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Master Thesis

Enhancing Sustainable Sourcing in Humanitarian Relief Materials through Business Analytical Tools: A Strategic Framework for Ethical and Environmental Compliance in Crisis Zones

Author:

Abdul Halim Bin Abdul Hamid

Supervisor/s

Prof. Dr.-Ing. Thomas Masurat
(Technical University of Applied Sciences Wildau)

Second assessor

Doctor Miquel Angel Piera
(Riga Technical University)

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Technical University of Applied Sciences
WILDAU

Universitat Autònoma de Barcelona
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Name:	Abdul Halim Bin Abdul Hamid	Student number:	50157347
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Presenter of topic:	Technical University of Applied Sciences Wildau	Company advisor:	Prof. Dr.-Ing. Thomas Masurat
		Street:	Hochschulring 1
		Code and City:	Wildau

Title

Enhancing Sustainable Sourcing in Humanitarian Relief Materials through Business Analytical Tools: A Strategic Framework for Ethical and Environmental Compliance in Crisis Zones

Title (German)

Verbesserung der nachhaltigen Beschaffung von humanitären Hilfsgütern durch Business-Analyse-Tools: Ein strategischer Rahmen für Ethik- und Umweltkonformität in Krisengebieten

Goal

This study aims to establish a strategic framework leveraging business analytical tool to enhance sustainable sourcing practices in humanitarian relief materials, with specific focus on achieving ethical and environmental compliance in crisis zones.

Contents requirements / specific tasks

- Conduct a systematic review state-of-the art on sustainable sourcing assessment using business analytics tool in the context of humanitarian relief materials.
- Establish specific sustainability metrics within a comprehensive framework for assessing humanitarian aid materials, focusing on environmental impact and ethical sourcing practices.
- Create procedures for gathering and integrating supplier data into the analytical tool, ensuring the accuracy and completeness of information.
- Implement methods for analysing sustainability data within the analytical tool, generating reports and dashboards to support decision-making and supplier performance monitoring against environmental and ethical standards.
- Establish mechanisms for ongoing monitoring and continuous improvement in the supplier sustainability assessment approach, adapting to evolving requirements and emerging best practices.

Consultation: on appointment with university advisor.

Prof. Dr.-Ing. Thomas Masurat	*approved*	Abdul Halim Bin Abdul Hamid
(University lecturer)	(Examination board)	(Student)

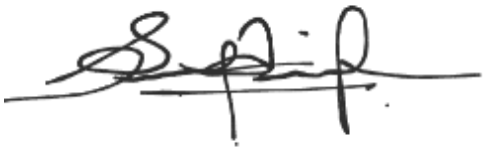
Submission date:

Declaration of Honour

I hereby declare the authorship of this thesis entitled **“Enhancing Sustainable Sourcing in Humanitarian Relief Materials through Business Analytical Tools: A Strategic Framework for Ethical and Environmental Compliance in Crisis Zones."** is on my own work. I did not receive any assistance or support from commercial consultants. The sources referenced in this work are the only ones used. All formulation and concepts are derived from printed, verbal, and online sources. Whether they are directly quotations and paraphrases, they are cited according to rules of good scientific conduct as indicated by footnotes or detailed references. Any assistance during the work, including significant supervision, is acknowledged. Only specified sources and resources were utilized. The information contain in this thesis is accurate and truthful, to the best of my knowledge.

I also affirm that I have not submitted this work for publication elsewhere or as part of another examination. I have adhered to all guidelines concerning academic integrity.

I am aware and acknowledge the legal consequences of a false declaration of honour.



As of 05.10.2024
Abdul Halim Bin Abdul Hamid

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— Abdul Halim bin Abdul Hamid

Abstract

Title: Enhancing Sustainable Sourcing in Humanitarian Relief Materials through Business Analytical Tools: A Strategic Framework for Ethical and Environmental Compliance in Crisis Zones

Abstract:
The research aims to develop a strategic framework leveraging business analytical tools to enhance sourcing practices within humanitarian logistics and supply chains. The study targets key stakeholders, including humanitarian organizations, government agencies, donors, workers, and refugees, to address the complexities of sustainable sourcing in conflict zones. Through a comprehensive literature review, the research evaluates current sustainable sourcing assessments and the application of business analytics in this context.

A central aspect of the framework is the development of procedures for accurately gathering and integrating supplier data into analytical tools. The study also explores methods for analysing sustainability data, with an emphasis on generating actionable reports and dashboards to support decision-making and monitor supplier performance against environmental and ethical standards. The thesis proposes specific sustainability metrics within a structured framework for assessing humanitarian aid materials. This approach focuses on environmental impact and ethical sourcing, offering a systematic method to evaluate and enhance sustainability performance.

Additionally, the thesis advocates for the establishment of continuous monitoring mechanisms and adaptation to emerging best practices, fostering a culture of sustainability in humanitarian supply chains. This ongoing improvement is essential to maintaining relevance and effectiveness in a rapidly changing environment. We are advancing sustainable and ethical sourcing solutions in crisis zones. The goal is to ensure that humanitarian aid is delivered in a manner that is both ethically sound and environmentally responsible, thereby enhancing the effectiveness and integrity of relief efforts.

Abstract (*Auf Deutsch*)

Titel: Verbesserung der nachhaltigen Beschaffung von humanitären Hilfsgütern durch Business-Analytics-Tools: Ein strategischer Rahmen für Ethik- und Umweltkonformität in Krisengebieten.

Zusammenfassung:
Die Forschung zielt darauf ab, einen strategischen Rahmen zu entwickeln, der durch den Einsatz von Geschäftsanalytik-Tools die Beschaffungspraktiken in der humanitären Logistik und den Lieferketten verbessert. Die Studie richtet sich an wichtige Interessengruppen, darunter humanitäre Organisationen, Regierungsbehörden, Spender, Arbeiter und Flüchtlinge, um die Komplexität der nachhaltigen Beschaffung in Konfliktgebieten anzugehen. Durch eine umfassende Literaturrecherche bewertet die Forschung die aktuellen Ansätze zur nachhaltigen Beschaffung und die Anwendung von Geschäftsanalytik in diesem Kontext.

Ein zentraler Aspekt des Rahmens ist die Entwicklung von Verfahren zur genauen Erfassung und Integration von Lieferantendaten in analytische Tools. Die Studie untersucht auch Methoden zur Analyse von Nachhaltigkeitsdaten, wobei der Schwerpunkt auf der Erstellung umsetzbarer Berichte und Dashboards liegt, die die Entscheidungsfindung unterstützen und die Leistung der Lieferanten in Bezug auf Umwelt- und Ethikstandards überwachen. Die Arbeit schlägt spezifische Nachhaltigkeitskennzahlen innerhalb eines strukturierten Rahmens zur Bewertung humanitärer Hilfsmaterialien vor. Dieser Ansatz konzentriert sich auf Umweltwirkungen und ethische Beschaffung und bietet eine systematische Methode zur Bewertung und Verbesserung der Nachhaltigkeitsleistung.

Darüber hinaus plädiert die Arbeit für die Einrichtung kontinuierlicher Überwachungsmechanismen und die Anpassung an neue Best Practices, um eine Kultur der Nachhaltigkeit in humanitären Lieferketten zu fördern. Diese kontinuierliche Verbesserung ist entscheidend, um in einem sich schnell verändernden Umfeld relevant und effektiv zu bleiben. Ziel ist die Förderung nachhaltiger und ethischer Beschaffungslösungen in Krisengebieten, um sicherzustellen, dass humanitäre Hilfe sowohl ethisch vertretbar als auch umweltfreundlich geliefert wird und dadurch die Wirksamkeit und Integrität der Hilfsmaßnahmen verbessert werden.

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List of Abbreviations and Acronyms

Abbreviations	Definition
AI	Artificial Intelligence
ChatGPT	Conversational Hypertext Access Technology Generative Pre-Trained Transformer
CLA	Coordination Liaison Authority
CO2	Carbon Dioxide
CONOPS	Concepts of Operations
CRF	Conflict Recovery Framework
CRSV	Conflict-Related Sexual Violence
CSV	Comma-Separated Values
EDA	Exploratory Data Analysis
ERC	Emirates Red Crescent
GIS	Geographic Information System
HCC	Humanitarian Carbon Calculator
HDX	Humanitarian Data Exchange
IDMC	Internal Displacement Monitoring Centre
IDPs	Internally Displaced Persons
IFRC	International Federation of Red Cross and Red Crescent Societies
IoT	Internet of Things
IPC	Infection Prevention and Control
IPF	Investment Project Financing
ISO14001	International Organization for Standardization 14001 (Environmental Management)
IT	Information Technology
KPI	Key Performance Indicators
LOG	Logistics Operational Guide
MATPLOTLIB	Mathematical Plotting Library
NDVI	Normalized Difference Vegetation Index
NGO	Non-Governmental Organization
NumPy	Numerical Phyton

OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OPT	Occupied Palestinian Territories
PANDAS	Python Data Analysis Library
PLC	Palestine Logistic Clusters
PWA	Palestinian Water Authority
QGIS	Quantum Geographic Information System
RAG	Retrieval Augmented Generation
RDNA	Rapid Damage and Needs Assessment
RMNCH	Reproductive, Maternal, Newborn, and Child Health
SDA8000	Social Accountability 8000
SDG	Sustainable Development Goals
SHCC	Safeguarding Health in Conflict Coalition
UAV	Unmanned Aerial Vehicle
UN	United Nations
UNEP	United National Environment Programme
UNOSAT	United Nations Satellite Centre
UNRWA	United Nations Relief and Works Agency
UNSDG	United Nation's Sustainable Development Goals
UNSDGs	United Nations Sustainable Development Goals
UV	Ultraviolet
WASH	Water, Sanitation, and Hygiene
WFP	World Food Programme
WHO	World Health Organization
WREC	Waste Management Measuring, Reverse Logistics, Environmentally Sustainable Procurement and Transport, and Circular Economy Project
XlsxWriter	Excel Writer

1. Introduction

Responding to the urgency of humanitarian relief while highlighting the importance of environmentally and ethically performed sourcing strategies is crucial. The research is developed with the goal of sourcing the best possible materials, even in the face of acute emergencies. In addition to meeting immediate needs, the planned strategic framework also aims to improve the efficiency and effectiveness of humanitarian settings while making sure that enough resources are mobilized. Through the application of data-backed insights, humanitarian organizations can more efficiently tackle the challenges of sourcing under adverse circumstances, thereby enhancing the ability to recover and contribute to the recovery of the community.

1.1. Background and Context

Sustainable sourcing becoming a trend aspect in supply chain, which incorporates social, ethical, and environmental aspects for management, is a crucial component of global supply chain management. It goes farther, emphasizing eco-efficiency, fair labor practices, transparency, and environmental conservation. Businesses can employ a combination of intended tactics, including incorporating stakeholders, adopting the newest technologies, and closely adhering to legal laws, to address these issues and ultimately achieve sustainable sourcing. The United Nation Sustainable Development Goals (UNSDGs), ISO 14001, SDA800 and other international standards ensure that the companies' progress toward improving their reputation will be protected, even in a global setting. Studies show that businesses that participate in the SDGs perform better on sustainability-related measures and are more competitive. Executives in procurement are critical to enterprises' sustainability. Also, well-known standards like ISO 14001 are very important for helping businesses create good environmental management systems. It is important that these standards have strong metrics built in to make sure they are followed and that the business is sustainable (Pradhan, 2011).

Consider the most discussed aspects when focusing on sustainability improvements, which encompass environmental, social, economic, legal, and regulatory aspects. People are

discussing how to use technology, and they are implementing innovations to achieve sustainability goals. Environmental sustainability depends on setting goals to quantify and cut greenhouse gas emissions. Businesses are using asset intelligence to reduce energy use, which lowers costs and carbon footprint. Involving the circular economy entails renting, sharing, reusing, fixing, renovating, and recycling already-existing resources and goods. This methodology uncovers economic savings, minimizes waste, and restricts the use of natural resources. the study conducted thorough investigations on suppliers to ensure they follow ethical labour practices and safeguard the environment. Promoting diversity and social responsibility entails working with ethical businesses, certified green businesses, or companies owned by underrepresented groups that have an inclusive workforce, treat people fairly, and ensure equal pay for equal work.

1.1.1. Sustainable Sourcing in the Context of Humanitarian Relief

From the surface, sustainable sourcing between conventional and humanitarian are similar. But it differs significantly due to the unique challenges and priorities involved. In humanitarian settings, the focus is often on immediate needs, rapid response, and the necessity to ensure that aid reaches vulnerable populations efficiently. This may involve sourcing from local suppliers to stimulate the economy and reduce carbon footprints, while also ensuring that products meet specific ethical and quality standards. Unlike conventional sourcing, which may prioritize cost and efficiency, humanitarian sourcing must also consider factors like accessibility, resilience, and the potential for long-term community impact, making it a more complex and nuanced process.

In a humanitarian setting, environmental sustainability indicates the appropriate management of resources such as recyclable, biodegradable or renewable materials which reduce waste and energy consumption. ‘Ethical’ sourcing is fundamental to ensure that there are fair labour practices, safe environments, fair remuneration; no child or forced labour. It is paramount to support human rights by collaborating with those suppliers who share these principles, are transparent in their business practices and engage in social responsibility. Local outsourcing allows to reduce the costs of the project and the risks of implementers while contributing to the community development and reconstruction. Effective implementation of such strategy assumes regular, sustainable oriented supplier’s examinations. Sourcing for goods and services locally

reduces carbon emissions associated with transportation and hastens the delivery of the goods for use particularly in times of disaster.

It is possible to increase long-term resilience, uphold integrity, and achieve cost savings by placing a strong emphasis on openness and continual development in sourcing procedures. One example of sustainable sourcing is purchasing food supplies from nearby farmers in the wake of a disaster. This practice guarantees the prompt supply of fresh, nutrient-dense food, stimulates the local economy, and supports human rights and the welfare of the community.

Effective humanitarian response in crisis zones often involves coordination between various stakeholders' international organizations, local governments, NGOs, and military entities. Humanitarian relief efforts in crisis zones face unique challenges, including logistical constraints, volatile environments, and the urgent need for rapid response. Effective relief requires careful planning and coordination to ensure that aid reaches those in need without exacerbating existing problems.

1.1.2. Leveraging Business Analytical Tools in Supply Chain Management

As technology evolve throughout the time, it is essential leveraging technology and innovation as tool to provide and analysis and support decision making in humanitarian setting. Utilization of business analytical tools is critical and facilitate the management of supply chain processes, minimize expenditures, and improve the quality of aid delivery. These tools also provide the functionality of predictive analytics, assisting specialists in estimating what will be needed in times of crisis and what trends to expect. These tools also forecast resource consumption and risks, as well as plan actions based on risk assessment and time series analysis. This research report, data allows us to formulate the most effective strategies capable of reducing the effects of crises, thereby improving supply chain efficiency in conflict zones.

In addition, sustainability metrics are used to analyse the environmental and social effects of interventions in crisis areas. Such tools assist to explore supply chain operations, evaluate resource conservation levels, and recognize 'green' business opportunities. Integrating sustainability metrics into such initiatives not only makes

them effective but also brings marketable and social benefits to relief operations. This study focuses on identifying crucial factors related to environmental impact and sustainability sourcing within an organization's core code of ethics.

1.1.3. Ethical and Environmental Compliance in the Crisis Zones

Establishing ethical sourcing practices that align with ethical compliance is crucial for organizations seeking to enhance their corporate social responsibility and ensure sustainable supply chain management. Ethical sourcing involves the procurement of goods and services in a manner that respects human rights, promotes fair labour practices, and minimizes environmental impact.

In ethical sourcing, the primary purpose of data analytical tools is to interpret research results developed through a qualitative analysis approach, facilitating decision-making across multiple dimensions and ensuring compliance with sourcing practices. The integration of technological innovations, such as blockchain and data analytics, can further enhance visibility and traceability in supply chains, thereby supporting ethical sourcing initiatives (Abaku & Odimarha, 2018).

The World Bank identified three pillars of sustainability development, including the creation of sustainable metrics to assess environmental factors. The economic, environmental and social factors serve as principles that are also informally referred as “the 3 Ps” - Profit, People and Planet. By finding a balance among them, it can provide the best service while still enforcing and assuring a more conscious resource use. This approach is critical for accurately assessing and enhancing organizational performance in relation to environmental standards and regulations. Total Environmental Assessment Framework should include sustainable measurement metrics that take these three pillars of sustainability into account (Molnár & Dolinsky, 2013). The framework adopted in this study encompasses various dimensions from various aspects of the environment. The framework serves as a foundational methodology for organizations aiming to implement effective environmental metrics. Similarly, highlight the importance of a multidisciplinary approach to sustainability metrics, which should address the primary aspects of environmental systems and support sustainable development (Hopton et al., 2010).

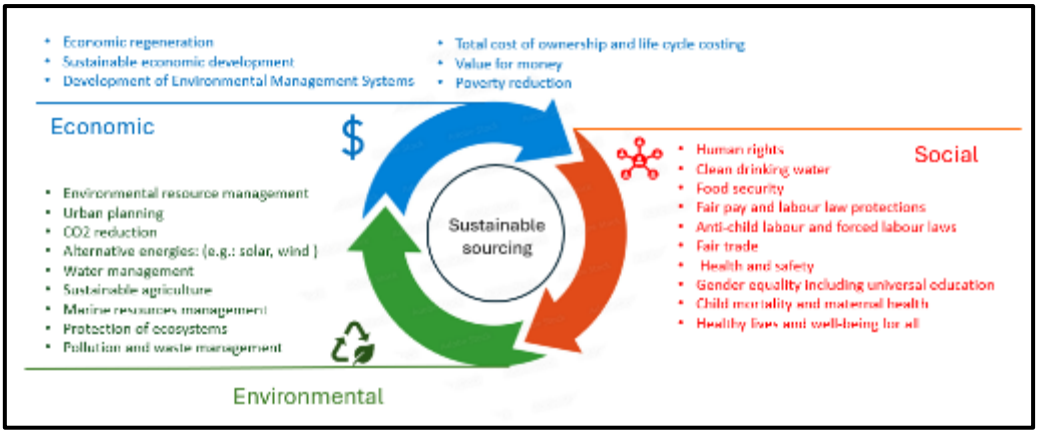


Figure 1: Three types of effects of sustainable development.
Contrsucted by the author and adopted from (Sustainable Procurement Guidance: An introduction to sustainable procurement in IPF projects for practitioners, 2023).

1.1.4. Crisis Zones with Primary Focus on Conflict and Warzones

Crisis zones are areas where normal functioning is disrupted, necessitating any input or support to ease the suffering inflicted on a region stricken by adversity. The study will take a closer look at what leads these regions to be crisis zones. The term conflict and war in this context applies to regions where wars are being waged in the literal sense (combat zones) or cause-likeable tensions on a geopolitical level. This leads to violent conflict, refugees, and the collapse of societies. Conflict and war are being explored in the primary domain of this study, as they are important to the scope of our inquiry on improving sustainable sourcing in humanitarian relief materials. More often and with greater intensity, conflict and war are types of crises for which a humanitarian intervention is so desperately needed. Such events result in widespread, immediate human misery that necessitate swift and effective relief efforts.

1.2. Problem Statement

Humanitarian action is particularly sensitive in armed conflicts and other types of crises. Such regions frequently deal with restricted access due to military activities, blockades, or armed groups that affect delivery routes and timelines. There are also security concerns when humanitarian staff and commodities are at risk due to bombing, theft, or sabotage. Even geographical regions in which such crises are actualized experience fatal ecological devastation that increases loss of life and mass migrations. The destruction of

infrastructure and health disasters necessitates prompt action, which makes aid delivery worse. Endemic shocks can also contribute to poverty and unemployment, as declining economies can negatively impact health and education services. It symbolizes the collapse of society as well as the loss of political power and governance. Crisis assistance includes infrastructure reconstruction, economic development, strengthening governance, health and education intervention, and peace and security measures. In such instances, ideal interventions would require the participation and cooperation of governments, international organisations, non-governmental organisations, and the local community.

1.3. Research Objectives

The objective is to develop a set of tools that include business analytics and will make the process of making decisions about sourcing humanitarian relief materials more efficient. The framework will employ data analytics, demand forecasting tools, and optimization for the supply chain of humanitarian relief materials. The goal is to improve sourcing effectiveness by incorporating data. The study also seeks to strengthen sustainable sourcing practices to align strategies with social dimensions of sourcing. Procurement decisions made to assess potential suppliers through the perspectives of their green credentials, social and ethical performance, and social responsibility. The study will seek ways of addressing environmental degradation and enhancing good citizenship. The framework also seeks to address policy and procedure issues in accordance with ethical and environmental legal requirements. This section of the study will tackle the challenges of sourcing and supplying humanitarian assistance in times of armed conflict and war, considering the unique logistics, ethical considerations, and environmental conditions involved in this process.

1.4. Detail Research Tasks

1.4.1. Reviewing State-of-the-Art on Sustainable Sourcing Assessment

Reviewing the most recent sourcing assessments reveals innovative ideas, best practices, and efficient strategies by analyzing the technology, tools, and processes used in sustainable sourcing. To improve the effectiveness of sustainable sourcing in

humanitarian relief efforts, it also identifies gaps in the literature and areas that require further investigation.

1.4.2. Establishing Specific Sustainability Metrics

Humanitarian relief materials should be evaluated using a comprehensive framework that incorporates sustainability measures that centre on ethical sourcing and environmental effects. These measures must be precise, quantifiable, and useful; they ought to be in line with international sustainability norms and provide uniformity and comparability amongst various humanitarian relief initiatives.

1.4.3. Creating Procedures for Data Gathering and Integration

Implementing thorough data collection and validation methods for demand and supply data, together with stringent data quality and integrity, is essential to ensuring accurate analytics and strategic decision-making. Advanced data integration procedures, such as data validation, cleansing, and enrichment, are also required to maintain high data quality and governance requirements.

1.4.4. Implementing Methods for Data Analysis

Using advanced data analytics techniques, organizations can analyse sustainability data to extract insightful information from large, complex databases. With the help of these technologies, stakeholders may track supplier performance in real-time against ethical and environmental standards by generating reports and dashboards that provide important sustainability metrics and performance indicators in a visual format.

1.4.5. Establishing Mechanisms for Ongoing Monitoring and Improvement

Using continuous improvement procedures, such as regular monitoring, compliance, and enhancement, organizations can improve supplier sustainability practices. It is imperative to maintain current industry standards and establish a feedback loop to enhance sustainability measures and data analysis techniques. This iterative method

enables quick modifications to evaluation criteria considering fresh information and organizational objectives, as well as informed decision-making.

1.5. Thesis Structure

The thesis has been divided into seven chapters each addressing some aspect of sustainable sourcing in humanitarian logistics and supply chain. Chapter 1, outline the background, introduction, problem statement, objectives, task details and hypotheses. Chapter 2, focusing on literature reviews concerning sustainable sourcing about humanitarian logistics and supply chain is reviewed and current areas of difficulties and obstacles are presented. Chapter 3, the research strategy and method component are explored with particular attention being laid on data collection strategy, data capture and both quantitative and qualitative methods used. Chapter 4 describes in a practical way of subsequent steps in achieving the research's results starting with data presentation, the creation of performance frameworks for assessing the impact on the environment, and the management of ethical sourcing using scenarios. The last and final step suggests the establishment of mechanisms for control and further enhancement of practices with the main emphasis on environmental and ethical sourcing practices.

Chapter 5 restructures the framework of the study to accentuate on dealing with ethical, environmental and logistical issues related to performance of humanitarian activities during a crisis, particularly in the Gaza and Levantine countries. The case study in question bears a direct linkage with the research structure undertaken for the humanitarian industrial operation and therefore provides opportunities for organization to alter their procurement, supply chain and sustainability strategies to fit the dynamic nature of conflict situations. Chapter 6 critiques the supply and demand of the basic needs for humanitarian activities in Gaza, the state of infrastructure in the Levant countries, and the internal displaced population. Managing scenarios works in providing a more long-term strategic perspective on the ethical sourcing, whereas the sustainable metrics offer a performance impact measurement tool. Finally, chapter 7 is thesis concludes with an overview of the major results, recommendations for the improvement of business processes, and ideas for further research.

2. Literature Review

Literature reviews are conducted to provide a comprehensive understanding of existing theories, methodologies, and findings related to the thesis's focus. These reviews help establish a strong foundation for the research by synthesizing previous knowledge and identifying gaps that the study aims to address. The literature reviews not only inform the research process but also contribute to the development of a theoretical and practical framework that can guide future interventions and strategies in crisis zones.

2.1. Sustainable Sourcing in Humanitarian Logistics

Humanitarian logistics includes the supply chain management include procurement of goods, services and materials in a way that takes care of the existing resources use to cover not only for the existing needs of the distressed populace, but also the resources' usage impact on the environment, society and economy in the long run. Recently, more efforts have been put towards initiating sustainable sourcing in humanitarian assistance with the knowledge of the link between humanitarian assistance and environmental management. It is a key area which emphasises the need for the embedding of sustainability values into the supplier evaluation process. This entails that apart from considering the financial status of the suppliers, they are evaluated on social and environmental factors and related sustainability (Anjomshoae et al., 2023).

Executing sustainable procurement is a multifaceted effort requiring a clear vision, empathy, and technology. It is also important that co-operation with the suppliers themselves as well as with Non-Governmental Organizations (NGOs) and governmental institutions be secured. More effective and inclusive sustainability results can be accomplished through multi-stakeholder approaches (Lee & Kim, 2023).

Some of the technologies that enhance sustainable procurement implementation are blockchain, IoT and AI. This is because these technologies enhance data management, real time monitoring and predictive strategizing. Use of AI in the SCM processes will lead to optimised utilization of resources and reduced levels of wastage (Wang et al., 2022).

