work within the infrastructure constraints. The development of easily usable and very contextual technologies enhances accessibility to the extent that AI systems can function in limited-resource settings. For successful integration of AI into operations, such constraints need to be addressed.

Funding Challenges and Organizational Constraints

Funding limitations have a direct bearing on AI integration efforts, and this is particularly acute among smaller organizations that usually do not have the resources needed to invest in advanced technologies. Limited financial resources constrain access to high-quality data, appropriate infrastructure, and skilled personnel that are required to deploy AI. Sustainable funding must be secured to overcome these barriers being faced, and a compelling argument should be made for the cost-effectiveness and impact of AI for the medium and long term, which might assuage donor concerns. Through regular reporting on the contributions of AI to efficiency and outcomes, there will be greater trust and investment from donors as well as the beneficiaries in it.

Coordination and Cultural Sensitivity

The AI integration does enhance coordination among stakeholders, which is more constrained by the barriers of data sharing, cultural and language differences. The fast implementation is also made impossible by the absence of standards and the technology barrier existing between the organizations. However, the development of culturally sensitive and context-aware AI systems, as well as collaborative frameworks among stakeholders, are the lynchpins to successful coordination. Such barriers can be overcome through partnerships, uniform standards, or including, by design, flexibility and adaptability across different operational contexts.

Data Quality and Information Management

The basis for effective decision-making in humanitarian logistics lies in the high quality of data and efficiency in information management. Several challenges, such as data inaccuracy, incompleteness, and inconsistency, decrease the reliability of the AI outputs. Additionally, information overload reduces the potential benefits a user could have from AI solutions and makes decision-making more difficult. It is necessary that data is accurate, complete, and filtered correctly to avoid overloading the system and to maximize operational outcomes.

The holistic approach will have to be made to really harness the powers of AI to the fullest that will help humanitarian logistics address the said challenges. Such investment would create a path to responsibly and effectively introduce AI by means of ethics governance, capacity building, and resilient infrastructures or culturally sensitive design. Moreover, funding constriction and scepticism need the same approach to transparency and stakeholder involvement. Collaboration by all stakeholders, combined with a commitment to human oversight, will ensure that the sector develops in meaningful ways without losing the trust and operational reliability of the sector.

5.3 Implications for Practice

Based on the previous analysis the subsequent practical implications set out possible strategies and recommendations to aid organizations into ways of overcoming barriers, enhancing coordination, and maximizing AI capabilities in humanitarian settings.

- *Holistic Planning*: Carry out a whole plan which would accommodate all interrelated themes, where efforts to adopt AI are not compromised by neglect for the human, ethical, or cultural angles.
- *Development of Policy*: The organizations should develop the policies that will address the relevant issues of data security and standardization for a well-coordinated way of introducing AI, while remaining well within the guidelines of ethics and other legal frameworks.
- *Ethics and Regulation Compliance*: Clearly specify the ethical guidelines and data protection policies that will address privacy issues, build trust and accountability in the AI systems. Ensure adherence to the regional and global regulatory frameworks with a view to the AI Act in Europe, for ensuring trustworthiness and legitimacy in AI applications.
- *Cultural Sensitivity*: AI models will have to be designed and tuned based on cultural and language contexts in the human sector so that they can complement each other well. They shall need sufficient fieldwork for testing and validating the models in concert with soon-to-be operational realities.
- *Capacity Building*: Training programs must be developed to give staff better competences in AI technologies to secure the buy-in of the workforce, hence lessen the likely resistance and bolster the staff. This will include technical training and workshops in which staff get first-hand knowledge of what AI can and cannot do. Encourage adaptability in senior staff's culture to mitigate resistance and embrace innovative technologies.
- *Technological Adaptation*: AI machines need when designed, to adapt to functioning within the infrastructural scarcities typical of a humanitarian situation. Integrate human validation within AI systems to make sure that their outputs are fit for purpose and in line with the humanitarian principles.
- *Collaborative Frameworks*: Partnerships and collaborative frameworks will help break the data sharing barriers as well as capture the technology gap that exists among the agencies. Trust and collaboration among all stakeholders will be built through an inclusive planning and implementation process that involves all stakeholders: staff, donors, beneficiaries, and partners. Strengthen partnerships with the providers of technologies and with academia to reach the cutting-edge in accessing innovation and expertise in AI.
- *Demonstrating Value*: Collect and display the evidence of the efficacy of AI systems in making operations to secure buy-in by donors and stakeholders. Show that AI solutions have cost-effective and large impacts in humanitarian operations to gain additional donor support.
- *Funding constraints*: Given that funding can be scarce, program design must include the strategic targeting of human resources towards those AI investments that promise greatest reward and foreshadowed value for securing donor support.
- *Data Management*: Improving the data collection, validation, and management practices to ensure that the AI systems receive top quality inputs. Encourage standardized data sharing practices among humanitarian organizations in order to enhance interoperability and coordination.