2.1.1. Challenges and Barriers

Nevertheless, several factors remain that prevent the full success of implementing sustainable sourcing management in humanitarian supply chains. The lack of commonly accepted sustainability indicators and the inability to evaluation effect or non-effect of sustainable practices becoming obstacles to effective implementation. Moreover, as human activity is constantly under an unexpected threat due to humanitarian objectives, concerns regarding sustainability are often prioritize rapid response and cost, which makes it challenging to introduce sustainable sourcing plans (Lee, S., & Kim, H., 2023). In the case of humanitarian supply chains, there is often a dilemma surrounding sustainability and cost effectiveness, since certain items would be procured ethically and sustainably, such may cost more. To meet these challenges, the scholars have put forward several approaches to improve humanitarian logistics sustainable sourcing. stablishing sustainability criteria which are aimed at the development of new services or optimization of older ones which include environmental, economic and social aspects. Such criteria will also influence the outcomes of procedures of procurement and hence foster sustainability alongside other production requirements (Anjomshoae et al., 2023).

The nature of supply chains in humanitarian settings especially in conflicted stricken zones makes it difficult to sustain sourcing practices due to logistics and operations related aspects. Overcoming these challenges the celebration among different stake holders requires collaboration among humanitarian organizations, government agencies, and industry partners to develop innovative solutions and establish robust frameworks for sustainable procurement. Collaboration with other humanitarian organizations, suppliers and stakeholders is also necessary for the promotion of sustainability. Partnerships that allow exchange of knowledge and development of capacity help in application of best practices and fresh ideas in sustainable sourcing (Chiappetta Jabbour et al, 2019).

2.1.2. State-of-the-art from Industrial Best Practices

Case studies of successful sustainable sourcing initiatives provide valuable insights into best practices and the benefits of sustainability in humanitarian logistics. Organizations

that have effectively integrated sustainability into their supply chains, highlighting the positive impact on operational efficiency, cost savings, and stakeholder satisfaction (Leiras et al. (2014).

The world bank has published Sustainable Procurement Guidance which is a practical toolkit for the practitioners engaged in Investment Project Financing (IPF) projects and underlines the need for environmental, social and economic aspects of the procurement process. The guide considers itself sustainable procurement with reference also to the most favorable internals of purchasing obtaining goods and services as per the intention of doing good rather than harm. Major aspects are transparency, responsibility and inclusive and equitable procurement and overall processes. There are specific strategies which highlight the execution of sustainable procurement. This includes the need to involve members of the public and other general stakeholders in the planning process, undertake a risk appraisal, and executing a capacity development program. Strategies on how sustainability will be integrated within the procurement processes are outlined which include but not limit to life cycle analysis, sustainable sourcing requirements, and supplier selection. The provision of developing active and result oriented monitoring and evaluation strategies is also provided to evaluate the implementation of sustainable procurement policies towards enhancing good practices.

Functional settings of International Federation of Red Cross and Red Crescent Societies (IFRC) concerning environment-oriented products allowing use only suppliers with advanced level of sustainability, have enabled the IFRC downscale its carbon footprint and strengthen its supply chain resilience. This case illustrates the practicality and benefits of the tool of sustainable procurement in the context of humanitarian assistance. The United Nations's World Food Programme (WFP) has enacted common sourcing strategies that make it a prerequisite to buy food from the local markets to help smallholder farmers and mitigate logistics-driven carbon emissions. This trend towards local sourcing does not only improve the reliability of humanitarian operations but also promotes the economic growth of the target markets.

2.2. Ethical and Environmental Compliance

Ethical and environmental compliance in crisis zones has become a critical aspect of humanitarian supply chain management. Humanitarian operations often occur in highly volatile environments, presenting unique ethical challenges. Researchers have highlighted several ethical issues, including the prioritization of aid, beneficiary selection, and the potential for exploitation or harm. The importance of conducting ethical research in humanitarian settings, pointing out the need for grounded approaches that respect the dignity and rights of affected populations (Bruno et al., 2020). Compliance is critical for humanitarian supply chain management's effectiveness and sustainability. By adhering to established frameworks, implementing sustainable practices, and fostering collaborative approaches, humanitarian organizations can significantly enhance their operations.

2.2.1. Ethical Sourcing Practices as a Key Focus in Ethical Aspect

Ensuring that the sourcing processes do not exploit labor, violate human rights, or engage in unfair trade practices. Ensuring that relief materials are sourced in a way that does not exacerbate the conflict or violate international laws and human rights standards is critical. Ethical sourcing ensures that products are obtained in a responsible and sustainable manner, with a focus on human rights, fair labour practices, and community impacts. Recent studies highlight several key aspects in ethical sourcing practices.

Child and or forced labour free and fair trade which advocate for labor rights in a nutshell aims on fair labour administration which seeks to eradicate child and or the exploitative forced labour workplace for every working-class citizen and that working environment is safe and health. Companies that implement fair trading principles not only improve the quality of life of their workers but perform better regarding brand equity and customer confidence (Yu et al., 2022). Ethical sourcing relies on the availability of relevant information on the supply chain. In fact, companies can utilize traceability systems which are usually integrated with some form of monitoring systems both dyadic and multilayered of the suppliers' ethical behavior. A very detailed description of how the use of blockchain can promote transparency, minimize fraud and build trust with customers (Kumar & Budhwar, 2021).

It's important to build healthy connections with the suppliers and that appropriate codes of ethics are put in place.

Firms that involve themselves with suppliers on ethical issues and offer education and assistance are more likely to be sustainable (Mena et al., 2023. It stands out that the suppliers' concentration on the local market aids not only the economy but encourages the self-sustainability of the given community as well. Assisting local enterprises in training and capacity-building to achieve international humanitarian standards is a focus of this program. Creating long-term relationships with local suppliers to support local supply chains.

2.2.2. Environmental Assessment as a Key Focus in Environmental Aspect

Conventional humanitarian logistics systems often avoid polluting the environment but emphasize speed in the operations on-site procedures. There is however a growing focus on reducing adverse impact on the environment when relief aid is given. Sustainable sourcing aims at promoting the conservation of resources and eliminating or minimizing the negative effects on the environment. Fulfilling these goals involves using materials and technologies that tackle climate change, prevent forest depletion and curtail toxic emissions. Minimizing environmental damage by choosing materials and processes that reduce carbon footprints, prevent deforestation, and limit pollution. Conflict zones often suffer from environmental degradation. Sustainable sourcing practices can help mitigate further environmental damage caused by humanitarian activities.

Carbon footprint reduction is an environmental issue that occupies the most nagging goal. The quest and urge to clean the environment have forced companies to manifest themselves into green logistics. Companies adopting green supply chain management practices greatly reduced their overall carbon emissions (Zhang et al., 2022). Development of efficient practices of waste management characterized by recycling and reuse of materials is the circular economy concept. The economic and environmental benefits of adopting circular economy practices in supply chains (Geissdoerfer et al., 2023). Biodiversity and ecosystem protection is yet another crucial issue. Such sourcing methods that do not lead to deforestation and loss of habitat are

essential. The discourse in the research outlines how the productivity of the land can stay the same and at the same time, biodiversity can be conserved through sustainable agricultural practices (Silva and Malhotra, 2021). Although the relief initiatives are aimed at helping people in crisis situations, they can also provoke adverse 'environmental refugee' consequences, such as deforestation or pollution from and the waste generated by such actions. Sufficient use of natural resources and import of refugees into resettlement environments with wasteful spatial practices often engenders negative environmental consequences (Seifert et al., 2018).

2.3. Integration of Ethical and Environmental Practices

Integrating sustainable practices into the humanitarian supply chain is crucial for minimizing environmental impacts. Several sustainable strategies, such as the use of renewable energy sources, sustainable procurement practices, and green logistics, these practices not only reduce environmental harm but also enhance the overall efficiency and effectiveness of humanitarian operations (Anjomshoae et al., 2023). Ethical compliance requires adherence to established frameworks and guidelines. The Sphere Standards and the Code of Conduct for sourcing strategies for the IFRC and Red Crescent Movement are notable examples that provide comprehensive guidelines for ethical behaviour in humanitarian operations.

The frameworks help ensure that aid is delivered impartially, neutrally, and independently, minimizing the risk of ethical breaches (European Civil Protection and Humanitarian Aid Operations, 2024). These The implementation of ethical guidelines can be seen in various case studies. For instance, the ethical response to the Ebola outbreak in West Africa involved strict adherence to protocols that ensured the dignity and safety of both patients and healthcare workers. Humanitarian organizations are increasingly integrating environmental criteria into their procurement processes. Sourcing locally whenever possible to reduce transportation emissions. Prioritizing products with recycled content and environmentally friendly packaging. Choosing suppliers with robust environmental management systems is also a way to prioritise sustainable sourcing practices.

2.3.1. Challenges and Barriers

Despite the benefits, integrating ethical and environmental compliance in humanitarian supply chains faces several challenges. These include limited resources, lack of infrastructure, and resistance to change within organizations. The need for comprehensive capacity-building programs and the establishment of robust monitoring and evaluation systems to address these challenges. Collaboration between humanitarian organizations, governments, and the private sector is essential for effective compliance. Role of partnerships in enhancing resource sharing, knowledge exchange, and technological innovation. Such collaborative efforts can significantly improve the implementation of ethical and environmental standards in humanitarian operations.

2.3.2. State-of-the-art from Industrial Best Practices

The Logistics Operational Guide (LOG) is an inter-agency document developed by the Logistics Cluster which is led by the World Food Programme (WFP). The LOG is designed from of various check lists, templates, process flows, and other resources aimed at efficient management to give reference during an emergency. It is intended to enhance the quality of decision-making processes concerning humanitarian assistance operations and speed up humanitarian assistance provision. The specific section from LOG focuses on identifiable on legal and ethical considerations. This section of LOG aims at making sure that the contracts entered are not against the law or humanitarian relief principles but are also ethical in terms of souring and procurement there are no side dealings with unethical suppliers or conflicts of interest. Furthermore, it is also promoting green public procurement by providing a selection of suppliers and products with reduced environmental pollution (low carbon emissions, environmentally friendly packaging, etc.) and benefiting the domestic market and decent work.

The Global Logistics Cluster formed a coalition of organizations with the goals of decreasing externalities in the humanitarian sector and launched the Waste Management Reverse Logistics Environmentally Sustainable Transport and Procurement Circular Economy (WREC) Project. The objectives of this project are to develop common approaches to waste and greenhouse gas emissions management, appreciate the concept

of green logistics and empower the practitioners in lowering the environmental risks. The WREC Project fosters collaboration between emergency responders, businesses and scientific institutions in a way that people's lives can be saved today without the tomorrow's shame of having to pick up the spillover effects of that search. Global Logistics Cluster harmonizes and integrates with other complementary awareness initiatives so that this messaging can be crafted, contextualised and available for field level practitioners use. The WREC platform helps in providing good recommendations towards minimizing the adverse environmental effects that come hiding and fixing logistical support for humanitarian actions.

World of Tents notably an eco-friendly tent manufacturer has developed different types target specific markets including scouting, disaster management, glamping and camping along with temporary lodging. There are some green practices that the firm has put on such as recycled materials, tree planting activities, eco-friendly production processes, green shipment methods, and longevity of products. Apart from promoting decent working conditions, the firm has been candid as far as its sourcing policies are concerned. Shrink wrap also known as plastic film in roll form has a wide range of applications in retail packaging and shipping, storage, bundling of items, and in building construction owing to its flame retardancy, Mold mildew grain, ultraviolet (UV) and weather resistance, and durability. It is also used in humanitarian aid to protect supplies during disasters. Dr. Shrink, Inc. is a company located in Michigan that has high quality shrink wrap materials suppliers. Waste shrinks wrap plastic recycling programs are initiatives that help address the problem of shrink wrap waste by fighting against its environmental problems. WFP offers crisis relief, school-based nutrition, and supplementary feeding to thresholders in fighting child hunger and under-nutrition. It works with governments, non-government, private businesses, and UN entities in efforts to decrease food waste through enhanced storage and handling, effective management of the supply chain, and recycling of profitable packaging materials.

Sustainable packaging propositions from renewable, recyclable, or biodegradable materials are cost-effective, socially responsible, and safe for the environment throughout their use. It improves the efficacy and environmental aspects of the humanitarian efforts by cutting down waste, costs and engaging the local population in

recycling and composting. Emergency food supplies can be packaged in biodegradable containers and medical materials may be packed in reusable crates to be sent to disaster areas. Incorporating sustainable packaging solutions within the humanitarian logistics adds value, addressing not only the short-term relief elements but also the longer-term and more sustainable developments of natural environment resiliency. Establishing in 2000 ShelterBox, which is a charity, has in the course of its service aided over 1 million people in 105 countries with a core value of being inquisitive about assistance and how to lessen its impact on the environment.

Humanitarian operations often rely on generators, contributing to greenhouse gas emissions. To reduce reliance on non-renewable resources and minimize carbon footprints, renewable energy sources like solar panels can be used to power operations. Energy-efficient technologies in warehouses and distribution centres can also be implemented. Solar power solutions, such as SolFly, Ecos PowerCube, and solar parks, can provide energy, clean water, and internet connectivity to remote and off-grid locations. SolFly is a solar-powered tent fly designed for emergency relief, while Ecos PowerCube is a mobile solar-powered generator that provides energy, clean water, and internet connectivity to remote and off-grid locations (Jones & Noyes, 2021). Solar parks, also known as solar farms or power stations, are large-scale photovoltaic systems that generate clean, renewable energy, reduce greenhouse gas emissions, and generate significant economic benefits, including job creation. Wind power is a cost-effective, sustainable, and energy-independent renewable energy source for humanitarian aid, offering scalability, sustainability, and energy independence. It can be adapted to meet various energy needs and reduce reliance on external fuel supplies, especially in conflict zones and disaster areas. Wind power can also be deployed for emergency response, long-term infrastructure, and hybrid systems, with organizations like WindAid Institute in Peru and Empower Energy Group in Kenya.

2.4. Leveraging Business Analytical Tool

Integration of business analytical tools in supply chain management has significantly transformed various industries, including the humanitarian sector. This literature review explores the recent advancements in leveraging business analytical tools for enhancing efficiency, transparency, and responsiveness in humanitarian supply chain management.

This review aims to highlight the benefits, challenges, and future directions of using business analytics in humanitarian contexts.

2.4.1. Technique and Tool

Big data analytics involves the examination of vast and varied data sets to uncover hidden patterns, correlations, and trends. Big data analytics can enhance situational awareness and improve decision-making in humanitarian operations by providing real-time insights into disaster-affected areas, resource availability, and supply chain performance (Anjomshoae et al., 2023. The importance of big data in predicting and mitigating the impacts of disasters (Lee & Mangalaraj., 2022). By analysing historical data and current conditions, humanitarian organizations can forecast demand for relief materials, optimize inventory levels, and allocate resources more effectively.

Predictive analytics uses statistical algorithms and machine learning techniques to identify the likelihood of future events based on historical data. This approach is particularly valuable in humanitarian supply chains, where anticipating future needs and potential disruptions is critical. Predictive analytics can aid in the proactive planning of supply chain activities, such as identifying potential bottlenecks, assessing risks, and developing contingency plans (Alsolbi et al., 2023). Optimization techniques focus on finding the most efficient and effective ways to allocate resources and manage operations. In the humanitarian context, optimization models can help organizations minimize costs, reduce delivery times, and maximize the impact of their interventions. The application of optimization tools in routing and scheduling of transportation, which is crucial for timely delivery of aid to disaster-stricken areas (Ülkü et al., 2024).

2.4.2. Challenges and Barriers

While the benefits of business analytical tools are substantial, several challenges hinder their widespread adoption in humanitarian logistics. These challenges include data quality and availability, technological infrastructure, and organizational resistance. Humanitarian organizations often operate in environments where data is scarce, incomplete, or unreliable. This limitation affects the accuracy and effectiveness of analytical tools. Improving data collection methods and establishing robust data-

sharing protocols are essential for overcoming these challenges (Seifert, 2018). The implementation of advanced analytical tools requires significant investments in technology and infrastructure, which can be a barrier for many humanitarian organizations with limited resources. Collaborations with private sector partners and technology providers can help bridge this gap. Adopting new technologies and processes often encounters resistance within organizations due to cultural and operational inertia (Anjomshoae et al., 2023). Training and change management strategies are necessary to ensure that staff understand and embrace the benefits of business analytical tools. Comprehensive capacity-building programs to enhance the analytical capabilities of humanitarian personnel (Lee, S., & Kim, H., 2023).

2.4.3. State-of-the-art from Industrial Best Practices

A notable example is the use of big data analytics by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) during the 2015 Nepal earthquake. By analysing social media feeds, satellite imagery, and other data sources, OCHA was able to map affected areas, assess damage, and prioritize relief efforts. This approach significantly improved the coordination and effectiveness of the humanitarian response. The implementation of predictive analytics in health supply chains by organizations like the World Health Organization (WHO) has demonstrated the potential for improved forecasting and inventory management. By predicting disease outbreaks and demand for medical supplies, WHO has been able to ensure timely and adequate delivery of essential health commodities. The International Federation of Red Cross and Red Crescent Societies (IFRC) has employed optimization techniques to enhance its transportation logistics. By using optimization models to plan the routes and schedules of their relief convoys, IFRC has reduced delivery times and operational costs, ensuring that aid reaches beneficiaries more efficiently.

2.4.4. Other Technology and Innovative Approaches

Blockchain technology ensures the authenticity and traceability of medical supplies and equipment, reducing fraud and counterfeiting. 3D printing enables on-site production of medical tools, reducing reliance on disrupted supply chains. Unmanned Aerial vehicle (UAV) or drones provide timely delivery of essential supplies to remote areas,

bypassing traditional logistical challenges. The Aarogya Maitri Cubes, the world's first disaster hospital deployed by India's national Army, is designed to be deployed anywhere at any time for emergency response. It uses artificial intelligence and data analytics to facilitate coordination, real-time monitoring, and efficient medical management.

Integrated communication systems provide secure channels for coordinating aid efforts, even in areas with compromised terrestrial networks. IoT devices and smart inventory management optimize resource allocation, preventing shortages and overstocking. Geospatial Information Systems aid in resource allocation and prioritizing response efforts. AI and predictive analytics help predict demand for medical supplies based on factors like disease spread or disaster impact, improving response times and directing resources where they are most needed. Collaborative platforms facilitate collaboration among NGOs, governments, and private sector partners, streamlining efforts and improving coordination. Localized production and sourcing reduce dependence on international supply chains, supporting local economies and building resilience. Crowdsourcing and community involvement enhance the relevance and acceptance of supplied materials, improving the effectiveness of humanitarian interventions. Public-Private Partnerships leverage the strengths of various sectors to enhance the overall capacity and impact of humanitarian aid efforts.

2.5. Geographical Focus is of the Crisis Zone

Although specific case studies are not conducted throughout the entire study, data collection is undertaken that may have specific case studies on specific countries or regions, but it's merely for a data sampling purposed to generate research results. The collection of relevant data helps to understand the broader context of crisis zones and contributes to the development of evidence-based recommendations within the strategic framework. Data collection for this study is taken from various humanitarian platforms. Clusters within these platforms develop the data, each focusing on a specific country or region and a case study. To bolster the research findings and conduct hypothesis-finding analysis, we have gathered several data sets from specific clusters within the case study, which demonstrate strong relevance to this research objective.

3. Research Methodology

A research methodology is a comprehensive strategy for answering a research question using empirical data. Methodology involves making decisions about the overall research objectives; both approaches, qualitative and quantitative, apply in this study. It elaborates on sampling methods and data collection techniques, as well as a brief explanation of the case study chosen for the crisis zones. The focus of research design and development is on developing, interpreting, and representing data in various data visualizations using analytical tools and software, which aid in the development of research results and data analysis strategies.

3.1. Data Preparation through Research Questionnaires

3.1.1. Distributing Research Questionnaires

The distribution of research questionnaires is a common method of collecting data or obtaining opinions from respondents. Through this approach, structured questions are presented to individuals or groups to elicit certain information that is targeted in the research.

3.1.2. Defines Goals and Objectives

The questionnaire narrows down the goals and objectives of seeking answers from an audience on the topic and explains how each section relates to it. The section provides a basic understanding of humanitarian logistics, sustainable logistics supply chain, environmental impact, ethical sourcing of goods, sustainable sourcing practices, and the use of business analytical tools during the research study.

3.1.3. Identify the Target Respondents

The main target audience in disaster management is the sourcing department, humanitarian logistics managers, government policymakers, international organizations, and non-governmental organizations, private contributors, and international financial institutions understand the role of funds in sourcing practices.

3.1.4. Development of Questionnaires

Development of questionnaire took place in 3 stages. In the Initial stages is to list all questions that can provide an answer to the research objectives. The second stage is construct and restructure the research questions. The final stage is reviewing the questionnaires sequencing and framing of questions, logical arrangement of questions, randomization of options to avoid bias.

3.1.5. Construction of Questionnaires

The methodical way of approaching the question development is to formulate the polled questions in the form of both closed-ended and open-ended questions. When two or more questions are present, they generate a structured response that simplifies analysis and offers flexibility by providing relevant options and variety of ways of interpreting responses.

3.1.6. Perform Pilot Run

Run the pilot is to test the questionnaire with a small sample this is to ensure running a pilot for questionnaires helps ensure the final version is clear, accurate, and effective, ultimately leading to more reliable and valid research outcomes.

3.1.7. Selecting a Distribution Method.

The methods for distributing research questionnaires are available through online platforms, mail, and in-person distribution to reach a generic and specific target population based on accessibility, cost, and feasibility.

3.1.8. Ensuring Ethical Considerations

The questionnaire obtaining informed consent from participants, ensuring confidentiality and anonymity, and to protect the rights and privacy of participants involved in the research study.

3.1.9. Monitoring Response Rate and Follow-Up.

Monitoring the response rate of the distributed questionnaires to gauge the success of the data collection process. Follow-up reminders sent to stimulate participation and boost response rates, sufficient sample size for analysis and improve the overall quality of the data collected.

3.1.10. Conducting Data Analysis and Interpretation.

The analysis research questionnaires are evaluated through formal respondent debriefings, communication methods like email, chat, and phone calls, and a random survey to gather feedback on the question ask. These techniques aim to improve the questionnaires for future use and emphasize the importance of effective communication. Techniques used in combination, provide a comprehensive approach to evaluating and improving research questionnaires, ensuring that the data collected is both accurate and meaningful (Stanley et al., 2004). The second technique used longitudinal survey design method that involves repeated observations of the same variables over long periods. Longitudinal studies are a method used by researchers to track changes and developments in subjects over time, identifying trends and long-term effects (Voelkle & Hecht, 2020). Data collected in two phases, Round 1 provides an overview of responses, while the final round offers more precise results. These findings are compared against target outcomes to determine if the approach has achieved its objectives, guiding the development of research results with a specific focus area.

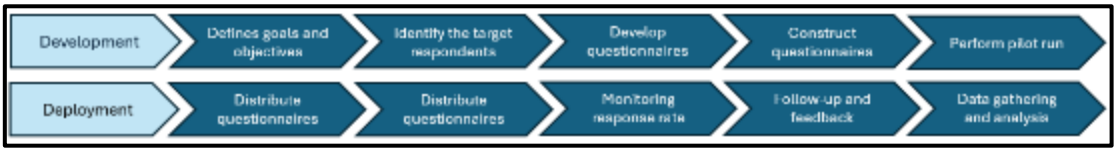


Figure 2: Process steps of developing questionnaires.
Note: Constructed by the Author (Author's development process of research questionnaires)

3.2. Data Explorations

3.2.1. Data Collection from the Open-Source Data Repository

The Humanitarian Data Exchange (HDX), an online platform created by the Office for the Coordination of Humanitarian Affairs (OCHA) of the United Nations, is used in this study to exchange humanitarian data. This platform caters to a broader spectrum of users, such as the public, scholars, policymakers, and humanitarian workers. HDX, utilizing standardized data standards and formats, facilitates interoperability and provides easily understood visualization tools.

3.2.2. Access and Evaluate Research Papers

Excess current research papers on the current state-of-the-art solutions from industry experts or solutions companies. Incorporating the latest best practices from the industry ensures that the research is grounded in practical, real-world applications, enhancing its relevance and applicability. Research seminars provide expert knowledge, feedback, networking possibilities, interdisciplinary insights, skill development, motivation, resource sharing, peer learning, and publication opportunities. It facilitates talks and seminars and gives attendees direct access to state-of-the-art ideas, research, and techniques.

Participating in Disaster Expo Europe, a conference and trade exhibition, catastrophe Expo Europe is centred around resilience, recovery, and catastrophe management. The purpose of the event is to bring experts together, encourage teamwork, and increase knowledge of industry issues facing the European Union. Big Data & AI World is a technology event that provides professionals with the opportunity to learn from thought leaders and source the latest technologies and services from international suppliers. As this study's backbone is utilizing data analytical tools, the event directly contributes to providing insight into the into the approach of utilizing data to develop a research result. It is an open opportunity to access business case studies from information technology (IT) users in various industries.

3.3. Data Collection Methods

3.3.1. Data Collection from Questionnaires Response

Data collection involves two stages: the first and the final round, which enhance data quality, response rates, analysis, and resource management. This iterative process reduces overwhelm and increases response rates. The early data collection stages as pilot tests to ensure accurate responses and minimize the risk of failed data collection. To obtain a more representative sample, use adaptive sampling to target underrepresented demographics with refined methodology leading to higher quality and reliable data. Adaptive sampling techniques ensure underrepresented demographics are targeted, resulting in a balanced and representative sample.

3.3.2. Data Collection from Open-source Data Repository

For data sampling, this study focuses on country case studies. These case studies provide stronger findings, more insightful information, and a better knowledge of the situation. Creative Commons Attribution Share-Alike licenses the dataset, which employs order forms and report consolidation. Methods for local conditions, test findings with empirical data, and gain deeper insights through adaptive sampling. The information gathered comes from several clusters located throughout the State of Palestine and the Levantine nations of Cyprus, Israel, Jordan, Lebanon, and the Syrian Arab Republic. In line with the present conflict, Gaza is the focus area in relevant crisis zones. Since the information is current as of July 2024, it is accurate and relevant.

3.3.2.1. Data source 1: Gaza Supplies and Dispatch Tracking

The dataset provides a comprehensive overview of the delivery and dispatch of aid to the Gaza Strip via the Rafah, Western Erez, and Kerem Shalom crossings. The data provides detailed insights into the status of supplies, dispatched items, and manifest details. It empowers humanitarian agencies by enabling them to efficiently search for and track essential items, enhancing their ability to facilitate aid distribution and monitor the movement of critical resources.