5.4 Limitations and Future Research

The study is a remarkably important point of reference in the understanding of the use of AI in decision-making and coordination in humanitarian logistics, but it has limitations that may affect the generalizability and scope of its findings. First, the grounded theory findings arise from a small number of interviews with logistics professionals. Such a small number of case illustrations may not provide an adequate depiction of the range of experience encountered across different organizations, regions, and geographical unrest. As a result, the transferability of the insights to other contexts may be constrained. In addition, humanitarian logistics is inherently complex, with rapidly changing situations and very different operational environments, which means it will be inherently problematic to draw universally applicable conclusions. Other influencing factors such as the specific nature of the disaster, different mandates and structures of organizations, and ever-changing political and cultural climates can be influential in the applicability of the reports. Attached to this overwhelming complexity, therefore, is the need for more extensive empirical evidence, contextual in nature, to validate and refine the patterns that this study highlights.

Challenges related to data also represent limitations. The most recurrently presented obstacles to AI integration have been cited as data scarcity, quality issues, and information overload, but little empirical research has been done on how to systematically improve practices in data collection, validation, and management. Addressing these gaps requires not only methodological innovations, but investments in technology and capacity-building. Like the other, the present study recognizes ethical considerations and fails to offer anything in a general approach to tackling challenges such as privacy, responsibility, and algorithmic bias. Further research is necessary to translate theoretical ethical and legal guidelines into actionable protocols tailored to humanitarian contexts.

Several avenues may be taken regarding future research. Longitudinal case studies and comparative analyses of different humanitarian operations and organizations would enrich our understanding of how the role of AI is developing through time and in different settings. These studies could examine how AI integration differs across phases of disaster preparedness, response, and recovery, and whether any particular AI tools have proved to be worth scaling up or customizing for specific cultural and infrastructural settings.

Likewise, such empirical investigations about measuring the real impact of using AI—whether in terms of efficiency, cost-effectiveness, or beneficiary outcomes—could help substantiate the theoretical claims made by both literature and practice. Rigorous cost-benefit analyses could inform decision-makers and donors with a view to rationalizing investments in the development and implementation of AI. In addition, surveys and experimental designs aware of stakeholder perceptions—particularly from the donor community, beneficiaries, and local authorities—could help investigate trust dynamics and offer means of enhancing transparency, explainability, and acceptance of AI-enabled solutions.

In addition, future studies may look at several innovative approaches of capacity-building in relation to targeted training programs, workshops, and toolkits for the purpose of narrowing the skill and know-how divide between humanitarian personnel. To substantially gain, it would be interesting to find out which pedagogies would work best towards overcoming resistance to technological change and at building confidence in AI tools.

Relatedly, research could investigate the interplay between human expertise and AI across different operational roles, clarifying how best to harness this synergy to maintain agility, adaptability, and moral judgment in time-sensitive and ethically complex situations.

Finally, addressing the impact of the policy regulatory framework, instruments, and tools-for-integration mechanisms upon the AI-enabled humanitarian logistics constitutes another line of research. This area could explore how governments, international organizations, and donors create standards and guidelines that influence organizational behaviours to align with ethical norms and to promote sustainable implementation through AI initiatives. There is also a need to ascertain the policy levers and incentives that could encourage collaboration and facilitate data-sharing to ensure usage of AI intersects with personal responsibility yielding the utmost benefit to all parties involved.

In conclusion, while this preliminary study actually brings to light the opportunities, challenges, and interrelated themes relevant to the subject of AI adoption into humanitarian logistics, still, it remains limited in scope. In that light, the coupling of research designs with different contexts can provide a more robust background for theoretical refinement and direction to be taken for the strategic, ethical, and contextual implementation of AI within the humanitarian framework.

6. CONCLUSION

AI presents the field of humanitarian logistics with a unique chance for transformational decision-making and coordination improvements that might address these persistent impediments: resource allocation, response time, and operational efficiencies. This review shows that, while AI has an optimization potential in supply chains, delivers forecasts of impacts of disaster, and allows real-time coordination, successful adoption will need overcoming some difficult obstacles. These include data quality and scarcity, technology constraints, ethical issues, organizational resistance, and cultural considerations.

A key finding is that AI reaches its full potential through the enhancement of human expertise, especially in the dynamic and uncertain context of disasters, where human judgment and versatility remain indispensable. To establish genuine integration, the study posits an integrative approach whereby technology, capacity-building, ethical frameworks, and organizational changes are all aligned. Once these interdependencies are dealt with, humanitarian organizations can be enabled to use AI, not so much as an alternative solution but as an extremely viable means to augment human capacity in efficiently and speedily responding to disasters.

References

1. Khan, M., Khan, M., Ali, A., Khan, M. I., Ullah, I., & Iqbal, M. (2022). Digitalization for Fast, Fair, and Safe Humanitarian Logistics. *Logistics*, 6(2), 31. <https://doi.org/10.3390/logistics6020031>
2. Paciarotti, C., Piotrowicz, W. D., & Fenton, G. (2021). Humanitarian logistics and supply chain standards. Literature review and view from practice. *Journal of Humanitarian Logistics and Supply Chain Management*, 11(3), 550–573. <https://doi.org/10.1108/JHLSCM-11-2020-0101>
3. <https://www.weforum.org/impact/how-humanitarian-logistics-partners-have-stepped-up-delivery-amid-multiple-crises/>
4. Guo, X., & Kapucu, N. (2020). Engaging Stakeholders for Collaborative Decision Making in Humanitarian Logistics Using System Dynamics. *Journal of Homeland Security and Emergency Management*, 17(1), 20180061. <https://doi.org/10.1515/jhsem-2018-0061>
5. Mohammed Zain, R., Mohd Zahari, H., & Mohd Zainol, N. A. (2023). Inter-agency information sharing coordination on humanitarian logistics support for urban disaster management in Kuala Lumpur. *Frontiers in Sustainable Cities*, 5, 1149454. <https://doi.org/10.3389/frsc.2023.114945>
6. Hu, S., Dong, Z. S., & Dai, R. (2024). A machine learning based sample average approximation for supplier selection with option contract in humanitarian relief. In *Transportation Research Part E: Logistics and Transportation Review* (Vol. 186). <https://doi.org/10.1016/j.tre.2024.103531>
7. Nguyen, S., O’Keefe, G., Arisian, S., Trentelman, K., & Alahakoon, D. (2023). Leveraging explainable AI for enhanced decision making in humanitarian logistics: An Adversarial Coevolution (ACTION) framework. *International Journal of Disaster Risk Reduction*, 97, 104004. <https://doi.org/10.1016/j.ijdr.2023.104004>
8. Swasdee, A., Anshari, M., & Hamdan, M. (2020). Artificial Intelligence as Decision Aid in Humanitarian Response. In 2020 International Conference on Decision Aid Sciences and Application, DASA 2020 (pp. 773–777). <https://doi.org/10.1109/DASA51403.2020.9317111>
9. Płaczek, E., & Świtalska, A. (2023). New Technologies in Humanitarian Logistics. *Journal of Public Governance*, 65(3), 48–58. <https://doi.org/10.15678/PG.2023.65.3.04>
10. Zarei, Baharmand, H., Bashiri, M., & Madanian, S. (2024). Technological advancements in humanitarian aid. *International Journal of Disaster Risk Reduction*, 109, 104527. <https://doi.org/10.1016/j.ijdr.2024.10452>
11. Singh, R. K. (2024). Leveraging technology in humanitarian supply chains: Impacts on collaboration, agility and sustainable outcomes. *Journal of Humanitarian Logistics and Supply Chain Management*. <https://doi.org/10.1108/JHLSCM-05-2024-0063>
12. Tahla U., *Artificial Intelligence and the Humanitarian Sector*, 2024. Retrieved 23/11/2024 from [Artificial Intelligence and the Humanitarian Sector | Innovation Consulting & Solutions](https://www.innovationconsulting.com/artificial-intelligence-and-the-humanitarian-sector/)