3.3.2.2. Data source 2: Gaza Health Cluster Logistics and Medical Supply

The dataset provides detailed information on partners supplying to Gaza and requests from health service providers. The group collaborates with partners to manage information efficiently, reducing the amount of work required. The dashboard is updated with new information from supply partners and health service providers.

3.3.2.3. Data source 3: Series of Environmental Data Collection of Levantine Countries

The World Bank Group has provided case studies on the environmental index of Cyprus, Israel, Jordan, Lebanon, the Syrian Arab Republic, the West Bank, and Gaza. Historical data range is from 1960 to 2022. The data set includes data from the World Bank's data portal and a consolidated country dataset on World Bank Open Data.

3.3.2.4. Data source 4: Gaza Strip Infrastructure Damaged Assessment Report

The United Nations Satellite Centre (UNOSAT) uses Normalized Difference Vegetation Index (NDVI) satellite imagery and other methods. The data is loaded into a standardized UNOSAT geodatabase and exported as shapefiles. 4 datasets collected from 6 different governorates in the Gaza Strip, which include croplands, agriculture wells, solar panels, and sites with road and building damages. These data contribute to a comprehensive understanding of the infrastructure damage caused by the ongoing conflict in Gaza, which has a direct impact on the environment and exacerbates humanitarian challenges.

3.3.2.5. Data source 5: Demographic Data of Internal Displaced Persons (IDPs)

The Internal Displacement Monitoring Centre (IDMC) conducted case studies on the Internal Displace Persons of West Bank and Gaza from February to July 2024. Demographic data helps organizations develop tailored sourcing strategies to understand specific needs, prioritize resources, and select suppliers who align with

ethical standards. This data also allows for efficient resource allocation, informed supplier selection, and monitoring of outcomes.

3.3.2.6. Data source 6: Demographic Data of Incident Attacks on Aid Operations, Education, Healthcare and IDP/Refugee Camps

The study looks at the types of attacks and incidents that happened to people in the OPT, especially those who lived in the West Bank and Gaza, from January 2016 to July 2024. This secondary meta-data from the Safeguarding Health in Conflict Coalition (SHCC). Using demographic data, organizations can create customized sourcing strategies, identify needs, set priorities, and choose suppliers who share their values with them. Additionally, this data makes it possible to evaluate results, choose suppliers wisely, and allocate resources efficiently.

3.3.2.7. Data source 7: Data Collection Form Research Questionnaire Response

This research focuses on the use of research questionnaires and industry best practices to gather original, relevant data. The researcher constructs the data. The data extraction from the response mainly emphasizes ethical assessment, addressing critical moral and ethical considerations in today's socially conscious environment.

3.4. Research Development

Data visualization, which is derived from the collection of diverse datasets, is used to conduct research. The source serves as a reference for designing and producing research results and for developing new findings based on the research's own interpretations. These outcomes are presented using various visualizations with different key measurements, offering diverse perspectives for analysis through a research-produced dashboard, thereby providing a broader view than the original source. Framework development and data analysis processes employ several tools. These tools enable efficient data collection, organization, and management, ensuring data integrity and accuracy. They also facilitate exploratory data analysis, statistical analysis, predictive modelling, and forecasting. Data visualization and reporting are crucial for effectively communicating research findings and making complex data more accessible to stakeholders. Overall, business analytical tools are essential for enhancing research results and strategic frameworks.

3.4.1. Microsoft and Google Forms for Data Gathering Tools

The tools used for designing research and questionnaire forms include standard templates to ensure consistency. Microsoft Forms serves as the primary platform, with Google Forms as an alternative to reach a broader target audience. The forms are developed on both desktop and mobile devices, with QR codes enabled for easy access.

3.4.2. Office 365 suites and Google Forms

Data files both Microsoft Excel format and Comma-spare value (CSV). Data cleaning is performed using both traditional methods of excel and assistance of machine learning for the complex data structuring to ensure data integrity and proper structuring without altering the original format. Word and PowerPoint used for writing and presenting while research questionnaires developed through Microsoft and Goggle Form.

3.4.3. Business Analytical Tools for Research Development

3.4.3.1. Tableau Desktop 2024.2

Tableau Desktop 2024.2 is a comprehensive data visualization and analytics tool with a user-friendly interface, data connectivity, interactive dashboards, advanced visualizations, real-time data analysis, collaboration, customization, mobile compatibility, security, and scalability. Its drag-and-drop interface allows users to create complex visualizations without extensive technical skills. Tableau connects to various data sources, allowing seamless integration of diverse datasets. It supports various visualization types, including charts, graphs, heat maps, scatter plots, geographical maps, and other visualizations. Tableau's dashboards are easily shared within organizations through Tableau Server or Tableau Online. It is optimized for mobile devices, offering accessibility on tablets and smartphones. Tableau offers security features, user permissions, data encryption, and integration with enterprise security systems. The development work for this study primarily consists of using Tableau to present interactive data visualization in a dashboard that interconnects multiple data sets.

3.4.3.2. Quantum Geographic Information System Desktop 3.2.4.1

Quantum Geographic Information System (QGIS) is a free and open-source Geographic Information System (GIS) that enables users to create, edit, visualize, analyse, and publish geospatial data. It is widely used in fields like environmental science, urban planning, disaster management, and resource management. In this study, the primary purpose of using QGIS is to integrate and visualize environmental data. The task involves facilitating integration with diverse data sources, such as other GIS platforms, databases, and web services.

3.4.3.3. Julius AI 1.0.52: Machine Learning-based Generative AI

Julius AI is an open-source speech recognition engine that is widely used in academic and research settings due to its flexibility and support for various languages and acoustic models. It is known for its business and analytical capabilities. Julius AI generates ideas and insights by processing large datasets, identifying patterns, and suggesting different angles for presenting findings. It enhances analysts' ability to explore creative solutions and communicate complex information more effectively, leading to more comprehensive and compelling analysis presentations.

To conduct the research result of this study, Julius AI used to interpret and respond to complex queries related to data processing and analysis. Pandas, a Python library, facilitates data interpretation and analysis by loading, exploring, and modifying Excel spreadsheets and data frames. NumPy performs numerical calculations to develop matrix, random scores for suppliers in the evaluation scenario. Matplotlib is used to create visual representations of KPI metric performance. Jupyter Notebook, the environment for running Python code and scripts, facilitates interactive data analysis and visualization. Excel with XlsxWriter allows to export results into spreadsheets for reporting, chart enhancement and integrations. Retrieval Augmented Generation (RAG) Tools improved text data retrieval and generation capabilities, allowing large data.

3.4.4. Development of Sustainable Metrics

3.4.4.1. Sustainable Metrics Through Environmental Assessment

This framework offers a thorough method for tracking and measuring several sustainability elements. These measurements can inform policy decisions and monitor progress toward sustainable development targets. The metrics development approach involves using a quantitative method to identify key environmental factors or indication names from the environmental data source file.

3.4.4.2. Implement Scenario Management for Ethical Sourcing Assessments

The first part is to count keywords based on the number of responses from research questionnaires. Qualitative approach to establish the relevance and influence matrix of these key words, which in turn defines key variables. Employ scenario management to pinpoint the scenarios that impact these critical factors, and then showcase the outcomes through metrics.

3.5. Data and Analysis Techniques

For the humanitarian situation, the best way to look at and use data would be to use a technique that combines descriptive statistics, time series analysis, and anomaly detection. This would be especially useful for keeping an eye on supplier compliance from a quantitative point of view. However, this study employs ethical sourcing and scenario management to monitor suppliers, utilizing both qualitative and quantitative methods.

3.5.1. Quantitative Data Analysis Techniques

The study uses descriptive statistics like mean, median, and mode to summarize data, while standard deviation and variance measure data variability. Correlation analysis is used to identify relationships among variables. Key performance indicators (KPIs) like on-time delivery rates, quality standards adherence, and ethical practice scores are developed.

3.5.2. Qualitative Data Analytics Techniques

Content Analysis on coding and theming to categorize and identify patterns or themes within qualitative data. While narrative analysis-based storytelling to analyse the structure and content of narratives or stories within the data.

3.5.3. Mixed Method Analytics Techniques

This study uses triangulation to combine quantitative and qualitative data for a comprehensive environmental impact assessment. It develops a dashboard using numerical methods and establishes sustainable metrics based on narrative analysis from best practices in industrial domains.

3.5.4. Framework Analysis

A structured framework is used to manage and analyze qualitative data, aligning it with predefined objectives. This method ensures objective, repeatable, and transparent analysis, allowing researchers to draw meaningful conclusions, identify patterns, and make informed decisions by identifying key insights.

3.5.5. Visualization and Interactive Dashboard Analysis

Varius charts and matrix developed to visually represent data distribution. Parameters and calculated fields with logical expression also developed to identify correlations and patterns in the data presented interactively.

3.5.6. Storytelling

Narrative generation is a technique that uses advanced algorithms to analyze large datasets, identifying patterns and trends. It creates narratives, providing context and explaining the data's meaning. This method bridges the gap between technical data insights and non-technical stakeholders, making information more accessible and actionable. It guides stakeholders through insights, ensuring important patterns aren't overlooked and connecting them to broader goals.

3.5.7. Sustainability Metrics Analysis

Sustainable Performance Indicators is to assess the environmental, ethical data compliance in sourcing practice. By clustering the data around sustainable assessment metrics, the research aligns with global sustainability goals and provides valuable insights into sustainable practices and their impact.

3.5.8. Bias Detection and Mitigation

Fairness analysis in generative AI detects and mitigates biases in data, ensuring ethical and equitable outcomes in AI-driven decisions. By comparing outcomes across demographic groups, AI systems identify and mitigate biases, promoting trust and ethical business practices in AI models.

4. Strategic Framework Development

Assessing the research questionnaire responses is the first step in the development process. The effort will begin with the construction of data visualization and concentrate on analysing supply and demand for humanitarian aid supplies, with a particular emphasis on basic commodities such as foods, non-food items, fuel, and medical and healthcare supplies. These are the most crucial components that are required for the delivery of humanitarian supplies and operations. The second step is to create a research result environmental data file, and the final step is to build sustainable metrics from the data file using both qualitative and quantitative methods to produce metrics that focus on environmental assessment and ethical sourcing practices through scenario management. Key Performance Indicator (KPI) metric tables were made to keep track of how ethical sourcing practices are always getting better, and scorecards were made to rate the performance of suppliers.

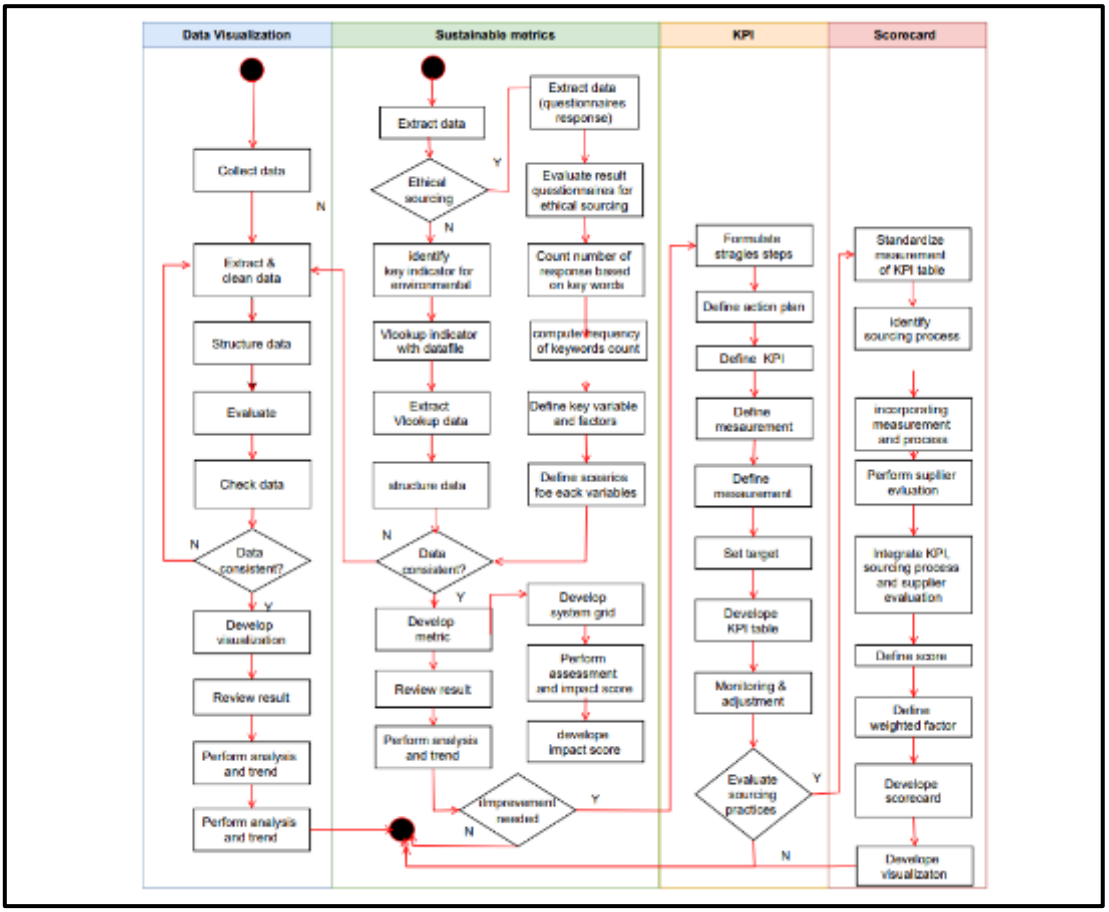


Figure 3: Process flows show the implementation framework development.
Note:: Constructed by the author. (draw.io, 2024)

4.1. Evaluate Response Results from the Questionnaires

According to the response results, there is a strong emphasis on quality, safety, and cost-effectiveness in humanitarian logistics. Ethical and transparent practices are highly valued across all aspects of operations. Environmental concerns are present but not the top priority compared to immediate humanitarian needs. Supplier assessment, monitoring, and compliance are key areas of focus in sustainable sourcing. The sector is balancing immediate humanitarian needs with long-term sustainability goals, utilizing technology to improve operations and transparency. Environmental impact is considered moderately important, but reducing environmental footprints is the top priority for environmental practices. This aligns with research objectives and is relevant for developing research results focusing on environmental aspects. Ethical and transparent practices are highly valued across all operations. Therefore, focusing on ethical sourcing for research development is a relevant and important aspect of sustainable sourcing. The focus area will become the framework's implementation scope.

Table 1: displays the final count of questionnaire responses, grouped by various factors.

Factor	Number of Responses
Quality and Safety	164
Cost-effectiveness	159
Environmental impact	118
Reducing environmental footprint	155
Transparency and accountability	206
Perform regular assessment	166
Ethical sourcing and procurement	159
Transparent supply chain	163
Community engagement	159
Continuous monitoring	161
Monitoring supplier compliance	157
Capturing and integrating data	183

Refer to Appendix 1: Researcher-Constructed Questionnaires and Final Response Count

4.2. Implementation of the Framework

The implementation of the framework consists of four main tasks. First, interactive dashboard develops to represent data visualization using various data sources. Second, a sustainable matrix for environmental assessment was developed. Third, ethical sourcing practices were established through scenario management. Lastly, development of KPI metrics and supplier scorecards to establish mechanisms for monitoring and continuous improvement.

4.2.1. Development of Data Visualization

Development of research result mainly developed through tools and the result is representing with various visualizations through data analytics tools, Tableau Desktop version 2024.2 and Geographic Information System (QGIS) with an assistant machine learning of Phyton programming with Pandas and Matplotlib library.

The development begins with the details process steps including data extraction, cleaning, structuring, interpreting, connection of each data source through joining multiple sets and union. Developing the visualization using key features from the software tools. The task is involving combination of data analytics tools with the machines learning though generative artificial intelligence (AI).

4.2.1.1. Dataset Extraction

Data extraction starts by storing a series of data files and defining the dates as the primary data source. The data set was collected from various open sources, such as humanitarian data exchange and World Bank Open Data, in collaboration with other humanitarian organizations operating in various fields. The data set is based on specific humanitarian operations across various clusters, including logistic, health, operational, and disaster responses. Collecting 9 data sets from meta data, while we construct 1 data set from raw data obtained from research questionnaires. These data sets include both current and historical information, displaying demographics, trends, statistics, and comprehensive assessments.

Table 2: List of data sets collected from various data sources

Data set	Title	Owner/Contributor
Data set 1	Gaza Supplies and Dispatch Tracking.	UNRWA
Data set 2	Health Cluster contains comprehensive dataset of demand and supply medical, and healthcare items build from several variables.	Global Health Cluster and Logistic
Data set 3	Environmental Data Index for Cyprus, Israel, Jordan Lebanon, Syrian Arab republic and Wet bank and Gaza	World Bank
Data set 4	Geographical data set of UNOSAT on Gaza Strip Site Damages Assessment Report	UNOSAT
Data set 5	Geographical data set of UNOSAT on Gaza Strip Agriculture Croplands Damages Assessment Report	
Data set 6	Geographical data set of UNOSAT on Gaza Strip Agriculture Wells Assessment Report	
Data set 7	Geographical data set of UNOSAT on Gaza Strip Solar Panels Damages Assessment Report	
Data set 8	The State of Palestine – Internal Displacements (New Displacement)	IDMC
Data set 9	The State of Palestine (PSE) demographic data on incidents attacks on aid operations, education, healthcare, and IDP/refugee camps.	SHCC
Dataset 10	Data collection of research questionnaires	Author's research data

4.2.1.2. Dataset Cleaning

The data cleaning process involves several steps to ensure the dataset is accurate, consistent, and ready for analysis. The process starts with gathering and importing data from various sources into a suitable format. The initial inspection is performed using phyton functions to preview the data structure and identify issues like missing values, duplicates, and incorrect data types. Identify missing values by removing duplicates, correct data types, and handle outliers using statistical methods or visualizations. The data is then standardized and normalized, and feature engineering is performed to enhance analysis. By cross-checking against original sources and consistency checks, data validation ensures accuracy.

4.2.1.3. Dataset Interpreting

The process of interpreting a dataset involves several steps, starting with exploratory data analysis (EDA) to understand its structure, patterns, and anomalies. Significant trends are identified through time series, regression, or clustering analysis. The findings are then interpreted in relation to the research

question or business problem, considering factors such as industry benchmarks or historical data. Hypothesis testing is performed to validate or refute assumptions. Finally, conclusions and recommendations are drawn based on the data interpretation, suggesting actionable steps and strategies.

4.2.1.4. Definition and Connections of Data Sources

Data sources are defined based on data set names and connect each of the sources linked by a key field with many to many relationships.

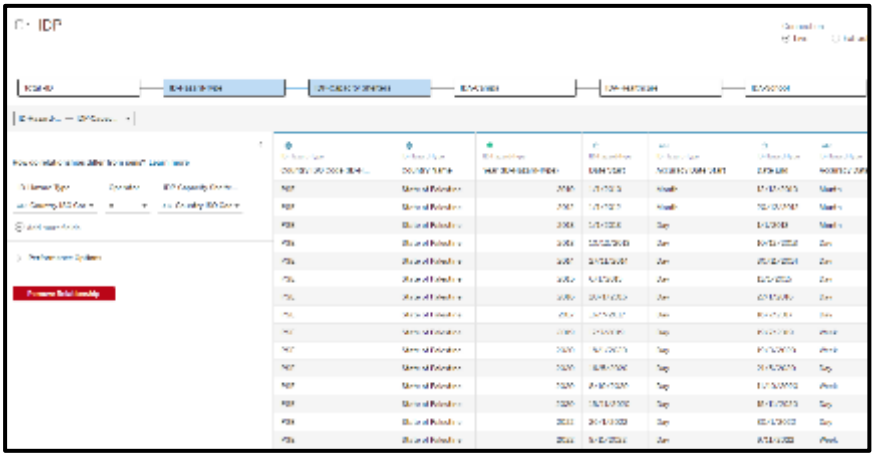


Figure 4: Process of connecting various data sources in Tableau.
Note: Constructed by the author. (Tableau Software LLC, Tableau Desktop 2024.2.)

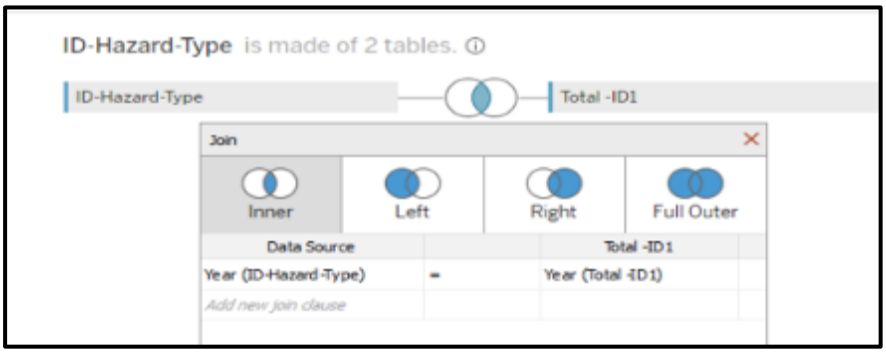


Figure 5: Process of joining datasets across different tables in Tableau
Note: Constructed by the author. (Tableau Software LLC, Tableau Desktop 2024.2.)

4.2.1.5. Development of Data Visualization

Tableau has been used to create diverse visualizations, including bar charts, scatter plots, and maps, showcasing its extensive analytical depth. Eight interactive dashboards are designed to update in real time, providing continuous access to the

latest insights and data trends. The study also features connectivity to seven different data sources, facilitating seamless data integration and blending across structures. Analytical tools that use drag-and-drop functionality to improve usability are among the key features. Advanced analytical features, such as coding, report and parameter customization, and advanced filtering functionality, are also applicable to the development work. Geo-spatial analysis allows geographic data to be visualized on maps, providing valuable location-based insights and aiding in spatial decision-making. The dashboards have multiple download options, including crosstab data tables, images, Adobe PDF, and PowerPoint presentation slides. Tableau's sharing features enhance collaboration by allowing secure publication of dashboards, making insights accessible and actionable. The mobile-responsive design ensures decision-making can occur anywhere, at any time, with seamless access across various devices.

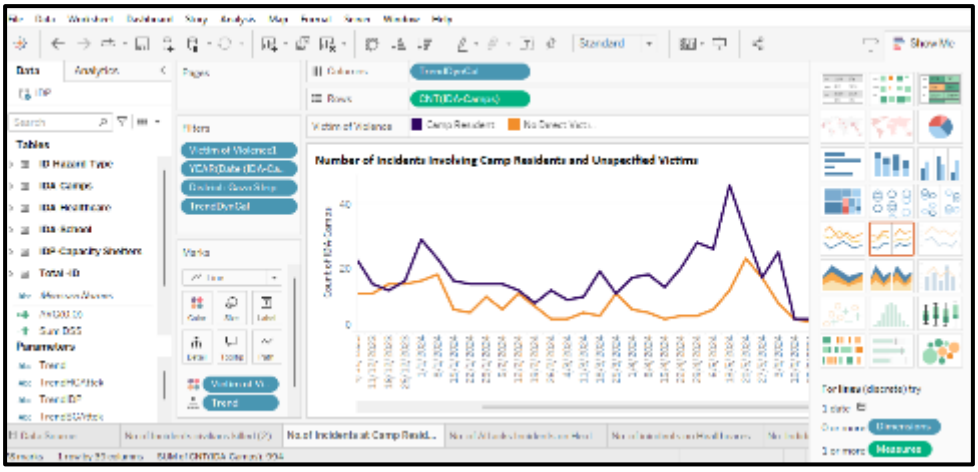


Figure 6: The user interface of data visualization workbook in Tableau.
Note: Constructed by the author. (Tableau Software LLC, Tableau Desktop 2024.2.)

4.2.2. Establish Sustainable Metrics of Environmental Impact

To systematically analyse and visualize sustainable metrics focusing on environmental impact, it took place for the selected countries in the Levant regions. The following steps were taken in the implementation process. A phyton code generator with Pandas powers the machine learning assistance, while the Matplotlib library package creates heatmap metrics for this process. The entire process involves structuring data and

turning it into a pivoted format using machine learning and phyton-coded data. Then, plot pivoted structure data into metrics for visualization.

4.2.2.1. Data Loading

The environmental data was loaded using function PANDAS.READ_EXCEL(), and the indication names were retrieved from text using Python's file handling capabilities. To increase clarity, replace with: The text file will execute cross-checking logic and provide a lookup value to the primary data source file in Excel.

4.2.2.2. Data Cleaning

To ensure all values were numeric, which is essential for accurate visualization, we cleaned the data using the functions PANDAS.DATAFRAME.APPLY() and PD.TO_NUMERIC().

4.2.2.3. Data Filtering

Filtering was performed using function PANDAS.DATAFRAME.ISIN() to narrow down the data to the specified countries and indication names, ensuring the focus remained on relevant metrics.

4.2.2.4. Data Grouping and Sorting

Use function PANDAS.DATAFRAME.SORT_VALUES() to sort the data by year and function PANDAS.DATAFRAME.GROUPBY() to group the data to select the most recent data for each country-indicator combination.

4.2.2.5. Calculation Logic of Data Frame

The calculation logic involved creating a pivot table with 'Country Name' as the index, 'Indicator Name' as columns, and 'Value' as the data. All values were converted to numeric for compatibility with the heatmap function, providing a clear visual representation of the data matrix with colour intensity indicating magnitude.

4.2.2.6. Data Pivoting

A pivot table was created using function PANDAS.DATAFRAME.PIVOT(), transforming the data into a matrix format. This structured the data with 'Country Name' as rows and 'Indicator Name' as columns, and the results were saved to an Excel file using function TO_EXCEL() for further analysis.

4.2.2.7. Developing Heatmap Metric

Finally, a heatmap was created using Tableau Desktop 2024.2 with annotations, colour maps, and titles to visually represent the data.