13. World Food Programme, *Machine Learning for Early Warning Systems*, 2023. Retrieved 23/11/2024 from <https://www.wfp.org/publications/2023-machine-learning-early-warning-systems>
14. AI for Humanitarians: Introducing the Innovations—Elrha. (n.d.). Retrieved 23 November 2024, from <https://www.elrha.org/news-and-blogs/ai-for-humanitarians-introducing-the-innovations/>
15. Seelos C., Sofer M., Burton C. and Mair J., *Making Health Innovations Thrive in Africa*, 2024. Retrieved 23/11/2024 from <https://ssir.org/articles/entry/zipline-health-innovations-africa#>
16. Aryatwijuka, D. W., Mutebi, A. P. H., Nagawa, P., Tukamuhabwa, A. P. B., Ssekajja, S. M., Kyomuhangi Diana, & Akashabaluhanga, A. (2024). Artificial Intelligence and Humanitarian Supply Chain Resilience: Mediating Effect of Localized Logistics Capacity. *European Journal of Technology*, 8(5), 1–20. <https://doi.org/10.47672/ejt.2449>
17. Fernandez-Luque, L., & Imran, M. (2018). Humanitarian health computing using artificial intelligence and social media: A narrative literature review. In *International Journal of Medical Informatics* (Vol. 114, pp. 136–142). <https://doi.org/10.1016/j.ijmedinf.2018.01.015>
18. Schiffing, S., Hannibal, C., Tickle, M., & Fan, Y. (2022). The implications of complexity for humanitarian logistics: A complex adaptive systems perspective. *Annals of Operations Research*, 319(1), 1379–1410. <https://doi.org/10.1007/s10479-020-03658-w>
19. Milaninia, N. (2020). Biases in machine learning models and big data analytics: The international criminal and humanitarian law implications. In *International Review of the Red Cross* (Vol. 102, Issue 913, pp. 199–234). <https://doi.org/10.1017/S1816383121000096>
20. Dzyaloshinsky, I. M. (2022). Artificial Intelligence: A Humanitarian Perspective; [Искусственный интеллект: Гуманитарная перспектива]. In *Vestnik Novosibirskogo Gosudarstvennogo Universiteta, Seriya: Istoriya, Filologiya* (Vol. 21, Issue 6, pp. 20–29). <https://doi.org/10.25205/1818-7919-2022-21-6-20-29>
21. Kahn, L., Ortiz-Ulloa, B., Pavon-Harr, V., Savas, O., (2019). Artificial Intelligence (AI) Augmentation for Humanitarian Logistics: A Framework and Visual Tool for Planning and Communicating Optimal Evacuation Routes for Natural Hazards. Retrieved 06/06/2024 from <https://www.researchgate.net/publication/355078811>
22. Louis, F., Hubert, K., (2024). The Impact of Artificial Intelligence on Logistics Decision Making. Retrieved 29/06/2024 from <https://www.researchgate.net/publication/380320025>
23. Paz-Orozco, H., De Brito Junior, I., Chong, M., Anacona-Mopan, Y., Segura Dorado, J. A., & Moyano, M. (2023). Earthquake Decision-Making Tool for Humanitarian Logistics Network: An Application in Popayan, Colombia. *Logistics*, 7(4), 68. <https://doi.org/10.3390/logistics7040068>
24. Haak, E., Ubacht, J., Van Den Homberg, M., Cunningham, S., & Van Den Walle, B. (2018). A framework for strengthening data ecosystems to serve humanitarian purposes. *Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age*, 1–9. <https://doi.org/10.1145/3209281.3209326>