4.2.2.8. Establish Ethical Sourcing Through Scenario Management Approach

Development consists of both quantitative and qualitative methods. Quantitative methos is mainly to perform the total number keywords counting of ‘ethical’, ‘sourcing’ and ‘ethical sourcing’ from response data of research questionnaires. The counting result used to determine key variable to perform qualitative methods in scenario managements.

4.2.2.9. Establish the Ethical Sourcing through Scenarios Development

For ethical assessment, we use the qualitative approach, which focuses on scenario management for holistic analysis. This approach analyses key variables based on relevance and influence factors and develops a metric based on scoring rates. Factors influencing this score are determined by the number of responses from data source files.

4.2.2.10. Data Loading and Preprocessing

The data was loaded and analysed using Python's data load function, with indication names retrieved from text. Preprocessing was performed using PANDAS.DATAFRAME.ISIN() to narrow down the data to specific countries and

indication names. Data was sorted, grouped, and pivoted using PANDAS.DATAFRAME.PIVOT(). Data was transformed into a matrix format using TO_EXCEL() and cleaned using PANDAS.DATAFRAME.APPLY() and PD.TO_NUMERIC() for accurate visualization.

4.2.2.11. Themes Identification

Using function EXTRACT_THEMES(TEXT); is to identify extract key ethical sourcing key words with the lookup key words 'ethical', 'sourcing', 'sustainability', 'responsible', 'environmental', 'social responsibility', 'fair trade', 'transparency'. Use the function THEME_COUNTS.GET() + 1 to count the number of each key word, then sort the theme frequency using SORTED(THEME_COUNTS.ITEMS()).

4.2.2.12. Key Variable Definition

Define key variables using the function DEF EXTRACT_KEY_PHRASES(TEXT).
The phrase is extracted from data file that contains 'environmental impact', 'ethical sourcing', 'responsible sourcing', 'sustainability', 'transparency', 'social responsibility', 'fair trade', 'eco-friendly', 'renewable energy', 'supplier evaluation', 'ethical practices', 'sustainable procurement', 'waste reduction', 'carbon footprint', 'human rights', 'labour conditions', 'community engagement', 'ethical standards', and 'supply chain visibility'. The function will output the value in terms of both counts and percentages.

4.2.2.13. Develop a Set of Distinct Plausible Scenarios

Create a set for each scenario by varying the key variables and defining them in different possible states. For each key variable scenario, generate all possible combinations. Five distinct scenarios were randomly selected, and subsequent chapters mention the details of 5 distinct scenarios.

4.2.2.14. Develop Relevance Metric

The task involves several subtasks, one of which is to calculate the correlation matrix using a function.

CORRELATION_MATRIX = DF.CORR().

Create a relevance matrix (absolute values of correlations)

RELEVANCE_MATRIX = CORRELATION_MATRIX.ABS()

Use the provided code function to plot the relevance matrix. Build the metrics visualization in Tableau Desktop.

4.2.2.15. Develop Influence Metric

This involves calculating the influence of each variable on the others, often using correlation or other statistical measures. Using the function DF = PD, the subtask loads the scenario

DATA.READ_EXCEL().

Using the code function, calculate the correlation matrix as a proxy for influence. Identify the most influential relationships with an adjustable threshold. Build the metrics visualization in Tableau Desktop.

4.2.2.16. Plot System Grid

This system grid will help visualize the relationships between variables in terms of their influence and dependence. We'll use the concept of a Power-Interest grid, adapting it to show Influence-Dependence relationships. The subtasks involve of loading the influence matrix using INFLUENCE_MATRIX = PD.READ_EXCEL() function. Calculate total influence and dependence for each variable. Create a data frame with the results and finally plot the system grid. Finally, develop a visualization of the system grid in Tableau.

4.3. Research Result

The data is gathered from a specific humanitarian setting across various clusters during the ongoing armed conflict in the Gaza Strip. The set of historical environmental data was also collected to interconnect with the ongoing wars that contribute directly to the

environmental of the Levant region. This event plays a crucial role in generating precise research outcomes that align with the research objective, which centres on the crisis zone.

4.3.1. Data Visualization

The generated result illustrates the demand and supply of food items, as well as non-food items. Medical and healthcare supplies, fuel, and gas serve as basic commodities to support affected populations and humanitarian operations. The visualizations also include demographic data on IDPs and damage attacks that occurred throughout the conflict. This information will help the humanitarian organization to perform logistics and supply chain planning. The visualization of environmental depicts infrastructure damage in Gaza that impacts the entire Levant region. This will assist the key environmental players in making decisions and developing strategies for environmental sustainability action plans.

4.3.1.1. Basic Commodities

Created six visualizations to divide commodities into four categories: foods, non-foods, medicines, and mix items. The visualizations show the total number of classified commodities, and their frequency based on receipt dates. A stacked bar chart displays the quantity of goods received by receiving points. Another six visualizations, based on supply data, were created to represent the top 10 most received commodities in Gaza. These visualizations include maps, scatter plots, bar charts, and box-and-whisker plots. They are integrated into a single interactive dashboard.

Six visualizations have been created for fuel and gas distribution for humanitarian operations in Gaza. These visualizations include quick charts, area charts, two-line charts, and pie charts. Fuel is crucial for powering humanitarian operations, from transporting supplies to running critical infrastructure. By analysing trends in fuel usage, delivery points, and contributions from donors, organizations can optimize fuel allocation, anticipate shortages, and ensure a steady supply for ongoing relief efforts. This approach enhances operational efficiency and ensures uninterrupted

humanitarian activities. Additionally, a fuel and gas permit dashboard are intended to assist organizations in monitoring the status of fuel permits. A crucial document requiring approval from the Coordination Liaison Authority (CLA) includes five visualizations, including quick statistics, a dual-axis scatter plot, a horizontal bar chart, and a pie chart. These visualizations provide visibility and transparency into permit status, enabling organizations to plan their fuel logistics effectively. The tool also details permits required for different humanitarian operations, ensuring transparency and effective planning. Refer to

Appendix 2: List of Data Visualizations Depicting Basic Commodities Received as Humanitarian Aid in Gaza

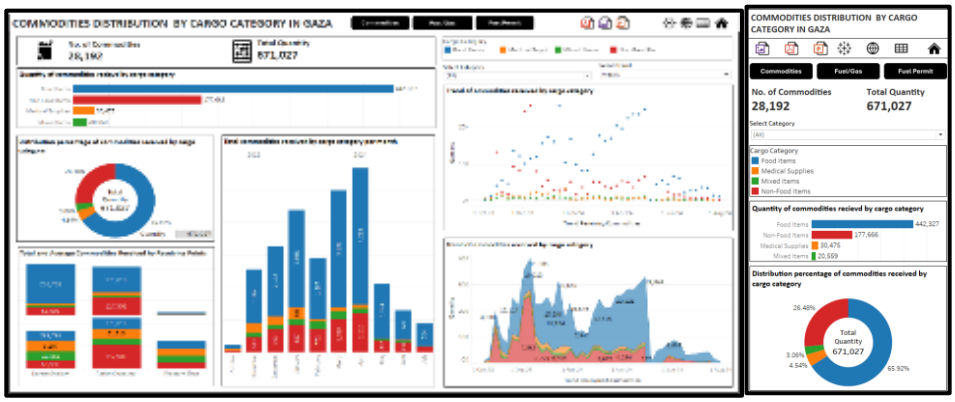


Figure 7: Data visualization produced in a dashboard for desktop and mobile version.
Note: Constructed by the author, (Tableau Software LLC, Tableau Desktop 2024.2.)

4.3.1.2. Medical and Healthcare

Six visualizations make up the first dashboard, which illustrates the demand and supply of healthcare consumable items in humanitarian aid efforts. These visualizations display the total demand and supply, the total demand value, and the amount spent on procuring these items. The first two scatter plots compare total quantities between supply and demand, while a box-and-whisker plot illustrates the average difference between supply and demand. A pie chart represents the top five categories of consumable items by purchase value, and a shape scatter plot compares the number of items demanded versus supplied.

Identical dashboard also developed for to assess demand and supply for medicines with the similar charts for the same purpose. These visualizations provide an overview of total demand and supply, including total demand value and procurement expenditure. The first two scatter plots compare total quantities of supply versus demand, while a box-and-whisker plot shows the average difference between supply and demand. A pie chart highlights the top five categories of medicines by purchase value, and a shape scatter plot compares the number of items demanded to those supplied.

Another dashboard developed to represent data for all medical and healthcare item by category. The visualizations include a pie chart, crosstab tables, scatter plots, vertical bar charts, and dual-axis scatter plots. These tools help identify trends and gaps in inventory, enabling better forecasting and resource allocation. The dashboard also provides insights into the timing and financial aspects of demand and supply, allowing for better stock level management, timely procurement and distribution, and greater accuracy in responding to needs.

Refer to Appendix 3: List of Data Visualizations Depicting Demand and Supply for Medical and Healthcare Items Received as Humanitarian Aid in Gaza

4.3.1.3. Demographic Data of IDPs and Incidents Attacks

A dashboard depicts internal displacement in Gaza, revelling 3.72 million displaced people and 1.46 million currently in shelters. The dashboard uses five visualizations: a vertical chart showing total affected displacement by crisis type, a pie chart showing distribution percentages by subcategory, two-line charts showing different types of displacement by weeks, and a scatter plot showing the cumulative number of affected shelters. The visualizations also show weekly displacement trends, scatter plots tracking shelters, pie charts dividing displacement into subcategories, and a combined bar graph and line chart highlighting a sharp increase in recent years.

A series of visualizations have been created to display the number of attacks on civilian residences, healthcare facilities, and educational institutions in Gaza. The

data is displayed on a yearly, quarterly, monthly, weekly, and daily basis, with trends selected from an interactive menu. The dashboard displays the number of daily attacks on healthcare facilities, the number of affected facilities, and the number of healthcare worker fatalities. The data shows a decreasing trend over time, with frequent spikes from October 2023 to July 2024. The dashboard also displays incidents involving camp residents and unknown victims, as well as a bar chart detailing educators and students killed by month.

Refer to Appendix 4: List of Data Visualizations Depicting Internal Displacement and Count of Attack Incidents

4.3.1.4. Infrastructure Damages

Four visualizations were created to assess the impact of infrastructure damage in Gaza and the Levant region. The first three pairs used donut charts and horizontal bar charts to display the total damaged croplands, agriculture wells and solar panels by different governorates, while the fourth pair used a scatter plot to compare damaged site between months and the rate of increase in damaged sites by municipality. The data allowing for the prioritization of sustainable rebuilding practices. The most important aspect is that the damage to this infrastructure has a significant impact on the environment, not only in Gaza but also in surrounding countries in the Levant region.

4.3.1.5. Environmental Data of Gaza and Other Levantine Countries

A series of visualizations have been developed to provide a comprehensive overview of gas emissions in the Levant region, focusing on carbon emissions. These visualizations include line charts, maps, bar charts, scatter plots, and vertical charts. The interactive dashboard allows users to select and analyse data for each country in the Levant region. Carbon emissions, particularly from greenhouse gases like carbon dioxide, methane, and nitrous oxide, contribute to climate change and air quality degradation.

The other six visualizations have been developed to provide a comprehensive overview of water and energy consumption in the Levant region. These visualizations include vertical bar charts displaying the percentage of the population with access to basic drinking water and sanitation services, horizontal stacked bar charts focusing on rural versus urban areas, shaped charts illustrating total consumption of basic services, and donut charts representing annual freshwater withdrawal, energy consumption, and electricity access. These visualizations are integrated into a single interactive dashboard, allowing users to select and view data for each country in the Levant region.

Another series of visualizations to provide a comprehensive overview of air pollution and biodiversity in the Levant region. These visualizations include scatter plots, box-and-whisker plots, line charts, statistical tables, and vertical bar charts. The dashboard integrates these charts into a single dashboard, allowing users to view data by country. Air pollution and biodiversity threats are significant environmental issues, causing ecosystem degradation, climate change, and species loss. Refer to Appendix 5: List of Data Visualizations Depicting Damaged Infrastructure in Gaza and Environmental Impact in the Levant Region

4.3.2. Establish Sustainable Metrics of Environmental Aspects

These metrics typically cover environmental aspects of sustainability. This framework provides a comprehensive approach to measuring and monitoring various aspects of sustainability. These metrics can be used to track progress towards sustainable development goals and inform policy decisions. Phyton code is used to create structured approach for developing analysing metrics. Pandas is used for data interpretation and Tableau Desktop for visualization.

4.3.2.1. Result from Data File Extraction

The data source contains 23,905 records, with 3,500 to 4,000 records grouped into six countries in the Levant region. A total of 150 indicators represents various environmental aspects. From these indicators, only 51 indicator names were selected through a lookup process, aligning them with key factors identified from the research

questionnaire responses. This matching ensures that the selected indicators correspond with the feedback received. Group 51-indication names into categories that encompass several critical dimensions. Energy and emissions focus on metrics such as access to electricity, renewable energy consumption, and CO2 emissions across various sectors, alongside methane and nitrous oxide emissions within the energy industry. Exposure levels to PM2.5 evaluate air pollution, while the number of threatened species, including birds, fish, plants, and mammals, gauges biodiversity.

4.3.2.2. Filtered Metrics Result by Countries

The metrics are developed by creating a structured dataset with key indicators for each category. The focal geographical area is filtered to include countries in the Levant regions.

4.3.2.3. Metrics Visualization

The structured data is then saved into a pivot dataset. This pivoted format serves as the outcome for the metrics. Tableau Desktop is used to create the heatmap metrics visualization. The results consist of five different metrics. The first metric emphasizes the top five most important aspects, which serve as the final key indicators: access to electricity (% of population), renewable energy consumption (% of total final energy consumption), CO2 emissions (metric tons per capita), PM2.5 air pollution (mean annual exposure in micrograms per cubic meter), and the percentage of people using at least basic drinking water services. The other four metrics provide detailed information on key indicators categorized under greenhouse gas emissions, water and energy consumption, air pollution, and biodiversity threats. All these metrics are represented in a single dashboard for comprehensive analysis. Additional 6 metrics is to represent the environmental trends of each of the 6 Levantine countries: Cyprus, Israel, Jordan, Lebanon, the Syrian Arab Republic, the West Bank, and Gaza. These metrics developed based on key indicators simulated from historical data spanning a 5-year period from 2018 to 2022.

Refer to Appendix 6: Framework Development for Sustainable Environmental Metrics and Data Tracking

Sustainable Metrics of Enviromental Impact by Key Indicators

Country Name	Access to electricity (% of population)	Renewable energy consumption (% of total fin..	CO2 emissions (metric tons per capita)	PM2.5 air pollution, mean annual exposure (microgra..	People using at least basic drinking water services (% ..
Cyprus	100.00	15.02	5.47	15.57	99.77
Israel	100.00	5.61	6.35	19.76	100.00
Jordan	99.90	11.04	1.92	30.65	98.97
Lebanon	100.00	6.71	3.79	28.96	92.60
Syrian Arab Republic	88.82	1.08	1.21	30.95	94.08
West Bank and Gaza	100.00	14.73		31.30	98.44

Figure 8: Sustainable metrics of environmental impact by key indicators.
Note: Constructed by the author. (Tableau Software LLC, Tableau Desktop 2024.2.)

4.3.3. Ethical Sourcing Assessment through Scenario Management Approach

First part, the study uses a quantitative approach to evaluate the significance of ethical sourcing in humanitarian supply chains. The data is extracted from a raw data file extracted from number of responses of research questionnaires. Then employ key words counting using RAG methos with phyton code library to perform the key words count. and analysis reveals that key terms 'ethical', 'sourcing', and 'ethical sourcing' are present in 429, 458, and 321, respectively. The assessment metric provides a quantitative interpretation of the prominence and importance of key concepts related to ethical sourcing. The composite score of 1.7905 represents a weighted average of keyword frequencies, with "ethical sourcing" given slightly more emphasis due to its specificity. "sourcing" is the most frequently mentioned keyword, appearing an average of 2.07 times per response. "Ethical" appears in 98.18% of responses, indicating widespread awareness of ethical considerations, while "ethical sourcing" is mentioned in 93.64% of responses, making it a central focus for most respondents. The high percentages across all keywords and composite score of 1.7905 underscore the importance of ethics and sourcing in the dataset.

Table 3 displays the keyword count, frequency, weight, and score.

Keyword	**Count**	**Frequency**	**Weight**	**Weighted Score**
ethical	429	1.95	0.3	0.585
sourcing	456	2.0727272727	0.3	0.6218181818
ethical sourcing	321	1.4590909091	0.4	0.5836363636

Second part is to identifies the plausible scenarios through text traction relate dto ethical sourcing. The Plausible scenarios is foundation approach of Scenario management. It is a strategic planning tool that helps organizations anticipate and prepare for potential future events or conditions. It involves identifying key variables, developing plausible scenarios, analysing their impacts, formulating flexible strategies, and continuously monitoring and updating the environment. Scenario management is particularly useful for assessing ethical sourcing, as it offers holistic evaluation, identifies risks and opportunities, enhances strategic planning, engages stakeholders, and allows for flexibility and adaptability. The integration of ethical sourcing into humanitarian supply chains can enhance the overall effectiveness and efficiency of operations, as it aligns logistical practices with the humanitarian principles of humanity, neutrality, impartiality, and independence (Alsolbi et al., 2023). Furthermore, scenario management can help organizations anticipate ethical dilemmas and develop strategies to address them proactively, thereby improving decision-making processes (Dubey, 2022). Scenario management also allows organizations to adapt their strategies as dynamic factors evolve, ensuring their ethical sourcing practices remain relevant and effective.

4.3.3.1. Themes Identification

The analysis of ethical sourcing in a dataset involves data exploration and understanding, extracting text related to ethical sourcing, identifying recurring themes, and categorizing them into broader categories. properly load the dataset and align the column names with expectations. The qualitative analysis focuses on identifying themes, patterns, and potential scenarios related to ethical sourcing. The main themes related to ethical sourcing, according to the counting record from the dataset. The keywords for environmental impact have a count of 223, ethical has a count of 216, sourcing has a count of 214, transparency has a count of 106, responsibility has a count of 164, sustainability has a count of 139, and social responsibility has a count of 4.

4.3.3.2. Key Variable

The dataset identifies key themes related to ethical sourcing in humanitarian logistics, with environmental impact being the most prominent theme. Ethical sourcing involves responsible and sustainable practices that consider the well-being of workers, communities, and the environment. Transparency in the sourcing process emphasizes clear communication about sourcing practices, product origins, and supply chain operations. Renewable energy is crucial for reducing environmental impact. Community engagement is essential for positively impacting local communities affected by sourcing activities. Eco-friendly practices include using sustainable materials and reducing waste. Sustainability focuses on long-term practices that balance environmental, social, and economic considerations. Social responsibility addresses sourcing's broader social impacts, including labor conditions, human rights, and fair trade. These variables provide a framework for analyzing and managing ethical sourcing scenarios in humanitarian logistics, helping to develop strategies, set goals, and measure performance.

Table 4: Key variable frequency and percentage-based om counting number of respondence.

Key variables	**Frequency**	**Percentage of frequency**
Environmental impact	215	91.49%
Ethical sourcing	206	87.66%
Transparency	206	87.66%
Renewable energy	173	73.62
Community engagement	158	67.23%
Eco-friendly practices	155	65.96%
sustainability	139	59.15%
Social responsibility	4	1.70%

4.3.3.3. Plausible Scenario Description

Five distinct, plausible scenarios for ethical sourcing in humanitarian logistics, created by varying the key variables.

Scenario 1: In this scenario, the humanitarian logistics operation is characterized by a high environmental impact, active community engagement, sustainability as a long-term focus, and social responsibility as a high priority. However, the operation faces challenges in terms of environmentally friendly practices that are minimal.

This scenario presents unique opportunities and challenges for ethical sourcing in humanitarian logistics.

Scenario 2: In this scenario, the humanitarian logistics operation is characterized by high environmental impact, strong ethical sourcing, and high social responsibility. However, the operation encounters minimal challenges in terms of community engagement and eco-friendly practices. This scenario presents unique opportunities and challenges for ethical sourcing in humanitarian logistics.

Scenario 3: In this scenario, the humanitarian logistics operation is characterized by a long-term focus on sustainability and a high priority on social responsibility. However, the operation encounters a lack of renewable energy, minimal community engagement, and a lack of eco-friendly practices. This scenario presents unique opportunities and challenges for ethical sourcing in humanitarian logistics.

Scenario 4: In this scenario, the humanitarian logistics operation is characterized by extensive renewable energy, active community engagement, and sustainability as a long-term focus. However, the operation faces challenges in terms of social responsibility being a low priority. This scenario presents unique opportunities and challenges for ethical sourcing in humanitarian logistics.

Scenario 5: The humanitarian logistics operation is characterized by high environmental impact, strong ethical sourcing, high transparency, active community engagement, widespread eco-friendly practices, and long-term sustainability. This scenario presents unique opportunities and challenges for ethical sourcing in humanitarian logistics.

These scenarios provide a diverse range of conditions and challenges for ethical sourcing in humanitarian logistics, highlighting different aspects such as environmental impact, community engagement, and transparency. Each scenario presents unique opportunities and challenges, offering insights into how different variables can influence ethical sourcing practices.

4.3.3.4. Relevant Matrix Development

To better understand the relationships between variables, a relevance matrix was created from the ethical sourcing scenarios file and its visualizations. The previous chapters' process steps provide detailed instructions on how to use the phyton code and its library to compute the results. It uses a threshold of 0.5 (relevance > 0.5) to identify the most relevant relationships between variables.

	Environmental Impact	Ethical Sourcing	Transparency	Renewable Energy	Community Engagement	Eco-friendly Practices	Sustainability	Social Responsibility
Environmental Impact	1	0.422577127	0.534522484	0.534522484	0.133630621	0.133630621	0.21821789	0.597614305
Ethical Sourcing	0.422577127	1	0.395284708	0	0	0.790569415	0.645497224	0.707106781
Transparency	0.534522484	0.395284708	1	0.375	0.6875	0.5625	0.102062073	0.838525492
Renewable Energy	0.534522484	0	0.375	1	0.375	0.25	0.612372436	0.559016994
Community Engagement	0.133630621	0	0.6875	0.375	1	0.5625	0.612372436	0.559016994
Eco-friendly Practices	0.133630621	0.790569415	0.5625	0.25	0.5625	1	0.102062073	0.838525492
Sustainability	0.21821789	0.645497224	0.102062073	0.612372436	0.612372436	0.102062073	1	5.07E-17
Social Responsibility	0.597614305	0.707106781	0.838525492	0.559016994	0.559016994	0.838525492	5.07E-17	1

Figure 9: Relevance matrix created in through the Python library Pandas, NumPhy, Matplotlib. *Note: Constructed by the author.* (Julius AI Lab 1.052, 2024.)

4.3.3.5. Influence Matrix Development

An influence matrix from the ethical sourcing scenarios file is used to create visualizations to help understand the relationships between variables. Using a threshold of 0.5 (both positive and negative influences > 0.5).

	Environmental Impact	Ethical Sourcing	Transparency	Renewable Energy	Community Engagement	Eco-friendly Practices	Sustainability	Social Responsibility
Environmental Impact	1	-0.422577127	-0.534522484	-0.534522484	-0.133630621	-0.133630621	0.21821789	-0.597614305
Ethical Sourcing	-0.422577127	1	0.395284708	0	0	0.790569415	-0.645497224	0.707106781
Transparency	-0.534522484	0.395284708	1	0.375	-0.6875	0.5625	0.102062073	0.838525492
Renewable Energy	-0.534522484	0	0.375	1	-0.375	0.25	0.612372436	0.559016994
Community Engagement	-0.133630621	0	-0.6875	-0.375	1	-0.5625	-0.612372436	-0.559016994
Eco-friendly Practices	-0.133630621	0.790569415	0.5625	0.25	-0.5625	1	-0.102062073	0.838525492
Sustainability	0.21821789	-0.645497224	0.102062073	0.612372436	-0.612372436	-0.102062073	1	5.06745E-17
Social Responsibility	-0.597614305	0.707106781	0.838525492	0.559016994	-0.559016994	0.838525492	5.06745E-17	1

Figure 10: Influence matrix created through the Python libraries Pandas, NumPy, and Matplotlib. *Note: Constructed by the author.* (Julius AI Lab 1.052, 2024.)

4.3.3.6. System Grid

The system grid is a tool used to visualize the relationships between variables in the ethical sourcing process. Key variables with high influence and dependence include transparency, eco-friendly practices, and social responsibility. These are central to the system and play a crucial role in shaping the ethical sourcing landscape. Influential variables have high influence but low dependence, driving changes in the system. Dependent variables have low influence but high dependence, largely shaped by changes in other variables. Environmental impact, ethical sourcing, renewable energy, community engagement, and sustainability are all examples of variables that don't depend on or affect each other much. They work on their own within the ethical sourcing framework. This system grid provides valuable insights into which variables are most integral to the ethical sourcing process and which are peripheral, helping prioritize strategic focus and improvement in ethical sourcing initiatives. Refer to

Appendix 7: Framework Development for Ethical Sourcing Using Scenario Management

Table 5: Each variable with influence and dependence metric values

Variables	**Influence**	**Dependence**
Environmental Impact	1.5611331208	1.5611331208
Ethical Sourcing	3.698777192	3.698777192
Transparency	6.6555778605	6.6555778605
Renewable Energy	2.2870892424	2.2870892424
Community Engagement	3.5271590636	3.5271590636
Eco-friendly Practices	5.2412127977	5.2412127977
Sustainability	0	0
Social Responsibility	10	10

Table 6: Each variable categorized based on its influence and dependence

Variables	Category
Environmental Impact	Autonomous Variable
Ethical Sourcing	Autonomous Variable
Transparency	Key Variable
Renewable Energy	Autonomous Variable
Community Engagement	Autonomous Variable
Eco-friendly Practices	Key Variable
Sustainability	Autonomous Variable
Social Responsibility	Key Variable

4.4. Mechanism for Monitoring and Continuous Improvement

4.4.1. Continuous Improvement of Environmental Monitoring

To effectively monitor environmental indicators like CO2 emissions, renewable energy consumption, and air quality, humanitarian organizations should use real-time data collection and analysis tools, deploy IoT sensors, and use data analytics platforms. Benchmarking top-performing countries in renewable energy consumption and sustainability metrics can help set targets and develop best practices. For this study, the approaches used to perform monitoring and continuous improvement utilize historical data collection developed in sustainable metrics shows the and analysis tools to monitor key environmental indicators such as CO2 emissions, renewable energy consumption, air quality and other indicators Then, establish a benchmark base for top-performing countries. In terms of renewable energy consumption and other sustainability metrics. Example: taking insights from countries like Cyprus, the West Bank, and Gaza, which have high renewable energy consumption, to set targets and develop best practices. The benchmark is also based on tracking data from sustainable metrics developed and transformed into a KPI metric for continuous improvement monitoring. Formulating strategies or action plans across various indicators involves leveraging the strengths of tracking data from Environmental Trend Analysis over a Simulated 5-Year Period from 2018 to 2022, and addressing the strategic issues based on the trends identified in the data.

4.4.1.1. Identify Key Indicators

From the data source file, 51 key indicators were identified to be used as a key factor for assessment to gather the sustainable metrics. Tracking data reveals key trends in environmental impact and compliance. The combination system proposes measuring five key indicators that have a direct impact on actionable recommendations in humanitarian logistics.

4.4.1.2. Strategy Formulation Steps

Focus on the key indicators and define them as the main KPI metric. This key indicator is derived from sustainable metrics and will be defined as a key variable for the KPI metric. Include additional KPI in the metrics to provide more comprehensive evaluation.

4.4.1.3. Strategies and Action Plans

Using strategies and action plans, develop the details of the KPI metric table for ongoing and monitoring purposes.

4.4.1.4. Adds Additional Variable to the KPI metric table

An additional variable represents the humanitarian focus. The author added this variable based on observations made throughout the study. This approach is solely based on assumptions and current best practices for monitoring the environmental impact. The dimension will relate to the interrelation mechanism for monitoring and continuous improvement in environmental impact assessments. These additional findings will be incorporated into the KPI metrics to specifically align with the operational perspective of humanitarian-focused objectives. The detailed findings will be elaborated in the next chapter. Refer to Appendix 8: Development of Sustainable Environmental KPI Metrics for Monitoring Continuous Improvement

4.4.2. Continuous Improvement of Ethical Sourcing Practices

Regular Monitoring by establishing a review schedule and assigning specific team members to monitor ethical sourcing variables. This is followed by developing data collection methods, which involves creating tools such as surveys, audits, and data analysis techniques to gather relevant information on each variable. In this study, the data mainly collected from data file based on the surveys from research questionnaire. Data audit is done on surface level to ensure the data consistency, structured and analysis technic is done through trend and pattern. Then in this case the scenarios are defined base on the keywords response from the survey and identified key variable according to scenarios defined. From visualize data through metrics and system grid, the Analys and decision-making processes is to assess the impact scores from scenarios and detect significant shifts in the ethical sourcing landscape, allowing for timely updates to strategies and action plans. Strategies and action plans are transformed into KPI metric table. The KPI metric table designed as per scenarios impact scores, key variable of the metrics. The key metrics defined based on direct influence on ethical sourcing., defining each key variable into KPI metric steps, measure each indicator in the KPI metric with target and timeframe of the KPI metric achievement. The improvement in percentage is defined according to the current state vs target state from the ethical sourcing metric that is developed through the entire metric development process.

Table 7: Summary of KPI metric Table for Ethical Sourcing

Aspects	Variables	Current State	Target State	Improvement (%)
Environmental	Environmental Impact	2.2	2.64	20
Social	Ethical Sourcing	2	3	50
Social	Transparency	1.6	2.4	50
Environmental	Renewable Energy	2.6	3.38	30
Social	Community Engagement	2.4	3.12	30
environmental	Eco-friendly Practices	2.4	3.12	30
Economic	Sustainability	2.2	2.86	30
Social	Social Responsibility	2	2.8	40
	Impact Score	2.757	3.171	15.02

In this example, key variable social responsibility, ethical sourcing, transparency, community engagement are prominent to consider developing KPI metric fusing on theses specific aspect. Target sates and improvement generated from the system will be

used as a baseline to develop KPI metric table. The practice of continuous improvement ensures that the monitoring system evolves with emerging ethical concerns, while integrating with other systems connects this process with broader business intelligence tools to maintain a comprehensive view of operations. Scenario revision is critical and should be conducted periodically, assessing how ethical sourcing practices must adapt to changes in the industry or environment. Throughout the implementation, teams must focus on data collection and analysis to review both internal and external factors, evaluate strategies, establishing monitoring and evaluation system. Regular engagement with stakeholders, capacity building, and innovation in data analytics are crucial for adapting to new challenges and ensuring that ethical sourcing remains an integral part of business operations.

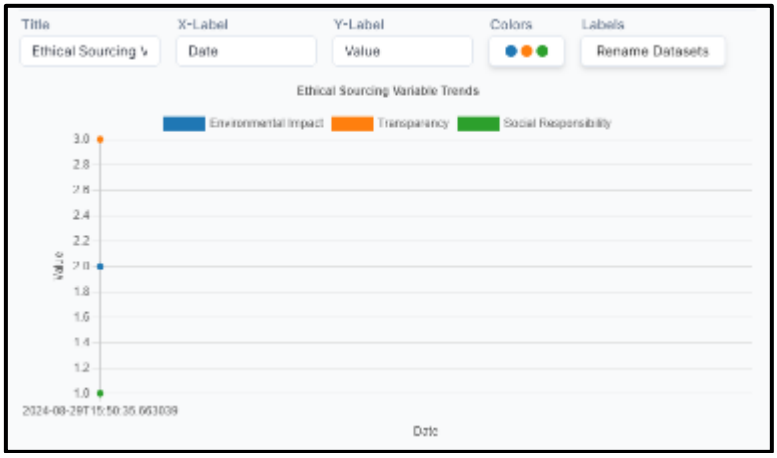


Figure 11: Variable trends for Ethical Sourcing.
Note: Constructed by the author. (Julius AI Lab 1.052, 2024.)

Continuous advancement of the supplier sustainability evaluation system necessitates the implementation of effective systems for its performance tracking and performance enhancement. This could carry out for example through internal assessments; performance management through key performance indicator (KPI Metrics) the use of intelligence and other software tools to assess the suppliers' accepted environmental and ethical standards. Feedback mechanisms should also be instituted to fill in the gaps and motivate the use of technology appropriately. Moreover, it is essential to establish a warm relationship with all the suppliers and embed sustainability criterions in the agreements made with the suppliers to keep abreast of the changing trends and promoting compliance and advancement with regards to sustainability.

4.4.2.1. Assessment of Scenarios through Impact Scores

Based on how key variables were analysed in the system grid, the system has come up with possible impact scores for each scenario. To assess the potential impact of each scenario, we can evaluate the influence and dependence of each variable within the scenarios. This entails examining how changes in one variable may affect others, as well as the overall scenario.

Scenarios 1 and 2 have the highest impact score (41.50), indicating significant potential influence on the ethical sourcing system. These scenarios have high values for transparency, eco-friendly practices, and social responsibility. Scenarios 2 and 5 have moderate impact scores, while Scenarios 3 and 4 have lower scores (18.07 and 13.83, respectively). Prioritizing high-impact scenarios in strategic planning and implementation is crucial, as they are likely to have the most significant effects. To analyse these scenarios, examine their characteristics, including their values for transparency, eco-friendly practices, and social responsibility. Scenarios 3 and 4 may offer valuable insights, but understanding their lower impact could help identify areas for improvement in ethical sourcing practices. Implementing a combination of high-impact and moderate-impact scenarios can create a comprehensive and effective ethical sourcing strategy. Regularly reassessing the impact of these scenarios and adjusting strategies accordingly is essential as the ethical sourcing landscape evolves.

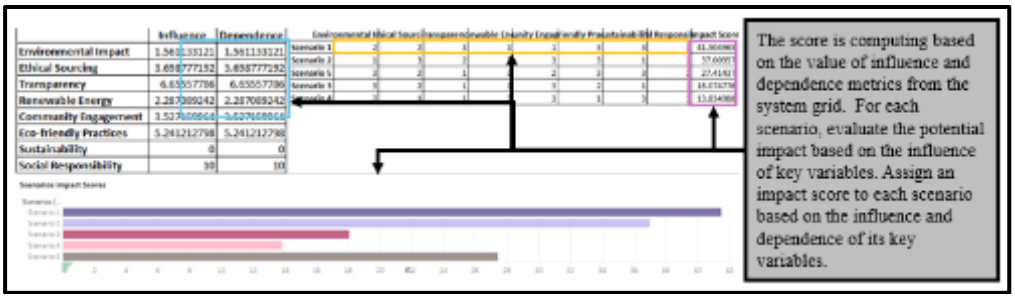


Figure 12: Scenarios impact scores calculated based on the metrics' influence and dependence values.
Note: constructed by the author. (Julius AI Lab 1.052 and (Tableau Software LLC, Tableau Desktop 2024.2.)

4.4.2.2. Formulate Strategies Steps

To formulate strategies or action plans across these scenarios, one must leverage the strengths of high-impact scenarios while addressing the weaknesses of lower-impact scenarios. Focus on the key variables that have the most influence and dependence, as identified in the system grid. Use the strengths of high-impact scenarios to drive improvements across the system. Identify and address the weaknesses in lower-impact scenarios to enhance their effectiveness. Create specific, actionable steps for each scenario to achieve desired outcomes. Continuously monitor the impact of these strategies and adjust as needed.

4.4.2.3. Strategies and Action Plans

In Scenario 1, characterized by high impact, the focus is on key variables such as transparency, eco-friendly practices, and social responsibility. Enhance transparency through reporting and communication channels, promoting eco-friendly practices by investing in sustainable technologies, and strengthening social responsibility by engaging with communities and stakeholders to uphold ethical standards.

Scenario 2, also with high impact, emphasizes innovation and collaboration. The strategy is to foster innovation in sustainable practices and technologies, collaborate with suppliers and partners to enhance ethical sourcing and transparency, and increase community engagement to support local initiatives.

For Scenario 5, which has a moderate impact, transparency and eco-friendly practices remain the key variables. Developing clear guidelines and standards, expand eco-friendly initiatives to cover more areas of the supply chain, and educate employees and partners on sustainable practices through targeted training.

Scenario 3, with lower impact, centres on social responsibility. The strategy focuses on enhancing social responsibility by implementing community programs and ensuring ethical labor practices, while increasing the visibility of these efforts to stakeholders.

Finally, Scenario 4, also with a lower impact, prioritizes community engagement. The strategy aims to fortify relationships with local communities and stakeholders, fostering inclusivity to guarantee the representation of diverse groups in community engagement initiatives.

4.4.2.4. Monitoring and Adjustment

To increase clarity, replace with: Establish key performance indicators (KPI metrics) to monitor the success of each strategy. Conduct regular reviews to assess the effectiveness of strategies and make necessary adjustments. Implement feedback mechanisms to gather input from stakeholders and communities. The KPI metrics are produced based on the action plan and strategies.

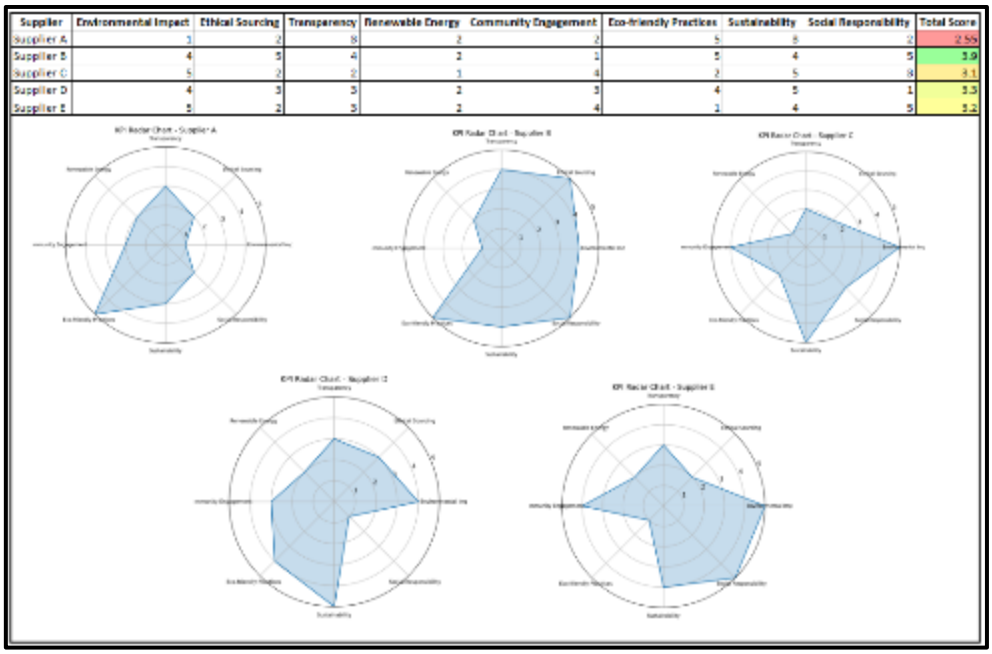
The first KPI metric, based on a scoring calculation of the scenarios, focuses on the important variables suggested by the system. To present a more comprehensive picture and cover significant areas that the system does not address, more generic variables are added to the ones that are already there. The second KPI metric, which is especially designed for ethical sourcing in the humanitarian context, is totally dependent on the researcher's observations made during the study. Refer to Appendix 9: Development of Ethical Sourcing KPI Metrics for Monitoring Continuous Improvement.

4.4.2.5. Supplier Assessment on Ethical Compliance Using a Scorecard

Development of the scorecard begins with data loading from KPI metric table for the ethical sourcing. Add the sample of suppliers. Assign random scores for each KPI metric (in the case of actual sicario, this would be actual evaluations. Calculate the weighted score. The score can be distributed equally or no one equally. On this score cards development, all the 8 KPI metrics is weighted as

$$weight = [0.15, 0.15, 0.1, 0.1, 0.1, 0.15, 0.15, 0.1]$$

But this weighted score can be adjusted as needed. the score cards are created through visualization for data recreation and analysis. Refer to the Appendix 10: Development of a Scorecard for Supplier Assessment and Evaluation



Supplier	Environmental Impact	Ethical Sourcing	Transparency	Renewable Energy	Community Engagement	Eco-friendly Practices	Sustainability	Social Responsibility	Total Score
Supplier A	3	2	3	2	2	5	3	2	2.55
Supplier B	4	5	4	2	1	5	4	5	3.9
Supplier C	5	2	2	3	4	2	5	3	3.1
Supplier D	4	3	3	2	3	4	5	1	3.3
Supplier E	5	2	3	2	4	1	4	5	3.2

Figure 13: Supplier evaluation on ethical sourcing practice using a scorecard
Note: Constructed by the author (Julius AI Lab 1.052, 2024)

5. Case Study: Application in Crisis Zones

The application of the research framework provides a structured approach to addressing the logistical, environmental, and ethical challenges of humanitarian operations in the specific crisis zone. The description of selected crisis zones provides a concise overview that explains the background of specific countries, regions, or territories. Then, translating data-driven insights into actionable strategies, the framework allows organizations to adapt procurement, supply chain, and sustainability practices to the unique demands of conflict settings. This involves implementing sustainable sourcing that adheres to environmental and ethical standards while ensuring efficient and timely delivery of aid. Testing the framework in such environments helps refine strategies, ensuring they are both practical and aligned with the specific constraints of the crisis, thus enhancing operational effectiveness in humanitarian missions. This research focuses on the ongoing conflict in the Gaza Strip, Occupied Palestinian Territories (OPT), and its environmental impacts on neighbouring countries in the Levant Region. Case studies and online sources collect data, providing access to pertinent information. The research aims to understand trends and gain insight into how the conflict has affected logistics and supply chain operations, leading to environmental impacts. The primary data access allows for interpretation, allowing us to understand trends and gain insights into how sustainable sourcing in humanitarian aid can improve these impacts. The research's targeted focus ensures that research objectives are met despite the complex and volatile environment in the region.

5.1. Description of Selected Crisis Zones

The Occupied Palestinian Territories (OPT), including the West Bank, East Jerusalem, and Gaza Strip, have been grappling with ongoing territorial disputes, military occupation, and violence for decades, leading to significant humanitarian challenges and economic hardship. The blockade of Gaza, frequent military operations, and settlement expansions in the West Bank have exacerbated these issues, causing displacement, food insecurity, and limited mobility for Palestinians. The political landscape, influenced by Israeli policies, complicates humanitarian efforts and poses a significant challenge to international law and human rights. Addressing the needs of the Palestinian population requires a nuanced approach that considers both immediate relief and long-term peace and stability strategies.

The Levant region, including Cyprus, Syria, Lebanon, Jordan, Israel, and the OPT itself, is grappling with environmental issues due to prolonged conflicts, political tensions, and civil unrest that are significant in this region. The interconnectedness of environmental systems means that changes in one area can have far-reaching impacts across the entire region. Obtaining data from multiple sources is crucial for a holistic understanding of environmental challenges and trends.

5.2. Implementation of the Framework

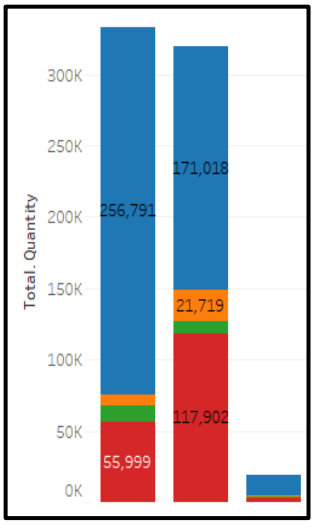
First, to derive data-driven results from the research, analyse them, and then apply them to the case study outcomes. Then review consistency of research result with established logistical, operational, and environmental procedures. The second part is the process, which involves adjusting strategies, practices, and operational procedures based on data analysis to create customized solutions. Mainly, it will focus on applying the results to sustainable sourcing practices that emphasize environmental and ethical compliance within humanitarian operations. By testing the framework's effectiveness, organizations can refine their approaches to ensure they match the unique challenges and constraints of the environment. This hands-on application provides critical feedback, allowing for continuous improvement and ensuring the framework's adaptability and relevance across diverse humanitarian operations.

5.2.1. Logistical and Operational Challenges

Humanitarian organizations report has no shortage of demand and supply for food, medical, and essential relief materials near the Gaza border. However, humanitarian workers face challenges at every point, including the Israel checkpoint and the active war zone. This has cosnsistency proven from the the research result it shows that Gaza received suffiecnt amount of aids from to feed the affected poplutaion. Especially when there is oversuppllies of foods and medicines compare to other commosities. However the bottleneck of humanitarian setting in gaza it’s to delievers those aids. Data shows the avarage time to deliever of aidsfer medical and healthcare items is between 2 to 24 days. Due to logistic challenges and limited receiving and crossing points into Gaza hinder this dstribution work has significant impact on-time delievery foods especially to those affeted peopluation that needed urgent attentions.

International aid arrives at Al Arish Airport and Port Said in Egypt, and aids are loaded into trucks into the border crossing points. Kerem Shalom and Rafah Crossing and Western Erez (Erez) are the only land crossings with the greatest capacity for aid delivery. Multimodal solutions, such as sea and air routes, are not viable due to port access restrictions and infrastructure destruction, complex deconfliction mechanisms, and convoluted convoy coordination processes further impede aid delivery. Widespread shortages of primary resources, power, telecommunications, and fuel also impact movement, markets, and communication, making assistance difficult to flow in and ensure delivery to affected populations. Critical crossing areas have extreme congestions and significant backlogs, limiting the capacity to handle large volumes of goods. Regulatory and procedural challenges, such as restrictions on relief items allowed into Gaza, insufficient land entry points, and multiple security screenings, have constrained operational fluidity and efficiency. The Coordination and Liaison Administration (CLA) approval process can lead to delays and partial fulfillment. Lack of real-time visibility over cargo along corridors and convoys inside Gaza hampers relief actors' ability to monitor and undertake operations. Infrastructure limitations, such as limited storage facilities, hinder effective preposition, storage, and distribution of assistance. Movement restrictions, military operations, security threads, limited time gate opening at the border crossing also cause the delay of dlivery aids.

(a)



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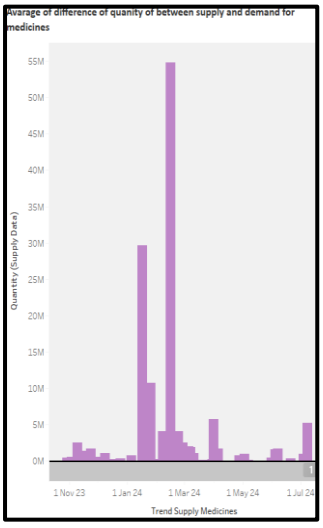

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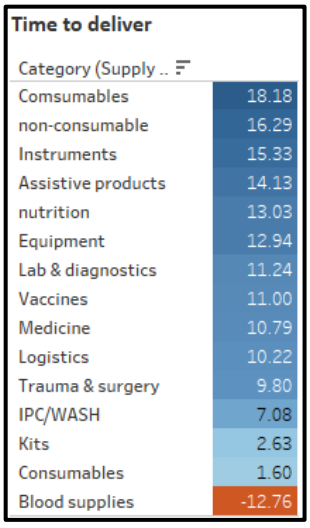


Figure 14: Various graphs illustrate demand and supply for basic commodities. (a) Total quantity commodities received by receiving point. (b) Total medicines receiving at receiving point by week. (c) Average time to deliver for medicines by number of days.
Notce: Constructed by the author. (Tableau Software LLC, Tableau Desktop 2024.2.)

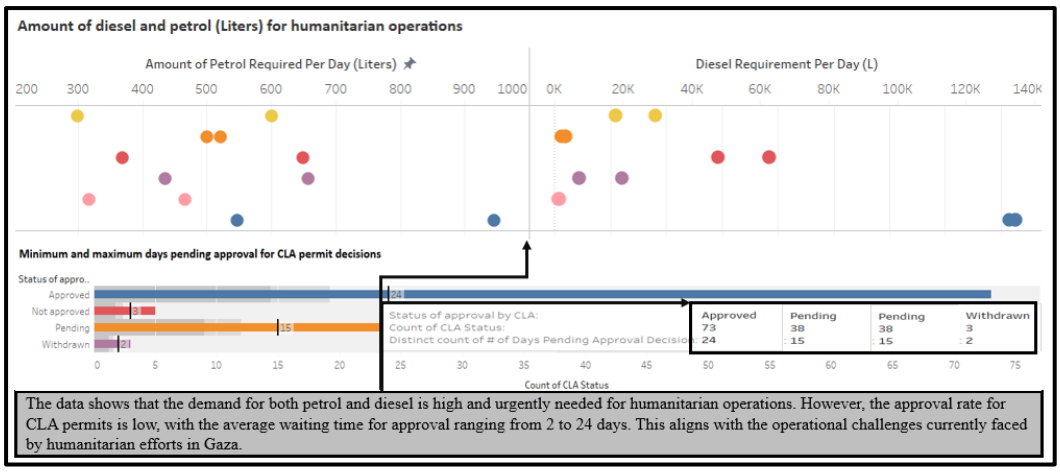
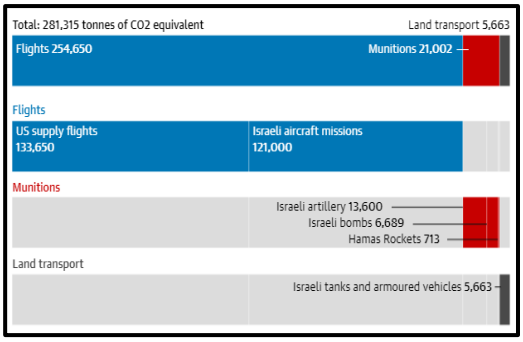


Figure 15: A scatter plot illustrates the amount of diesel required vs. requirements per day, and a bar chart illustrates the minimum and maximum number of days for diesel permit status.
Note: constructed from Author's research development work (Tableau Software LLC, Tableau Desktop 2024.2.)

5.2.2. Environmental Concern and Impact

Gaza faces severe environmental challenges due to its limited land area, high population density, poverty, and governance constraints. More than 99% of the 281,000 metric tons of carbon dioxide produced during the first two months of the Gaza conflict could be generated by burning at least 150,000 tonnes of coal. The examination covers rockets, artillery, tanks, bombs, CO2 from aircraft flights, and fuel from other vehicles. The transportation of military equipment to Israel by United States cargo planes accounted for about half of the total CO2 emissions. During that same time frame, rockets fired by Hamas into Israel produced roughly 713 tonnes of CO2, or 300 tonnes of coal. The data offers the first, although cautious, estimate of the carbon cost of the ongoing fighting in Gaza, which has resulted in unparalleled environmental harm, infrastructural destruction, and human misery. Research studies have produced historical data indicating that Israel has emitted the highest level of CO2 among Levantine countries. This aligns with other findings from various case studies, which demonstrate that CO2 emissions played a significant role in the conflict outbreak. These findings underscore the necessity for an action plan to decrease emissions, given Israel's significant contribution to environmental concerns in the region.

(a) 

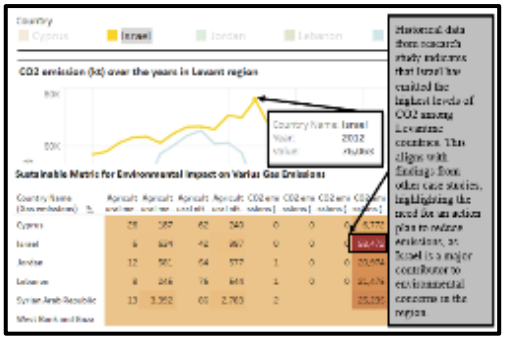
(b) 

Figure 16: Various graphs represent carbon footprints. (a) Breakdown of carbon emissions generated by the first 60 days of the Israel-Gaza War. (b) The research study shows Israel is main contributor of the gas emission in the region.
Source: (a) A multitemporal snapshot of greenhouse gas emissions from the Israel-Gaza conflict. (The Guardian, 2024).
Note: (b) Constructed by the author. (Tableau Software LLC, Tableau Desktop 2024.2.)