25. Olsher, D. J. (2015). New Artificial Intelligence Tools for Deep Conflict Resolution and Humanitarian Response. In *Procedia Engineering* (Vol. 107, pp. 282–292). <https://doi.org/10.1016/j.proeng.2015.06.08>
26. Chin, T., Cheng, T. C. E., Wang, C., & Huang, L. (2024). Combining artificial and human intelligence to manage cross-cultural knowledge in humanitarian logistics: A Yin–Yang dialectic systems view of knowledge creation. *Journal of Knowledge Management*. <https://doi.org/10.1108/JKM-06-2023-0458>
27. Vhikai, R., Mugoni, E., Mataka, A. P., & Saruchera, F. (2024). Digitalisation and efficient humanitarian logistical operations in Zimbabwe. *Cogent Social Sciences*, 10(1). <https://doi.org/10.1080/23311886.2024.2321725>
28. Beduschi, A. (2022). Harnessing the potential of artificial intelligence for humanitarian action: Opportunities and risks. *International Review of the Red Cross*, 104(919), 1149–1169. <https://doi.org/10.1017/S1816383122000261>
29. Tiwari, R. (2023). Ethical And Societal Implications of AI and Machine Learning. *INTERANTIONAL JOURNAL OF SCIENTIFIC RESEARCH IN ENGINEERING AND MANAGEMENT*, 07(01). <https://doi.org/10.55041/IJSREM17519>
30. Shrivastav, S. K., & Bag, S. (2024). Humanitarian supply chain management in the digital age: A hybrid review using published literature and social media data. *Benchmarking: An International Journal*, 31(7), 2267–2301. <https://doi.org/10.1108/BIJ-04-2023-0273>
31. Kouhizadeh, M., Saberi, S., & Sarkis, J. (2021). Blockchain technology and the sustainable supply chain: Theoretically exploring adoption barriers. *International Journal of Production Economics*, 231, 107831. <https://doi.org/10.1016/j.ijpe.2020.107831>
32. Besiou, M., & Van Wassenhove, L. N. (2020). Humanitarian Operations: A World of Opportunity for Relevant and Impactful Research. *Manufacturing & Service Operations Management*, 22(1), 135–145. <https://doi.org/10.1287/msom.2019.0799>
33. Kovács, G., & Falagara Sigala, I. (2021). Lessons learned from humanitarian logistics to manage supply chain disruptions. *Journal of Supply Chain Management*, 57(1), 41–49. <https://doi.org/10.1111/jscm.12253>
34. Papadopoulos, T., Gunasekaran, A., Dubey, R., Altay, N., Childe, S. J., & Fosso-Wamba, S. (2017). The role of Big Data in explaining disaster resilience in supply chains for sustainability. *Journal of Cleaner Production*, 142, 1108–1118. <https://doi.org/10.1016/j.jclepro.2016.03.059>
35. Dubey, R., Bryde, D. J., Dwivedi, Y. K., Graham, G., & Foropon, C. (2022). Impact of artificial intelligence-driven big data analytics culture on agility and resilience in humanitarian supply chain: A practice-based view. *International Journal of Production Economics*, 250, <https://doi.org/10.1016/j.ijpe.2022.108618>.
36. Tatham, P., Wu, Y., Kovacs, G., Butcher, Timothy (2017). Supply chain management skills to sense and seize opportunities. University of Tasmania. *Journal contribution*. <https://doi.org/10.1108/ijlm-04-2014-0066>
37. Baki, B., & Abuasad, N. (2020). The Evaluation of Humanitarian Supply Chain Performance Based On Balanced Scorecard-DEMATEL Approach. *Alphanumeric Journal*, 8(2), 163–180. <https://doi.org/10.17093/alphanumeric.736730>
38. Kovacs, G., & Moshtari, M. (2019). A roadmap for higher research quality in humanitarian operations: A methodological perspective. *European Journal of Operational Research*, 276(2), 395–408. <https://doi.org/10.1016/j.ejor.2018.07.052>