Over-abstraction from the coastal aquifer, agricultural pesticides, and sewage leaching all contribute to Gaza's freshwater crisis. The aquifer's nitrate concentrations are six times higher than WHO recommendations, and chloride concentrations are also high. Soil contamination occurs when raw and untreated wastewater is discharged into wadis and agricultural lands, as well as the widespread disposal of solid waste in informal dump sites. Unregulated industries contribute to high incidences of childhood lead poisoning in Gaza. The conflict has produced 39 million tonnes of debris, with over 107 kilograms per square meter. Debris includes asbestos, industrial and medical waste, unexploded munitions, dust, and other dangerous materials that can contaminate the environment and endanger human health.

Exposure to pollutants, lack of access to clean water, and insufficient sanitation are contributing to public health crises in Gaza. Nearly all water, sanitation, and hygiene systems are broken, and sewage has contaminated waterways, beaches, and coastal waters with infections, fertilizers, microplastics, and dangerous chemicals. The closure of Gaza's five wastewater treatment facilities has contaminated waterways, beaches, and coastal waters, putting the health of Gazans, marine life, and arable land at risk.

Destructive solar panels are expected to leak lead and other heavy metals, causing further risks to Gaza's soil and water. Israel's efforts to remove Hamas' tunnel network could exacerbate environmental harm, potentially leading to long-term dangers to human health from groundwater contamination and unstable land surfaces. Agricultural land has been destroyed or contaminated, affecting food security and livelihoods.

Crops, irrigation systems, and greenhouses have been damaged, and farmers have lost access to essential resources. The use of military-grade chemicals or residue from munitions can affect soil quality, leading to reduced agricultural productivity. These environmental challenges exacerbate the already dire health conditions caused by conflict. Environmental degradation also has long-term psychological impacts on the population, particularly on children and vulnerable groups, as they experience deteriorating living conditions. The ongoing conflict has weakened Gaza's ability to adapt to climate-related challenges such as rising sea levels, extreme weather, and drought, further exacerbating its environmental vulnerability.

(a)  (b) 

Figure 17: Various satellite images show illustrates croplands damaged in Gaza. (a) Satellite image shows the croplands damages in February 2024. (b) Satellite image shows the croplands damages in July 2024.
Note: Constructed by the author from the Geospatial data source from UNOSAT. (QGIS 3.24.1, 2024.)

5.3. Improvement Plan from Case Study

To produce unique solutions, the process entails modifying operational methods, practices, and strategies considering data analysis. Sustainable sourcing techniques leverage primary findings to ensure ethical and environmental compliance in humanitarian operations. The framework will focus on making sure that the results of the data analysis are consistent with different frameworks, such as the United Nations Appeal 2024, the World Bank's Sustainable Procurement Guidelines, and the UN Environment Program's pre-preliminary assessment of the conflict in Gaza's effects on the environment. Actionable

recommendations for practitioners in humanitarian logistics. The case study produces a framework that focuses on preliminary considerations for early recovery interventions and long-term plans, like the conflict recovery framework.

5.3.1. Food Security and Agricultural Recovery

Early recovery interventions in Gaza should focus on rehabilitating damaged food facilities, expanding food production capacity, and establishing market-based food supply systems to stabilize food prices and meet quality standards. Data shows food parcel and food items among the highest commodities received by number of supplies, frequency of receiving by date and respective donating countries. Despite statistics showing enough basic food supplies, the issue lies in whether the food meets demand and aligns with the population's actual needs. The population faces acute food insecurity, increasing malnutrition, dehydration, and a growing risk of famine. To ensure a consistent supply, focusing on ready-to-eat, high-energy foods, private sector priorities should include setting up temporary structures for essential goods providers and restoring partially damaged enterprises in critical sectors. A market-based approach to food supply, including expanding accessible kitchens near shelters, is also essential for long-term food security in the region.

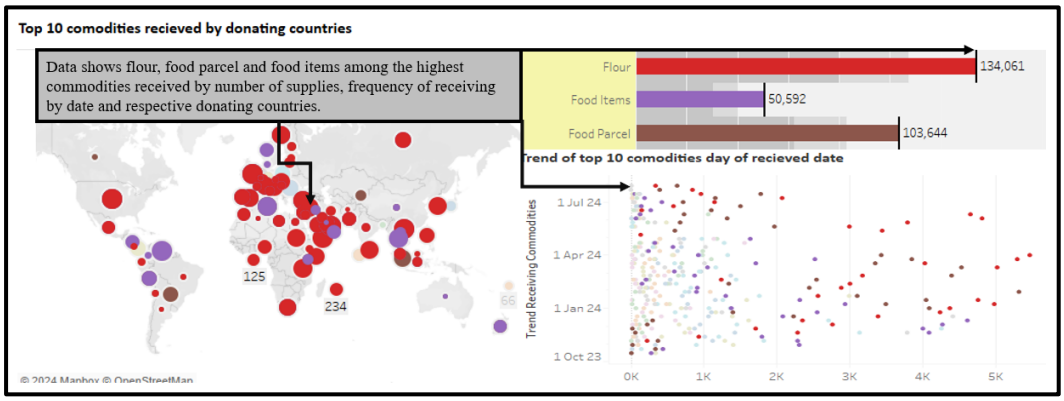


Figure 18: Various graphs of the top 10 commodities received by cargo description, donating countries, and the trend of commodities supplies by receive date.
Note: Constructed bythe author (Tableau Software LLC, Tableau Desktop 2024.2.)

5.3.2. Healthcare System Restoration

Gaza's healthcare system is facing critical issues, with hospitals operating beyond capacity and severe shortages of medical supplies and fuel. Short-term measures should focus on procuring essential medical supplies and devices, reopening primary healthcare clinics, and enhancing evacuation systems for emergencies. Restoring energy supply to healthcare institutions is crucial for uninterrupted electricity for essential services. Essential medical supplies, such as anaesthesia, antibiotics, intravenous fluids, insulin, and standard cholera treatment kits, must be procured. Medical devices such as monitors, ventilators, incubators, x-ray machines, and laboratory analysers must also be purchased. Emphasis should be placed on reopening primary health clinics, enhancing medical services, and coordinating with the Palestinian Authority for outbreak responses and vaccination drives. Surveillance systems should be identified and prepared, and new facilities should be built while existing ones are maintained. Blood donation from the West bank and enhanced road networks for ambulance and healthcare transportation are also essential for response preparation. As per data produce from this study, it is constancy with the current issues facing from medical and health care, laboratory and diagnostic tools, trauma and surgery and medical equipment indicates limited supply while the highest number of health worker and injuries and fatalities along with significant damage healthcare facilities urgently attention for recovery and immediate sourcing of the necessary supplies and services for restoration works.

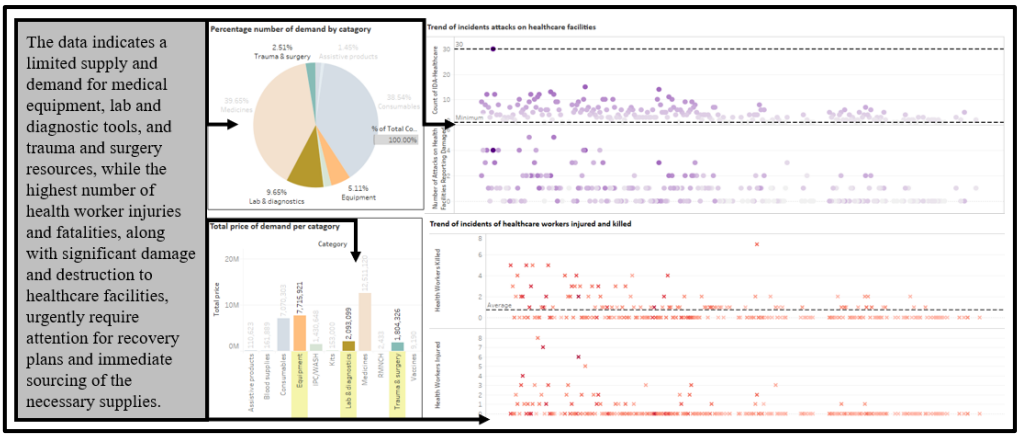


Figure 19: Various graphs produced to demonstrate a limited supply of essential medical item categories, as well as the highest number of health worker injuries and facility damage.
Note: Constsructed by the author. (Tableau Software LLC, Tableau Desktop 2024.2.)

5.3.3. Establish Concepts of Operations (CONOPS)

The Palestinian Logistic Cluster (PLC) has developed CONOPS, a strategic framework designed to streamline humanitarian logistics efforts in Palestine during crises. The framework focuses on coordination, resource optimization, overcoming access restrictions, and building local capacity while addressing logistical challenges. Key objectives include ensuring uninterrupted humanitarian supply flow, facilitating coordination between actors, providing information on logistics bottlenecks, offering shared logistics services, and supporting local capacity-building. The cluster also covers the Gaza Strip and the West Bank, where access to communities can be restricted due to political and security issues.

CONOPS includes prepositioning supplies, contingency planning, training local actors in logistics management, and considering sustainability and environmental considerations. It is a global digital platform that maintains a logistics coordination and information sharing system, synchronizing information within logistic providers, NGO agencies, local authorities, and other key players. The cluster advocates for increased logistical access and facilitation of aid flow for partners' emergency response implementation. Common services and capacity augmentation will continue to facilitate the provision of key common logistics services, such as cargo consolidation, storage, transportation, and cargo tracking.

The logistic cluster collaborates with authorities and humanitarian actors to develop guidelines for efficient humanitarian cargo dispatch to Gaza, gathering information on customs, border crossing points, route access, operational challenges, and collaboration opportunities. Operational information sharing is done through a dedicated webpage, instant messaging groups, and mailing lists, while mapping and capacity assessments are conducted to disseminate information on logistics gaps and capacities.

CONOPS aims to enhance national and partner capacities, increase efficiency, mitigate bottlenecks, and prevent duplication of efforts in the humanitarian supply chain. The operation aims to improve the efficiency of relief cargo and truck loading times for interagency convoys from Jordan to Gaza. The operation will also develop security

protocols for the upcoming maritime aid corridor from Cyprus to Gaza, reconstruct the port of Gaza, and initiate negotiations with Israeli authorities to allow aid imports to Gaza via the port of Ashdod.

5.3.4. Increase Shelter and Non-food Items

The destruction of housing infrastructure in Gaza has displaced over 1.8 million people, necessitating urgent shelter solutions. Mitigation involves providing emergency shelter materials and prefabricated housing units, assessing and rehabilitating damaged homes, establishing safe zones with adequate space, health, and educational services, and collaborating with suppliers to procure sustainable materials for temporary and long-term shelters. Allowing internally displaced persons (IDPs) from north Gaza to return to their original areas after clearing debris and unexploded explosive ordnances is essential. Strengthening shelter capacity, ensuring dignified living conditions, and preventing overcrowding are essential for IDPs currently unable to return. Safe zones and temporary housing should be identified near original community locations, with at least 1.5 square kilometres for every 30,000 people. In conjunction to the research result produced, the total new displacements and cumulative displacements caused by attacks involving civilians from Camp Residence and unspecified victims indicate a critical situation for internally displaced persons (IDPs) in Gaza. This underscores the urgent need for immediate action to ensure their protection and the establishment of safe zones. The data serves as a key indicator to expedite the demand and supply of shelter and non-food items, helping to address the growing humanitarian needs effectively.

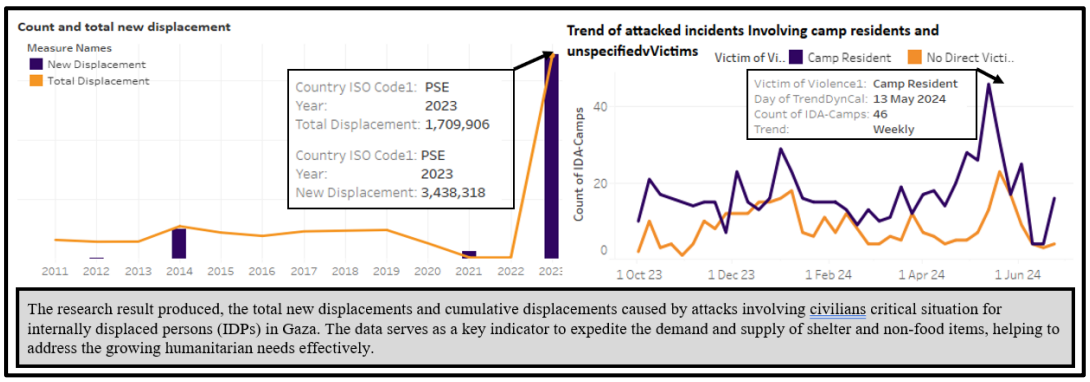


Figure 20: Various graphs of the total new displacement and the trend of attacked incidents involving camp residents and unspecified victims
Note: Constructed by the author. (Tableau Software LLC, Tableau Desktop 2024.2.)

5.3.5. Increase Access to Clean Water, Sanitation, and Hygiene (WASH)

People in Gaza receive the lowest access to safe drinking water and sanitation compared to neighboring countries. The ongoing situation has led to severe shortages in WASH supplies, alongside other medical items. Ensuring hygiene for the affected population is critical, as highlighted by research data. This was caused by a severe water crisis, with essential infrastructure severely damaged. Immediate measures include reopening water pipelines, distributing water purification tablets, repairing critical water infrastructure, expanding hygiene facilities, and distributing personal hygiene kits to reduce health risks. A joint initiative between the UN and the Palestinian Water Authority should focus on transporting water to northern Gaza through pumping stations and trucks. Human waste removal and disposal from populated areas are crucial to reduce health risks. Expanding hygiene facilities and supplies, particularly in densely populated areas, is essential. The distribution of personal hygiene kits should also be prioritized. A mechanism for rapidly importing and deploying solar-powered mobile units for wastewater treatment and greywater utilization should be developed to support long-term water management solutions.

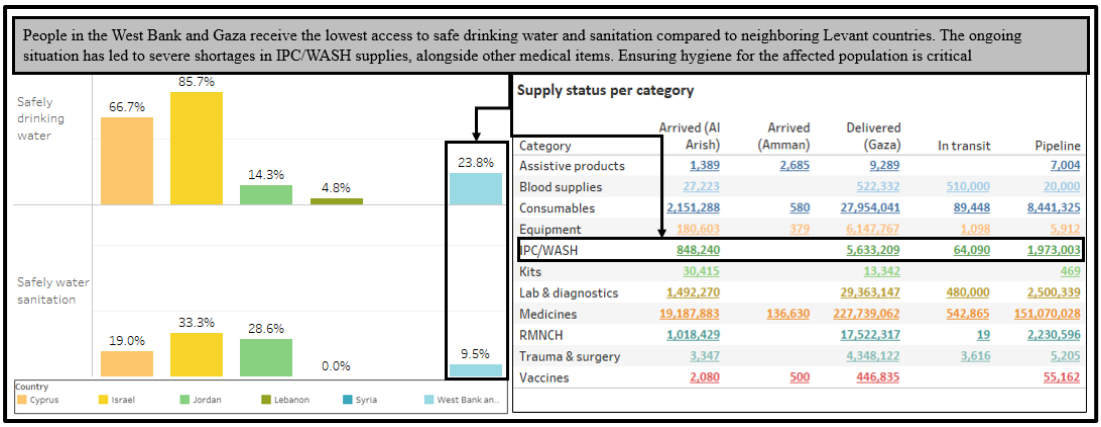


Figure 21: Various graphs represent the percentage of people accessing safe drinking water and sanitation, and the table illustrates the limited supply of IPC/WASH.
Note: constructed by the author. (Tableau Software LLC, Tableau Desktop 2024.2.)

5.3.6. Implement Strategies for Environmental Recovery

5.3.6.1. Developing Strategies for Emission Reduction, Contemplation Removal, Debris Disposal, And Air Pollution Monitoring.

The text emphasizes the importance of developing emission reduction strategies in logistics and supply chains to reduce the carbon footprint of humanitarian operations. Key actions include optimizing transportation routes, using fuel-efficient vehicles, and promoting carbon offset programs. The focus should also be on decreasing reliance on fossil fuels to lower the carbon footprint of both the local population and humanitarian operations. The text also calls for urgently clearing the large volume of rubble and debris from streets and roads, including the use of rubble as reconstruction material. Rapid mine action is also necessary to identify areas without contamination, remove unexploded ordnance, educate the population, and provide technical advice. The text also emphasizes air quality monitoring in operational areas to mitigate health impacts on staff and affected populations.

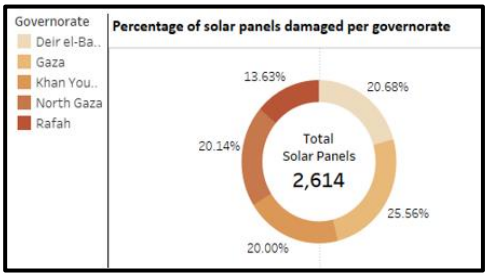
5.3.6.2. Enhance Renewable Energy Adoption

As with building materials, the ability to restore basic services will be determined by the ability to import needed parts and equipment, solar panels, and fuel for electricity generation (from Gaza Power Plant and diesel generators). The restoration of services will also depend on the resumption of electricity and water imports and the ability to guarantee secure access of operators' crews to priority sites for repair to achieve the most basic level of service. It is important to involve the Palestinian Water Authority (PWA) in planning for electricity and fuel supply for WASH plants. Increase the number of generators and explore alternative power solutions, including solar panels. Consider investing in solar panels, wind turbines, and other renewable technologies to generate energy for field operations. Explore another option: reviving power from Egypt via inactive lines and reestablishing connections with power lines from Israel.

5.3.6.3. Biodiversity Loses

There is a freshwater crisis in Gaza due to over-abstraction from the coastal aquifer, which is linked to a steady increase in demand, and poor water quality, which is caused by using agricultural pesticides and the leaching of sewage. Nitrate concentration in the aquifer was six times higher than World Health Organization (WHO) recommendations, with chloride concentrations also high. Contaminants found in the groundwater present risks to children and pregnant women. The flow of untreated or partially treated water and wastewater into the Mediterranean Sea pollutes the marine environment, impacting marine ecosystems, human health, and desalination operations. The war has damaged natural ecosystems, including coastal areas, wetlands, and agricultural land, affecting plant and animal species. Wildlife habitats have been disturbed, and some species may face long-term impacts due to habitat loss and pollution. The strategy is to deploy marine conservation efforts to protect coastal waters and marine biodiversity by establishing no-fishing zones, regulating fishing activities, and reducing waste and chemical pollution. Sustainable fishing can support both the environment and local livelihoods. Develop sustainable aquaculture systems that minimize environmental impact while providing food security, ensuring that fish farming is done in a way that does not degrade marine ecosystems.

(a)



(b)

Sustainable Metric for Environmental Impact on Biodiversity Threats

Country Name (Biodiversity)	Bird species, threatened	Fish species, threatened	Mammal species, threa..	Plant species (higher), thre..
Cyprus	7.00	24.00	6.00	22.00
Israel	18.00	50.00	15.00	23.00
Jordan	14.00	20.00	13.00	8.00
Lebanon	11.00	28.00	10.00	24.00
Syrian Arab Republic	17.00	51.00	14.00	26.00
West Bank and Gaza	15.00	2.00	4.00	6.00

Figure 22: Various graphs illustrate the solar panel damage and biodiversity loss. (a) percentage of solar panels damaged. (b) Metrics demonstrate the loss of biodiversity, with the highest number of fish species being affected.
Note: Constructed by the author. (Tableau Software LLC, Tableau Desktop 2024.2.)

5.3.6.4. Restoring the Telecommunications System

Extensive damage to infrastructure in Gaza has severely disrupted the telecommunications system, leading to intermittent internet connectivity and frequent shutdowns of service providers. With the growing demand for

telecommunications, it is crucial to increase the volume and expedite the sourcing and importation of telecommunications equipment for vetted international NGOs, including high-frequency (HF), very-high-frequency (VHF) radio equipment, and satellite phones. An alternative approach is to establish independent and reliable shared telecommunications services to ensure coordinated humanitarian service delivery to Gaza's population. Additionally, expanding access to Israeli SIM cards for UN agencies and NGOs is essential. A mechanism must be developed to protect communication sites from theft of fuel, generators, solar panels, and other critical goods. There is also an urgent need to increase the number of essential spare parts entering Gaza, particularly cables, to facilitate critical repairs and restore services. This requires collaboration among various stakeholders and agencies, with humanitarian workers on the ground ensuring comprehensive sourcing planning and coordinating with suppliers across the region to deliver these items promptly.

5.3.6.5. Other Environmental Sustainability Considerations

During the early stages of recovery, it is important to think about the long-term health of the environment, as well as the removal of debris and general waste management. It will also be necessary to make specific efforts to deal with the environmental effects of the conflict in Gaza, such as the contamination of the land and aquifer, which hurts water supplies, food production, and Palestinians' health. Environmental sustainability considerations in urban planning will also need to inform early recovery planning and interventions focused on transitional shelter solutions, as well as housing rehabilitation and reconstruction. Other dimensions of environmental improvements in Gaza are currently a low priority, but agencies like OCHA and UNRWA have outlined plans to promote environmental awareness and provide training for humanitarian staff and partners on sustainability and compliance practices. These efforts aim to build capacity for sustainable operations.

5.3.6.6. Establish Transparency of Accountability on Fund Management

Transparent and accountable fund management is crucial for building trust and improving aid delivery. Collaboration between local and international actors is essential for developing adaptable funds transfer systems. Enhancing tracking systems is

essential for monitoring fund dispersal and aligning with humanitarian needs. OCHA's appeal in Gaza faces challenges such as excessive reliance on self-pledged funds, lack of tracking of funds used outside appeal parameters, and a mix of Gaza's problems with West-Bank issues. Donor attention is often focused on short-term free goods provision, neglecting long-term needs. To mitigate these concerns, OCHA should focus on sustainable funding sources, particularly from Arab countries, and reshape support from in-kind donations to other formats like cash-buying vouchers or card-based payments. This will foster a need-based economy with private sector participation. In Gaza, digital payment systems could be established to enable electronic transactions, assuming internet service and cell phone connectivity are restored. Implementing a universal basic emergency income could also boost economic expansion in the region.

5.3.7. Planning and Coordination for Medium and Long-Term Recovery

The transition from humanitarian aid to recovery interventions necessitates careful planning and coordination. A Conflict Recovery Framework (CRF) is needed to guide institutional financing and policy decisions for medium- and long-term recovery. Essential services like healthcare, education, and social protection should be prioritized for rebuilding. Local stakeholders should be involved in recovery efforts for sustainable solutions. Post-disaster management is essential for restoring normalcy and supporting affected populations. Effective coordination between governments, humanitarian agencies, and local communities is crucial. Sustainable practices and risk reduction strategies are essential for preparing communities for future crises and enhancing their recovery capacity. The Rapid Damage and Needs Assessment (RDNA) aids in long-term recovery planning, with environmental policies regularly reviewed and updated to meet regulatory requirements.

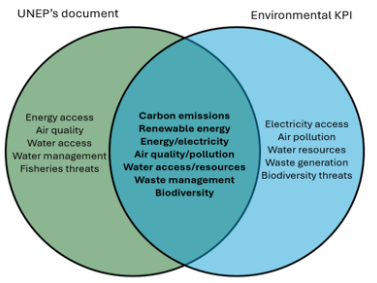
5.4. Incorporating Environmental KPI Metrics from the Research Framework with UNEP Pre-Assessment Guidelines

The strategies defined in the pre-assessment of environmental impacts will be integrated into key performance indicators (KPI metrics) for environmental assessment from research study. The goal is to combine and standardize similar variables between them, ensuring that they inform the action plan and establish mechanisms for

continuous environmental sustainability improvement. Then will be adjusted to align with the monitoring mechanisms and continuous improvement strategies presented in the research objectives. The United Nations Environment Programme (UNEP) has released a preliminary assessment of the environmental impacts of the ongoing conflict in Gaza. The report focuses on three main areas: the environment and natural resources in Gaza before the conflict, debris and rubble management, water contamination, air quality and waste management, and ecosystem damage. Over 137,000 buildings were damaged, resulting in massive amounts of rubble, including hazardous materials like asbestos. The UNEP estimates that 250 to 500 hectares of landfill areas will be needed to handle this debris. The Coastal Aquifer, Gaza's main water source, is likely contaminated by chemicals and heavy metals from the conflict, exacerbated the fragile water supply system. The report also highlights the damage to marine and terrestrial ecosystems, with areas like farmlands rendered unusable due to unexploded ordnance and military operations.

5.4.1. Cross-checking Mismatch and Correlations Variables

The steps involve extracting key environmental impacts from a UNEP's document and identifying main themes and specific impacts. Environmental KPI metric of research development data was extracted and analysed. Comparison and correlation were performed, identifying correlations and mismatches between the two datasets. A Venn diagram was created to visualize the relationship between them. The core concepts are very much aligned, suggesting that the environmental KPI metrics from research study effectively capture the key environmental issues identified in the UNEP's document. However, there are areas where additional data or refinement might be beneficial.



Variables	UNEP's Document	Environmental (KPI)
Gas emissions	Focused reducing on carbon footprint	Key variable
Adopting renewable energy	Emphasize on renewable energy	Renewable energy as ev variable
Energy consumption	Indicate on energy consumption	Key variable
Access to electricity	Mention need for electricity restoration	Key variable.
Air pollution	Mention precisely on the pollution	Key variable
Air quality	Explicitly discuss air qiality	Not precisely focus
Air pollution	didn't mention renewable energy	key variable.
Water access and resource	Do not using scenarios for evaluation.	Key variable
Waste management	As a main focus	Mentioned in general
Biodiversity	Mainly emphasize to marine threats	Key variable

Figure 23: A Venn diagram and table illustrate the interrelationships between variables from UNEP's document and environmental KPI metrics developed through research development.
Note: Constructed by the author. (Julius AI Lab 1.052, 2024)

5.4.2. Incorporating Variable into Environment KPI metric Table

Common themes were identified, and a data frame was created. The comprehensive KPI metric table developed is to map KPI metrics to environmental impacts and integrate data with related impacts. Validation and refinement were performed, identifying and fixing issues and refining the mapping process to ensure accurate correlation between KPI metrics and impacts. The final output was a comprehensive KPI metric table that linked each KPI metric to its related environmental impact, including measurements, current values, target values, trends, and other relevant information.

5.4.3. Summarize Findings from Incorporate Variables

The Carbon emissions is the most prevalent KPI metric category, indicating a strong focus on climate change mitigation. Some environmental impacts (Biodiversity, Forest Management, Waste Management, Water Quality) lack specific KPI metrics or progress data. Carbon Emissions KPI metrics are exceeding their targets (108.32% progress), which may require reassessment of goals. Other measured impacts (Renewable Energy, Air Quality, Energy Access, Water Access) show consistent progress around 90-91%.

5.4.4. Add New KPI Metric for Underrepresented Impacts

The analysis identified 90% progress in environmental impacts, developed new KPI metrics for underrepresented impacts, and reassessed carbon emissions targets. To improve data collection, standardized methods, clear timelines, improved data quality, regular audits, expanded data sources, real-time monitoring, and a centralized data management system should be implemented. A proposed action plan includes addressing carbon emissions targets, focusing on underrepresented environmental impacts, and implementing new KPI metrics for biodiversity, forest management, waste management, and water quality. Data collection and monitoring resources should be allocated, and factors contributing to 90% progress should be investigated.

5.4.5. Detailing Action Plan

The implementation plan includes data collection methods and responsible parties for each KPI metric across biodiversity, forest management, waste management, and water quality. Based on progress, the current targets adjusted to reduce them by 15% for KPI metrics over 110% and 10% for those between 100% and 110%. The action plan timeline, starting from October 1, 2024, includes key actions such as implementing new KPI metrics, adjusting targets, enhancing data collection methods, and conducting assessments. Stakeholder engagement should be developed, and workshops and training sessions should be organized. A comprehensive presentation of the results should be prepared for stakeholders, addressing identified issues and providing a clear path forward for improving environmental monitoring and management in Gaza.

5.5. Incorporating Ethical Sourcing from Research Framework with CONOPS's Procurement Guidelines

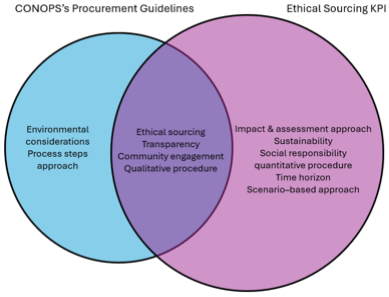
The standard operating procedure on procurement guidelines from CONOPS is being integrated with ethical sourcing from the research framework. CONOPS serves as the foundation for developing procurement procedures. It is designed to ensure efficient, transparent, and timely acquisition of goods and services during humanitarian crises, such as in Gaza. All humanitarian efforts, including complex humanitarian sourcing in Gaza, follow universal processes and practices known as standard guidelines. When speed is crucial or market conditions render competitive bidding impracticable, the guidelines prioritize direct purchase or single quotation. However, this method still requires documentation and justification to ensure transparency.

The procedures involve soliciting bids from multiple suppliers to ensure competition and achieve Best Value for Money (BVM). The cluster encourages fair competition to promote transparency and fairness. Depending on the procurement value, this can range from informal quotations to formal tenders. For larger procurements, the cluster employs an open or restricted tender process. Open tenders are publicly advertised, allowing any qualified supplier to submit bids, whereas restricted tenders limit participation to pre-qualified suppliers. CONOPS outlines specific thresholds that determine which procurement procedure to follow. Higher-value contracts may require more formal tendering processes,

while lower-value contracts could be handled through competitive quotations or direct purchase. It is also promoting long-term agreements with suppliers for frequently purchased items or services. These agreements allow for streamlined procurement processes, reducing lead times and ensuring cost predictability. Regular market analysis is performed to understand local supplier capabilities, prices, and risks. Suppliers are often pre-qualified based on performance, pricing, and compliance with ethical standards, ensuring the procurement process remains efficient and aligned with humanitarian principles.

5.5.1. Cross-checking Mismatch and Correlations Variables

These mismatches highlight that while the procurement guidelines provide a comprehensive guide to the procurement process, it may not fully align with the ethical sourcing from the research study. The ethical sourcing framework to focus more on the outcomes and impacts of sourcing decisions, while the procurement focuses more on the process of procurement itself.



Variables	CONOPS's procurement guidelines	Ethical sourcing KPI
Process and approach	Focused on process steps, principles, and procedures.	focuses on outcomes and impact areas.
Environmental Considerations	didn't explicitly mention environmental impact	Eco-friendly Practices as key variables.
Ethical sourcing	Focusing as principles	Focusing as key variable
Transparency	Focusing on transparency	Focusing on transparency
Community engagement	Do not mention specifically	As a key variable.
sustainability	mentioned sustainability i relation to BVM	As a key variable
Social responsibility	Explicitly discuss social responsibility	As a key variable.
Renewable energy	didn't mention renewable energy	As a key variable.
Scenario-based approach	Do not using scenarios for evaluation.	Using scenarios (Scenario 1, 2, 3, 4) for evaluation.
Operating procedure approaches	focused on qualitative principles and processes.	Qualitative and Quantitative metrics (High, Medium, Low, etc.) to evaluate different aspects.
Time Horizon	Explicitly discuss short-term vs. long-term focus	Includes short-term and long term as considerations.

Figure 24: A Venn diagram and table illustrate the interrelationships between variables from CONOP's procurement guidelines and ethical sourcing KPI metrics developed through research development. *Note: Constructed by the author* (Julius AI Lab, 2024)

5.5.2. Incorporating Variable into Comprehensive KPI metric Table

Incorporating more environmental and social responsibility considerations into the procurement process. Developing specific procedures for evaluating suppliers based on the KPI metrics in the table. Creating a more explicit link between procurement practices and their impact on community engagement and eco-friendly practices. Introducing scenario-based planning into the procurement process to align with the KPI

metric evaluation method. The process of incorporating we identified and visualized the overlap between SOP Procurement and KPI metric Ethical Sourcing strategies using a table and Venn diagram to understand commonalities and unique elements. To prioritize the strategies based on their impact, ease of implementation, and urgency, resulting in a ranked list of strategies. A timeline is developed for integrating these strategies, considering dependencies and durations to ensure a logical sequence of implementation. Creating performance metrics for each strategy to measure success, including specific targets and measurement frequencies. Identify potential challenges in implementing the strategies along with mitigation strategies and responsible parties. Details action plans is created for each strategy, and responsibilities were assigned to ensure accountability. Monitoring system is set up for tracking performance metrics, specifying tools and responsible parties. A risk management plan was developed to address identified challenges, including mitigation strategies and contingency plans. Comprehensive all the information was combined into a comprehensive metrics table. This structured approach ensured a thorough analysis and planning process, culminating in a comprehensive overview of the strategies and their implementation details.

5.5.3. Using Scorecards to Implement the Process of Evaluating Suppliers.

The process of creating a supplier scorecard template based on the comprehensive metrics table. The next logical step is to develop guidelines for using the scorecard to evaluate suppliers, including instructions for scoring and interpretation. The process begins with creation of Data Frame defined for criterion, metric, weight, score, and weighted score. The criteria are based on key ethical sourcing and procurement guidelines and assigned weights to each criterion and provided example scores. calculate weighted score by multiplying the score with the weight for each criterion. Scores for criteria on a 1-5 scale were adjusted to be out of 100 for consistency. The scorecards also provided in visualization presentation as radar chart for immediate viewing. This process creates a comprehensive tool for evaluating suppliers based on ethical sourcing and procurement guidelines, combining detailed metrics with an easy-to-interpret visual representation. The scorecard allows for quantitative assessment, while the radar chart provides a quick, visual overview of a supplier's performance across all criteria.

6. Discussion

The discussion involves analysing the research findings through four key approaches. The research results, presented through data visualization and dashboards, offer a clear overview of trends and insights related to the demand and supply of basic commodities in humanitarian aid efforts in Gaza, the damage to infrastructure that leads to environmental impacts in the Levant region, and finally, the demographic data of internally displaced persons and the number of casualties caused by incident attacks at residents' camps, healthcare, and education facilities. Second, the development of sustainable metrics offers a quantitative measure of performance and impact, helping to evaluate the effectiveness of sourcing practices. The interpretation of results from scenario management offers a strategic perspective on ethical sourcing, highlighting potential outcomes and guiding decision-making processes. Lastly, the goal is to offer a comprehensive understanding of the effectiveness of continuous improvement tools designed for humanitarian work.

6.1. Analysis on Data visualization

The analysis involves gathering research findings from the developed data visualizations are compiled from various dashboards, each focusing on four different aspects: the demand and supply of basic commodities for humanitarian aid, the environmental impact assessments conducted in affected areas, the direct and indirect effects on wider regions, and the demographic data on casualties and incidents of attacks occurring in crisis zones.

6.1.1. Basic Commodities

The discussion focuses on the key findings, implications, and challenges arising from the analysis of demand and supply for basic commodities such as foods, non-foods, medical and healthcare items, fuel, and gas. This analysis will provide an overall trend and pattern derived from data visualization to aid supply chain planning.

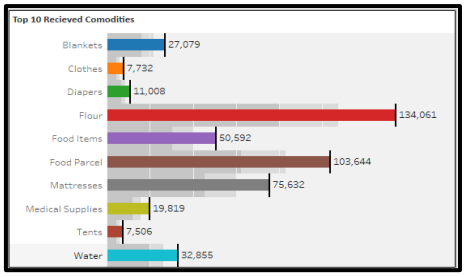
6.1.1.1. Key Findings

The top commodities received during the humanitarian crisis in Gaza were primarily food-related items, with flour accounting for nearly 20% of all items. Food parcels followed closely, accounting for 15% of the total. Other categories such as "Food Items" and "Non-Food items" collectively contributed another 7.54%, indicating the centrality of food aid in distribution efforts. Non-food essentials were also prominently featured, with mattresses ranking third, indicating a substantial need for basic living supplies. Water was the fifth most important item, while blankets and clothes were also among the top 10, highlighting the need for basic clothing and bedding.

The analysis revealed that Jordan and Italy are among the most prominent donor countries, with Jordan making significant contributions, particularly in providing flour and mattresses. The United Nations Relief and Works Agency (UNRWA) headquarters in Amman plays a prominent role in coordinating humanitarian aid to Gaza. Italy, home-based in Rome, plays a substantial role in humanitarian aid efforts through its World Foods Program (WFP). Belgium is another key contributor from the European Union, particularly for donations of food items, water, and food parcels. The Emirates Red Crescent (ERC) is a significant donor, supplying a diverse range of commodities, including food items, water, and flour, demonstrating its comprehensive approach to humanitarian aid.

Monthly trends indicate that December 2023 and April 2024 are key months for receiving essential commodities, particularly mattresses and food parcels. Flour is received steadily throughout the year, suggesting a consistent demand for this staple. Weekly trends indicate that mattresses and flour receive significant deliveries on weekends, whereas flour and food parcels distribute more evenly throughout the week.

Refer to Appendix 2: List of Data Visualizations Depicting Basic Commodities Received as Humanitarian Aid in Gaza.

(a) 

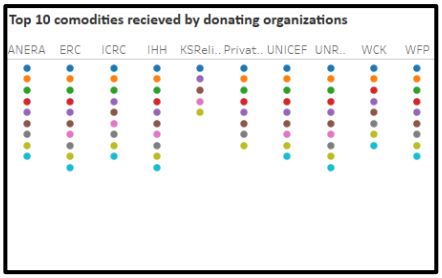
(b) 

Figure 25: Bar Chart and Statistical Plot illustrates the top 10 received commodities. (a) A bar chart illustrates the top 10 received commodities. (b) Statistical plot illustrates the top 10 received commodities by donating organizations.
Note: Constructed by the author. (Tableau Software LLC, Tableau Desktop 2024.2.)

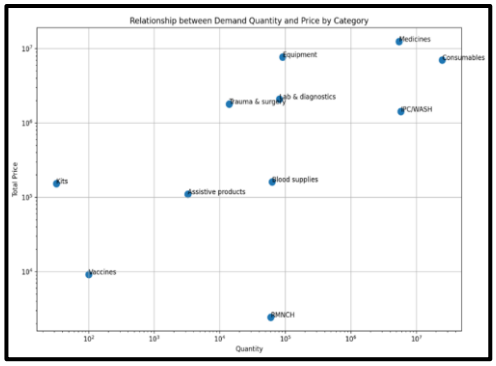
Medicines and consumables dominate the demand for medical items, accounting for 39% of the total requests and nearly 80% of the overall demand. The most significant categories, comprising 1.5% to 2.5% of the demand, are lab & diagnostics, equipment, trauma & surgery, infection prevention and control (IPC)/water, sanitation and hygiene (WASH), assistive products, blood supplies, and kits. To increase clarity, replace with: The most significant categories, comprising 1.5% to 2.5% of the demand, are lab & diagnostics, equipment, trauma & surgery, infection prevention and control (IPC)/water, sanitation and hygiene (WASH), assistive products, blood supplies, and kits. Vaccines and Reproductive, Maternal, Newborn, and Child Health (RMNCH) have the smallest percentages, but they are essential despite lower demand.

In terms of quantity distribution, consumables dominate, making up 68.24% of total items. IPC/WASH and medicines contribute 15.93% and 14.97%, respectively. Medicines led with 37.84% of the total cost, followed by equipment at 23.34%. Consumables rank third in total price, at 21.38%. The Pearson correlation of 0.7459 indicates a strong positive linear relationship between demand and supply quantities, suggesting that as demand increases, supply tends to rise as well. However, the Spearman Rank Correlation of 0.2667 reflects a weak positive monotonic relationship, indicating discrepancies in how certain categories are prioritized or fulfilled.

The log-scale scatter plot reveals a general trend of increasing supply as demand increases, but with significant variations across categories. Some categories, like consumables, have high demand and supply, while others show large discrepancies

between demand and supply. Vaccines, kits, and Lab & Diagnostics exhibit extreme oversupply, indicating potential resource wastage or inaccuracies in demand forecasting. IPC/WASH suffers from a significant undersupply, highlighting an urgent need for attention to meet critical demand. Consumables present a more balanced scenario, with an -83.94% difference between demand and supply.

Refer to Appendix 3: List of Data Visualizations Depicting Demand and Supply for Medical and Healthcare Items Received as Humanitarian Aid in Gaza.

(a) 

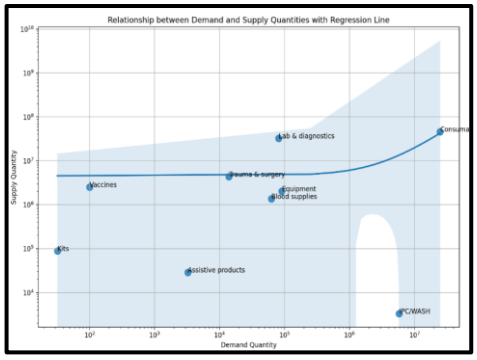
(b) 

Figure 26: Pearson correlation of demand vs. supply. (a) Pearson correlation coefficient between quantity and price. (b) The scatter plot illustrates the relationship between demand and supply. *Note: Constructed by the author.* (Julius AI Lab 1.052, 2024)

Table 8: Demand and supply quantities for medical items by category, showing absolute difference and percentage variance.

Category	**Demand quantity**	**Supply quantity**	**Abs Difference**	**Abs Percentage Difference**
Vaccines	100	2508810	2508710	2508710
Kits	32	88729	88697	277178
Lab & diagnostics	81364	32438326	32356962	39768
Trauma & surgery	13940	4356540	4342600	31152
Equipment	90921	2026705	1935784	2129
Blood supplies	62890	1369150	1306260	2077
Assistive products	3271	28629	25358	775
IPC/WASH	5807577	3312	5804265	100
Consumables	24880056	45785058	20905002	84

Fuel and gas are crucial commodities in humanitarian operations, especially humanitarian operations. This overall finding will elaborate on the detailed analysis of demand and supply of fuel in supporting humanitarian operations. The total number of diesel litters supplied is 20.53 million, with 461 diesel trucks facilitating this distribution. In contrast, the total number of gasoline litters distributed stands at 491,340 liters, with only 11 petrol trucks involved in the process. A monthly fuel distribution analysis shows that diesel distribution ranges from approximately 400,450 to 3,145,380 litters per month, with diesel represented in blue on the stacked area chart. Petrol distribution, depicted in orange, ranges from 0 to 88,500 litres per month.

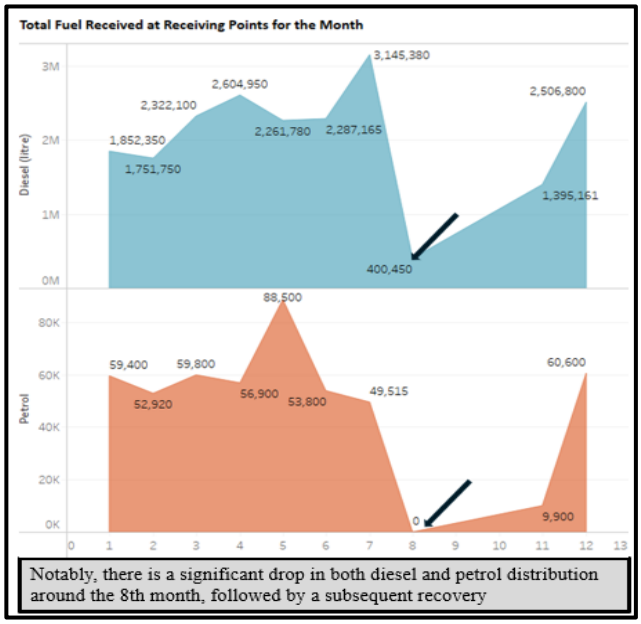


Figure 27: Area charts illustrate total fuel (petrol and diesel) received at by month.
Notee: Constructed by the author. (Tableau Software LLC, Tableau Desktop 2024.2.)

Compared to petrol, we distribute higher volumes. Its pivotal role in maintaining operational continuity is underscored by the high variability observed in daily and monthly fuel distributions, suggesting irregular supply or fluctuating demand patterns that could challenge consistent operations. This variability necessitates strategic planning to ensure a steady and reliable supply. Notably, there is a significant drop in both diesel and petrol distribution around the 8th month, followed by a subsequent recovery.

Daily fuel distribution patterns reveal that diesel is distributed more frequently and in higher volumes than petrol, as indicated by the line chart. Petrol distribution, however, is marked by sporadic spikes, with several days showing no distribution at all. Diesel deliveries occurred on 137 unique dates, indicating a consistent and frequent supply, which underscores its importance in humanitarian operations. It is essential for powering generators, vehicles, and machinery, all vital for logistics, transportation, and infrastructure support, ensuring that essential services and logistics remain uninterrupted.

6.1.1.2. Implications

The demand and supply dynamics for basic commodities in Gaza are crucial for the region's stability and humanitarian situation. A mismatch can lead to severe shortages, increasing prices, and making essential goods unavailable. Oversupply of shelter materials can strain storage capacities, diverting attention from other critical needs. Poor resource allocation can result in wasted and missed opportunities to address shortages elsewhere. Addressing these imbalances through better supply chain management and demand forecasting is essential for meeting Gaza's basic needs.

Examples of supply-demand mismatches in health and medical supplies reveal critical resource allocation inefficiencies. Vaccines, kits, and Lab & Diagnostics show extreme oversupply, suggesting potential resource waste or inaccurate demand forecasting. IPC/WASH is severely undersupplied and requires immediate attention. Consumables present a more balanced scenario, indicating better management. Moreover, specific needs during crises can shift rapidly, often leaving certain groups vulnerable. WASH products, for example, become critical yet are often neglected in supply distributions (Dr Inayat Thaver & Ashraf, 2023).

Improving demand forecasting and inventory management, addressing supply chain bottlenecks, diversifying suppliers, reallocating resources, and developing a more flexible supply chain can enhance overall efficiency and responsiveness to changing demand patterns. A sustainable and resilient fuel supply chain is essential for minimizing disruptions and ensuring a stable supply of diesel and petrol.

6.1.1.3. Challenges and Limitations

Developing research results or data visualizations that rely solely on metadata presents several challenges. This metadata is typically sourced from various contributors, each using different data structures, formats, and standards. Multiple clusters often collect data, each with its own unique definition, leading to inconsistencies in the process. Additionally, there is no centralized authority to ensure the harmonization of this data, further complicating the process. Metadata can be intricate and difficult to interpret, especially when it is extensive or poorly organized. This complexity makes it challenging to fully understand the underlying data and its implications.

When datasets are incomplete, inaccurate, or not standardized, metadata can lead to misinterpretation of the actual data. Poor-quality metadata reduces its usefulness and can introduce errors in data analysis. For example, in demand and supply data, the discrepancy in the records for consumables and medicines affects balance analysis. The demand for consumables is significantly higher than its supply, whereas the demand for medicines is significantly higher than its supply. This significant discrepancy and imbalance in demand and supply can have an impact on sourcing and supply planning, as well as potentially leading to data inconsistencies.

Specifically, the dataset for diesel shows 461 records out of 596, while petrol shows only 11 records out of 596. Due to this significant gap, it is challenging to compare trends between these two types of fuel. As a result, the analysis focuses on comparing the demand and supply of each fuel type individually, but no meaningful trend variations can be interpreted due to the gaps. Overall, this discrepancy can significantly impact the accuracy of the analysis. Understanding and analysing metadata can slow down data processing and delay decision-making.

The challenges associated with metadata—complexity, inconsistent data structures, lack of harmonization, and potential for misinterpretation—pose

significant limitations. These factors hinder the effectiveness of data analysis and decision-making, especially when metadata alone is used without the context of raw data or additional information.

The intricacy and unpredictability of crises pose a major challenge to humanitarian supply chains from an operational perspective, as they can seriously impede the delivery of supplies and services. Humanitarian supply chains should cover the planning, purchasing, transportation, storing, and delivery of supplies to impacted populations (Rahman et al., 2022). This complexity is further exacerbated in fragile and conflict-affected contexts, where the demand for necessities often outstrips supply capabilities.

Health commodities are the most important in humanitarian aid, but a lack of adequate health commodities, such as pharmaceuticals, can lead to dire consequences, particularly for vulnerable populations like children, who are at increased risk of diseases during such events (Ellison & Cook, 2020). Proper demand and supply planning is crucial to avoid inconsistency in supply that may affect vulnerable populations.

Lastly, the need for effective coordination among various stakeholders in humanitarian aid is paramount. As noted, managing relationships among all actors involved in humanitarian relief is essential for ensuring efficient aid delivery. This coordination is critical in addressing the multifaceted challenges of supply and demand, particularly in complex emergencies where the landscape is constantly changing.

6.1.2. Internal Displacement Persons and Incident Attacks

The analysis will examine demographic data on hostilities in high-cause areas, focusing on internally displaced persons (IDPs) and public attacks on residential camps, healthcare, and educational facilities. The findings will highlight significant internal displacement and frequent targeting of civilians and critical infrastructure. The analysis emphasizes the urgent need for comprehensive humanitarian assistance and conflict resolution. Ethical compliance in sourcing and supply chain management is crucial for humanitarian operations in Gaza. This includes verifying supply chains are free from

exploitation and aid distribution is equitable and transparent. Strengthening ethical practices can mitigate risks associated with corruption, ensure responsible material sourcing, and enhance aid delivery efficiency.

6.1.2.1. Key Findings

The number of internally displaced persons (IDPs) affected by various crises is 24,216, with storms being the most common type, accounting for 42.16% of the total population. The highest number of IDPs was 10,650 in 2013, with an average daily increase of 16,187.41. As of February 28, 2024, the total value of 'Affected Displaced Shelters Cumulative' is 1,700,000, with an average daily increase of 16,187.41.

The line chart shows a sharp rise in the number of affected shelters during the early part of the recorded period, indicating an intense initial impact. As the time series progresses, the curve flattens slightly, suggesting a deceleration in the rate of increase. The enduring nature of the crisis, with shelters consistently affected over at least a year, suggests the presence of sustained or multiple overlapping crises likely impacting the Gaza Strip. The cumulative nature of the data emphasizes the worsening and compounding effects of displacement, indicating a progressively deteriorating situation rather than showing signs of resolution.

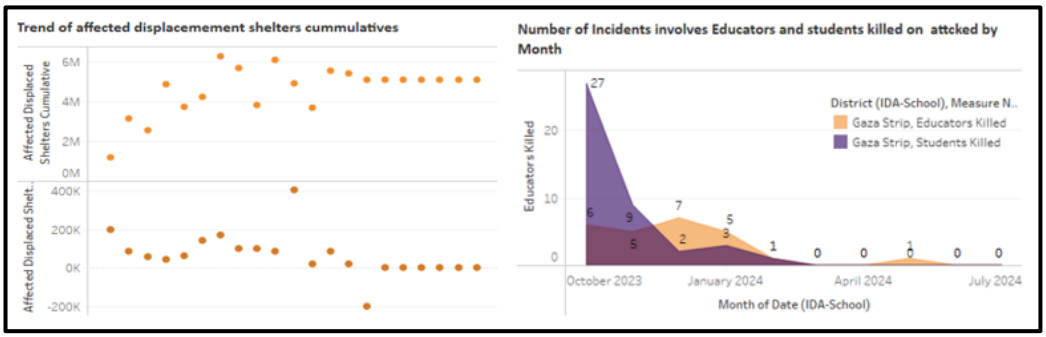


Figure 28: Various graphs illustrate the number of affected displacement shelters by number of weeks, as well as the highest number of educators and students involved in killings.
Note: Constructed by the author. (Julius AI Lab, 2024)

The crisis has led to a significant number of incidents at 36 resident camps, with the highest attack being 72.22% due to security operations. Most attacks occur in healthcare and education facilities, causing injuries and deaths, particularly for

healthcare workers, educators, and students. In July 2024, 203 attacks on health facilities resulted in the destruction of 248 facilities. The highest number of incidents occurred on December 9, 2023, highlighting the ongoing risks faced by these facilities. From November 2023 to July 2024, 159 health workers were killed, with the most significant loss occurring on March 24, 2024. Between October 2023 and July 2024, 25 educators and 42 students lost their lives, with the deadliest day for educators being October 12, 2023. The highest number of student fatalities occurred on October 14, 2023, with 27 students killed. These figures highlight the devastating impact of the crisis on educational communities.