39. <https://www.icrc.org/enjbgxc>
40. Allan, G. *A critique of using grounded theory as a research method*. Electron. J. Bus. Res. Methods 2003, 2, 1–10.
41. Turner, B.A. *Some practical aspects of qualitative data analysis: One way of organising the cognitive processes associated with the generation of grounded theory*. Qual. Quant. 1981, 15, 225–247. Retrieved 23/11/2024 from <https://dx.doi.org/10.1007/BF00164639>
42. Cho, J.Y.; Lee, E.H. *Reducing confusion about grounded theory and qualitative content analysis: Similarities and differences*. Qual. Rep. 2014, 19, 64. <https://dx.doi.org/10.46743/2160-3715/2014.1028>
43. Charmaz, K.; Thornberg, R. *The pursuit of quality in grounded theory*. Qual. Res. Psychol. 2021, 18, 305–327. <https://dx.doi.org/10.1080/14780887.2020.1780357>
44. Martin, P.Y.; Turner, B.A. *Grounded Theory and Organizational Research*. J. Appl. Behav. Sci. 1986, 22, 141–157. <https://dx.doi.org/10.1177/002188638602200207>
45. Chun Tie, Y.; Birks, M.; Francis, K. *Grounded theory research: A design framework for novice researchers*. Sage Open Med. 2019, 7, 2050312118822927. <https://dx.doi.org/10.1177/2050312118822927>
46. Timonen, V.; Foley, G.; Conlon, C. *Challenges when using grounded theory: A pragmatic introduction to doing GT research*. Int. J. Qual. Methods 2018, 17, 160940691875808. <https://dx.doi.org/10.1177/1609406918758086>
47. Walker, D.; Myrick, F. *Grounded theory: An exploration of process and procedure*. Qual. Health Res. 2006, 16, 547–559. <https://dx.doi.org/10.1177/1049732305285972>
48. Aldiabat, K.M.; Le Navenec, C.L. *Data saturation: The mysterious step in grounded theory methodology*. Qual. Rep. 2018, 23, 245–261. <https://dx.doi.org/10.46743/2160-3715/2018.2994>
49. Kelle, U. “Emergence” vs “forcing” of empirical data? A crucial of “grounded theory” reconsidered. Forum Qual. Sozialforschung 2005, 6. <https://dx.doi.org/10.17169/fqs-6.2.467>
50. Crouch, M.; McKenzie, H. *The logic of small samples in interview-based qualitative research*. Soc. Sci. Inf. 2006, 45, 483–499. <https://dx.doi.org/10.1177/0539018406069584>

Author’s Statement:

I hereby expressly declare that, according to the article 8 of Law 1559/1986, this dissertation is solely the product of my personal work, does not infringe any intellectual property, personality and personal data rights of third parties, does not contain works/contributions from third parties for which the permission of the authors/beneficiaries is required, is not the product of partial or total plagiarism, and that the sources used are limited to the literature references alone and meet the rules of scientific citations.