6.1.2.2. Implications

The large number of internally displaced persons affected shelters (1.9 million at its peak) implies a significant humanitarian crisis, likely involving a substantial portion of the population in the affected area. The continuous increase in affected shelters suggests an ongoing strain on resources, both for maintaining existing shelters and establishing new ones. The extended timeframe (over a year) indicates that many people are facing long-term displacement, which has implications for education, healthcare, and economic stability.

The high percentage of camps affected by security operations and targeted attacks suggests that these environments are highly volatile and dangerous. There is a critical need for enhanced protection measures for camps, especially against airstrikes and targeted attacks. The ongoing conflict in Gaza, characterized by internally displaced persons (IDPs) and frequent attacks, has significant implications for the Sustainable Development Goals (SDGs), particularly those related to welfare, protection, and ethical compliance in supply chains.

In conflict settings, the ethical sourcing of supplies in humanitarian operations is increasingly scrutinized. The need for ethical considerations in supply chains is underscored by the complexities of sourcing materials and services in environments where local economies may be destabilized. discuss ethical issues related to data use in humanitarian contexts, emphasizing the importance of transparency and accountability in sourcing practices (Fisher et al., 2021). This is particularly

relevant in Gaza, where the ongoing conflict complicates the ability to ensure that aid is sourced ethically and responsibly.

6.1.2.3. Challenges and Limitations

Although the data is up-to-date and highly relevant to the ongoing situation, some of it collected in January 2021 appears to lack value and does not impact trend plotting. Consequently, this data should be excluded from the analysis. Metadata can be intricate and difficult to interpret, especially when it is extensive or poorly organized. This complexity makes it challenging to fully understand the underlying data and its implications.

When datasets are incomplete, inaccurate, or not standardized, metadata can lead to misinterpretation of the actual data. Poor-quality metadata reduces its usefulness and can introduce errors in data analysis. For example, data on attack incidents collected from January 2021 until September 2023 is largely irrelevant because the actual conflict-related data only begins in October 2023. The earlier years show no trends or relevant patterns, making them unsuitable for analysis. As a result, this data must be filtered out to focus only on relevant trends. Additionally, the dataset for the number of attacks on resident camps contains many unidentified locations and reports no direct victims, offering little value.

Interpreting metadata, particularly from large or complex datasets, can be time intensive. Understanding and analysing metadata can slow down data processing and delay decision-making Metadata is limited by issues such as difficulty understanding, inconsistent data structures, the inability to harmonize, and the possibility of being misunderstood. These factors hinder the effectiveness of data analysis and decision-making, especially when metadata is used without the context of raw data or additional information.

Humanitarian supply chains often rely on a variety of data inputs, including demographic data, which may be collected from disparate sources with varying levels of accuracy and timeliness. emphasize that the lack of standardized data

collection methods can hinder the ability of humanitarian organizations to assess impacts effectively and make informed decisions (Kunz & Gold, 2015).

Refer to Appendix 4: List of Data Visualizations Depicting Internal Displacement and Count of Attack Incidents.

6.1.3. Environmental Data Visualization for the Levantine Countries

The interpretation will be based on damage infrastructure and agriculture to such as road, croplands, agriculture wells, solar panels and sites inclusive of building and other facilities in six governorates which is North Gaza, Gaza, Deir Al-Balah, Khan Yunis, and Rafah with top five highest damaged municipalities. And the second part is to evaluate how this damaging contributing to the overall environmental impact not only to Gaza but also other neighbouring countries in the Lavant region.

6.1.3.1. Key Findings

The Gaza Strip has suffered significant road damage, with 1,100 km of roads destroyed or severely damaged, constituting 17% of the region's total road network. North Gaza and Khan Yunis are the most severely impacted areas, with over 400 km of roads destroyed or severely damaged. Gaza has the highest total road damage, followed by Khan Younis and North Gaza. Rafah has the least road damage among the governorates. The average amount of agriculture damage across the governorates is 32.5 sq km, with some governorates experiencing more damage than others. Agricultural wells have also been severely damaged, with 2,098 affected, resulting in a 46.40% damage percentage. Rafah has the lowest percentage of destruction (21.34%), whereas Gaza has the highest destruction rate (57.63%). Solar panel damage in Gaza's five governorates reveals the extent of destruction, with Khan Younis having the highest number of destroyed panels. The top five most affected municipalities by July 2024 are Gaza City, Khan Yunis City, Rafah City, Jabalya, and Beit Lahiya.

To increase clarity, replace with: The damaged infrastructure in Gaza is contributing to the environmental impact throughout the Levant regions. The combined greenhouse gas emissions of the five countries in the Levant region, Israel, Syria, Lebanon, Jordan, and Cyprus, over a 20-year period, amount to approximately 4,588,025.66 kt of CO2 equivalent. Israel is the largest emitter, with CO2 accounting for 82% of its total emissions. Syria follows closely with 1,590,524 kt CO2 equivalent, with high methane emissions and unique negative "Other greenhouse gas emissions," potentially indicating mitigation efforts or data inconsistencies. Lebanon's emissions are around 565,226 kt CO2 equivalent, with CO2 and methane being the main contributors. Jordan's emissions total 604,827 kt CO2 equivalent, showing a balanced distribution across emission types. Cyprus has the lowest emissions (182,133 kt CO2 equivalent), with CO2 dominating its greenhouse gas output. CO2 emissions are the most significant across all countries, reflecting industrialization and energy use. Syria shows a dramatic decline, while Cyprus demonstrates relative stability. Although the variability in "Other greenhouse gas emissions," Especially Gaza and West with no record, warrants further investigation. To increase clarity, replace with: However, liquid consumption contributes to very low CO2 emissions.

The study of sanitation and drinking water services in five countries reveals high levels of access to basic services, with Israel leading at 99.9% and the Syrian Arab Republic at 95.0%. Access to basic drinking water services is nearly universal in Israel (100.0%), and very high in Cyprus and Jordan. However, Lebanon and Syria have slightly less access, indicating room for improvement. Cyprus and Israel have nearly universal coverage for safely managed drinking water services, whereas Jordan and Lebanon have seen significant declines in water safety management. Israel leads in urban sanitation with 96.4%, while Cyprus and Jordan trail slightly. The lack of data for certain indicators in Lebanon and Syria underscores the need for improved data collection.

Freshwater withdrawals across five countries show significant disparities in usage, with the Syrian Arab Republic consuming the most water, accounting for 76.4% of the region's total. The West Bank and Gaza lead with 44.62% of total energy consumption, followed by Israel, Lebanon, and Cyprus. The Syrian Arab Republic

has the lowest consumption at 1.08%, contributing to 2.7% of the total. The distribution of access to electricity across the Levant region over the two decades is clear, with Cyprus and Israel contributing 19.69%, Jordan approximately 19.52%, the West Bank and Gaza 15.31%, Lebanon approximately 13.47%, and the Syrian Arab Republic 12.31%.

Countries like the Syrian Arab Republic have significantly higher mean annual exposure to PM2.5 pollution compared to others, indicating a widespread issue with air quality. The World Health Organization (WHO) guidelines suggest that all countries have a 100% population exposure to levels exceeding the WHO guideline value. Interim Target Exceedance is variability in the percentage of the population exposed to levels exceeding WHO Interim Targets, with some countries like Cyprus having lower exposure compared to others. Stability in exposure levels suggests that exposure levels have been relatively stable over the years 2000 to 2019, but consistent Exceedance suggests a persistent issue with air quality. Fish species are the most threatened, accounting for approximately 44.3% of the total threatened species across the countries. Plant species are the second most threatened, accounting for 22.2%. Bird and mammal species are also significantly threatened, with birds at 18.3% and mammals at 15.2%.

6.1.3.2. Implications

The extensive damage to roads, agricultural infrastructure, and solar panels in Gaza not only affects local logistics and energy production but also has broader environmental implications across the Levant region. The destruction contributes to increased greenhouse gas emissions, affecting regional air quality and potentially exacerbating climate change. Data analysis must consider these cross-regional impacts to provide a holistic view of the environmental consequences. The disparities in greenhouse gas emissions and air quality data across the Levant region, particularly the lack of data from Gaza and the West Bank, highlight the challenges of inconsistent data collection and reporting. This inconsistency can lead to gaps in analysis and a lack of actionable insights. It underscores the need for

standardized data collection practices across regions to ensure accurate and comparable analysis.

The data on road and agricultural damage indicates that some areas are significantly more affected than others, suggesting a need for targeted recovery efforts. The uneven distribution of damage and the varying levels of access to essential services like water and electricity imply that resource allocation should be carefully planned based on detailed data analysis to prioritize the most affected areas. The analysis reveals significant public health concerns related to air quality, with high levels of PM2.5 pollution in certain regions, particularly in the Syrian Arab Republic. This poses a long-term health risk to populations and requires immediate policy intervention. Data analysis can help identify the most affected areas and guide mitigation strategies to improve air quality.

The threat to fish, plant, bird, and mammal species across the region suggests a need for urgent conservation efforts. Data analysis can help prioritize these efforts by identifying the most vulnerable species and regions, allowing for more effective use of resources in biodiversity conservation. The analysis underscores the importance of high-quality, complete, and standardized data. The gaps and inconsistencies in the available data, particularly in regions like Gaza, hinder the ability to draw accurate conclusions and make informed decisions. There is a clear need for improved data collection, reporting standards, and harmonization across the region to enhance the reliability of future analyses.

6.1.3.3. Challenges and Limitations

Analyzing real-time data versus historical data presents unique challenges and limitations, particularly in understanding and interpreting their interconnections. Real-time data, which is continually updated, provides immediate insights but often lacks the historical context necessary to identify long-term trends and causations. On the other hand, historical data provides valuable context for long-term trend analysis but may not accurately reflect current conditions or emerging trends, leading to potential misinterpretations if recent developments are not considered.

The analysis encountered significant limitations due to the lack of direct connectivity between the datasets on infrastructure damage and environmental assessments. This is due to the inconsistency and fragmentation of data sources. This disconnect stemmed from the assessments being conducted during the ongoing conflict in Gaza between 2023 and 2024, while environmental data for other Levant regions only extends to 2022. Integrating historical and real-time data is essential for a comprehensive analysis but poses difficulties due to differences in time scales, data formats, and collection methods. For instance, infrastructure damage data is based on real-time updates using NDVI satellite methods, recorded daily from August 2023 to July 2024. In contrast, the Levant region's environmental data is historical, with records spanning 50 years collected annually using undisclosed methods. This mismatch creates challenges in linking these datasets, resulting in a significant data gap and making it difficult to establish relevant connections.

The environmental context itself adds layers of complexity to the analysis illustrate how natural hazards can disrupt supply chains and necessitate a resilient response (Xu et al. 2021). The ambiguity of information regarding environmental conditions can lead to miscalculations in supply chain planning, ultimately affecting aid delivery on time. This highlights the need for robust data integration systems that can provide real-time insights into environmental factors influencing humanitarian operations. Consequently, the interpretation of the relationship between infrastructure damage in Gaza and its environmental impact on the Levant region is largely theoretical, based on assumptions rather than direct empirical evidence.

6.2. Analysis on Sustainable Metrics of Environmental Data

6.2.1. Key Findings

Most countries have achieved near-universal access to electricity, with rates close to 100%. Syria lags, with access at 88.82%, significantly lower than other countries in the region. Jordan leads the region in renewable energy consumption, with 15.02% of its total energy coming from renewable sources. In contrast, Israel has the lowest renewable energy consumption, at just 1.08%. This highlights a significant disparity in the adoption of renewable energy across the region. Israel has the highest CO2

emissions per capita, at 6.35 metric tons. The West Bank and Gaza report the lowest emissions, at 1.21 metric tons per capita. There is considerable variation in CO2 emissions across the countries, reflecting differences in energy use and industrial activity. Lebanon experiences the highest levels of PM2.5 air pollution, with an annual mean exposure of 31.30 µg/m³. Israel, on the other hand, has the lowest air pollution levels at 15.57 µg/m³. Despite these differences, most countries have PM2.5 levels that exceed WHO guidelines, indicating a widespread air quality issue. Access to basic drinking water services is generally high across the region, with most countries reporting rates above 95%. Lebanon, however, has the lowest access at 92.6%, indicating room for improvement.

Refer to Appendix 5: List of Data Visualizations Depicting Damaged Infrastructure in Gaza and Environmental Impact in the Levant Region and Appendix 6: Framework Development for Sustainable Environmental Metrics and Data Tracking.

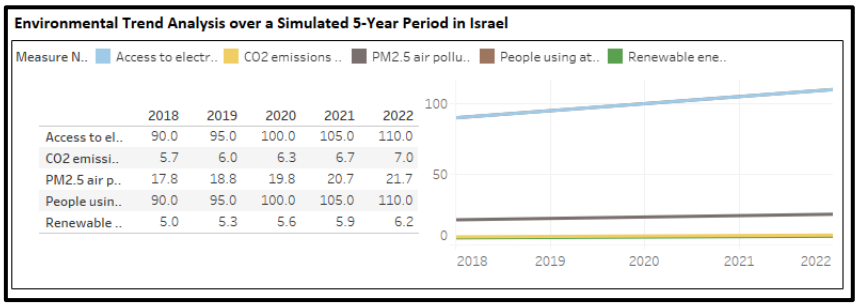


Figure 29: Metrics and line charts illustrate the environmental trend analysis over a simulated 5-year period in Israel.
Note: Constructed by the author. (Tableau Software LLC, Tableau Desktop 2024.2)

6.2.2. Implications

While access to electricity is high, the low renewable energy consumption in most countries indicates a heavy reliance on fossil fuels, which could hinder long-term sustainability goals. The high levels of air pollution, coupled with varying CO2 emissions, suggest potential health risks and environmental challenges. Although access to basic drinking water is generally high, there is room for improvement, particularly in Lebanon. Significant disparities between communities in various metrics highlight uneven progress towards achieving sustainable development goals.

6.2.3. Challenges and Limitations

Environmental systems are complex and interconnected, due to interconnectivity gaps, especially when to perform further visualization development. Creating sustainable metrics for environmental assessment in the focusing only Levant region may be a viable alternative due to gaps in data source connectivity. However, ensuring data quality remains a significant challenge. Inconsistencies and inaccuracies can lead to misleading conclusions. As the dataset in contains 23,904 records across six columns of Country Name, Country ISO3, Year, Indicator Name, Indicator Code, and Value. These columns are formatted differently, necessitating data cleaning and conversion to numeric types for analysis. Comprehensive data coverage is often lacking, with some countries or regions having incomplete data, making it difficult to conduct a holistic assessment. Furthermore, as the methodologies for data collection remain undisclosed, standardizing metrics and making meaningful comparisons is challenging.

Additionally, the temporal resolution of the data (e.g., annual or monthly) may not capture short-term environmental changes, while the spatial resolution may be too coarse to identify localized issues. The metrics must also consider interactions between different environmental components, as missing interconnectivities between variables could produce inaccurate and irrelevant results. Environmental data is subject to uncertainty and natural variability, making it essential to quantify and communicate this uncertainty for informed decision-making.

6.3. Analysis on Ethical Sourcing Through Scenario Management

6.3.1. Key findings

The analysis reveals that environmental and ethical concerns are the most frequently occurring themes, emphasizing the importance of minimizing environmental impact and adhering to ethical sourcing practices. Transparency and responsibility are also prominent themes, emphasizing the need for clear communication and accountability in sourcing activities. Sustainability and social responsibility are less frequent but still vital, emphasizing the need for long-term, socially responsible sourcing strategies. To enhance ethical sourcing, key recommendations include implementing blockchain

systems for supply chain tracking, promoting environmental practices by encouraging eco-friendly materials and renewable energy sources, strengthening ethical standards by developing and enforcing robust guidelines for suppliers, and fostering social responsibility by actively engaging with communities and stakeholders. These strategies aim to contribute positively to both society and the environment.

In the scenario matrix, the y-axis represents different scenarios, numbered from 1 to 5, while the x-axis displays the key variables identified earlier, such as Environmental Impact, Ethical Sourcing, Transparency, and others. The matrix uses colour intensity to indicate the level or strength of each variable in each scenario: darker colours (closer to 3) signify higher levels or a stronger presence of the variable, while lighter colours (closer to 1) represent lower levels or a weaker presence. Each cell in the matrix contains a number that corresponds to the following scale: 3 indicates a high level, strong presence, extensive activity, or long-term focus, 2 indicates a medium level, moderate presence, or short-term focus, and 1 indicates a low level, weak presence, or minimal activity. This matrix allows for a clear visual comparison of how each key variable manifests across different scenarios. This visualization allows for quick comparison and identification of strengths and weaknesses in each scenario, which can be valuable for decision-making and strategy development in ethical sourcing for humanitarian logistics.

For relevance matrix, social Responsibility has strong relationships with several other variables, particularly Eco-friendly Practices and Transparency (relevance of 0.8385). Ethical Sourcing is strongly related to Eco-friendly Practices (relevance of 0.7906) and Social Responsibility (relevance of 0.7071). Community Engagement shows a strong relationship with Transparency (relevance of 0.6875). Environmental Impact has moderate to strong relationships with several variables, including Social Responsibility, Renewable Energy, and Transparency. These relationships highlight the interconnected nature of ethical sourcing variables in humanitarian logistics. For example, organizations focusing on social responsibility are likely to also prioritize eco-friendly practices and transparency. Similarly, those emphasizing ethical sourcing tend to have strong eco-friendly practices and social responsibility.

An influence matrix shows social responsibility has strong positive influences on several other variables, particularly Eco-friendly Practices and Transparency (influence of 0.8385). 2. Ethical Sourcing strongly influences Eco-friendly Practices (0.7906) and Social Responsibility (0.7071). 3. Sustainability has a strong positive influence on Renewable Energy (0.6124). 4. Community Engagement has a strong negative influence on Transparency (-0.6875), which is an interesting finding that might warrant further investigation. 5. Environmental Impact has moderate to strong negative influences on several variables, including Social Responsibility, Renewable Energy, and Transparency.

These relationships highlight the complex dynamics between ethical sourcing variables in humanitarian logistics. For example, organizations focusing on social responsibility are likely to also prioritize eco-friendly practices and transparency. Those emphasizing ethical sourcing tend to have strong eco-friendly practices and social responsibility. Interestingly, as community engagement increases, transparency seems to decrease, which could indicate a potential area for improvement in ethical sourcing practices.

Potential impact of each scenario, we can evaluate the influence and dependence of each variable within the scenarios. This involves analysing how changes in one variable might affect others and the overall scenario. The influence matrix and the system grid to guide this assessment. Focus on the key variables identified in the system grid, as they have the highest influence and dependence. For each scenario, evaluate the potential impact based on the influence of key variables. Assign an impact score to each scenario based on the influence and dependence of its key variables.

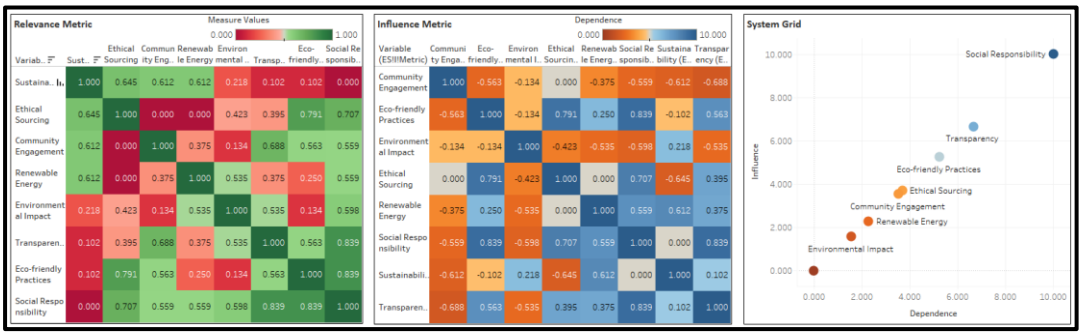


Figure 30 illustrates the integration of relevant and influential metrics with system grids through scenario management.
Note: Constructed by the author. (Tableau Software LLC, Tableau Desktop 2024.2)

6.3.2. Implications

Key variables such as transparency, eco-friendly practices, and social responsibility should be prioritized in strategic planning and resource allocation. Integrating efforts across the organization, leveraging high-impact scenarios, fostering innovation and collaboration, continuously monitoring and adapting, addressing weaknesses in lower-impact scenarios, balancing strategy, enhancing stakeholder engagement, using scenario analysis for informed decisions, risk management, ethical leadership and culture, integrating ethical sourcing strategies with other business functions, and considering the broader business context.

High-impact scenarios should receive more attention and resources, while innovation and collaboration are encouraged to enhance their effectiveness and sustainability. Continuous monitoring and adaptation are necessary due to the dynamic nature of the ethical sourcing landscape. Feedback loops can gather insights from stakeholders and adjust strategies accordingly.

Lower-impact scenarios may highlight areas needing improvements, such as community engagement or specific sustainability practices. A balanced strategy that addresses both high-impact and lower-impact scenarios can lead to more comprehensive and effective ethical sourcing strategies. Improved transparency and communication with stakeholders within humanitarian organizations can build trust and support for ethical sourcing initiatives. Integrating ethical sourcing strategies with other business functions, such as supply chain management, marketing, and corporate social responsibility, creates a cohesive approach. By understanding these implications, humanitarian bodies can effectively leverage the insights gained from scenario analysis and influence matrix to enhance their ethical sourcing practices, leading to more sustainable and responsible business operations, aligning with stakeholder expectations, and contributing to long-term success.

6.3.3. Challenges and Limitations

Since this analysis is based solely on responses to research questionnaires, predicting how the audience will respond introduces a high level of subjectivity. Different target audiences may interpret the questions from varied perspectives, influencing their responses in ways that lead to inconsistent conclusions and actions. Bias is another concern, as personal biases can affect both the development and interpretation of scenarios, potentially skewing the results. The complexity of ethical sourcing, with its numerous interconnected variables, makes it challenging to isolate the impact of individual factors. Additionally, the dynamic nature of the ethical sourcing landscape necessitates continuous updates to scenarios, further complicating the analysis.

Analysis based on research questionnaires response is not sufficient to assess ethical sourcing in the context of humanitarian supply chain. Ethical decision-making can be challenging for humanitarian organizations since it frequently operates in complicated situations with limited resources and a high degree of uncertainty (Sigala et al., 2020). Furthermore, firms may prioritize speed over ethical considerations when responding quickly to emergencies, which could jeopardize their ethical sourcing processes (Lewin et al., 2018). The conflict between ethical sourcing and urgency emphasizes the necessity for scenario-based evaluations to help companies strike a balance between these conflicting objectives (Gheibi et al., 2021).

Qualitative analysis often depends on incomplete or subjective data, which can limit the accuracy and reliability of the resulting scenarios. Furthermore, the quality of the data can vary, impacting the dependability of the conclusions drawn. The process is also resource-intensive, requiring significant time and effort for tasks such as reconciling questionnaire responses, identifying key themes and variables, and building relevant influence matrices to align with the interdependencies among these variables. Although the code for this analysis is often developed using machine learning techniques in Python, understanding the code's function and verifying calculations can be time-consuming. This need for thorough cross-checking and the process of coding and data reconciliation can place a considerable strain on resources.

Uncertainty is a pervasive issue in scenario management. Scenarios are based on assumptions about the future, which can be highly unpredictable, and unforeseen events such as economic shifts or regulatory changes can render scenarios obsolete. Moreover, the lack of quantitative precision in qualitative scenarios can limit their usefulness in decision-making, as it is difficult to measure their success or failure in precise terms.

The deficiency of uniform frameworks and criteria to analyse ethical practices is another factor contributing to the limitations of ethical sourcing assessments in humanitarian logistics. Due to a lack of resources and expertise, many humanitarian organizations are unable to perform thorough ethical assessments, which can lead to uneven practices in various circumstances (Kiswili et al., 2021). Furthermore, because humanitarian crises are dynamic in nature, assessments of ethical sourcing must be revised often to account for shifting conditions. This can be difficult to manage and resource-intensive (Altay & Labonte, 2014). Humanitarian stakeholders may experience dispersed efforts and lost potential for collaboration if there is no cohesive approach to ethical sourcing (Baidoo, 2018).

The process can also suffer from scenario overload, where too many scenarios can overwhelm decision-makers and dilute focus. Deciding which scenarios to prioritize can be challenging, leading to the possibility of overlooking important scenarios. There can also be gaps in implementation, where scenarios do not always translate into actionable strategies, and ensuring follow-through can be difficult.

Finally, scenario management relies heavily on expert judgment, which can vary and may not always be accurate. Knowledge gaps in certain areas can limit the depth of analysis, and communicating complex scenarios to stakeholders in an understandable way can be challenging, potentially affecting stakeholder engagement and buy-in for scenario-based strategies.

6.4. Analysis and Feedback of Incorporating Research Framework into Case Study

6.4.1. Incorporating Environmental KPI Metric into The Research Framework

The analysis has identified both mismatches and correlations between the environmental KPI metrics from research framework and the pre-assessment environmental from case study by UNEP are strongly align with almost variables are corelated to each other. There are some mismatches, such as missing data for certain countries and additional metrics not provided. Therefore, the KPI metric developed relevant and effective tools to perform comprehensive analysis of the environmental challenges in Gaza and outlines a strategic action plan for addressing these issues. The analysis has identified key areas for improvement, including carbon emissions reduction, biodiversity conservation, forest management, waste management, and water quality enhancement.

Carbon Emissions is the most prevalent KPI metric category, indicating a strong focus on climate change mitigation. Some environmental impacts (Biodiversity, Forest Management, Waste Management, Water Quality) lack specific KPI metrics or progress data. Carbon Emissions KPI metrics are exceeding their targets (108.32% progress), which may require reassessment of goals. Other measured impacts (Renewable Energy, Air Quality, Energy Access, Water Access) show consistent progress around 90-91%.

Current target of the carbon emission has been exceeded, necessitating adjustments. The new KPI metric has bene developed for underrepresented variables such as biodiversity, forest management, wate management and water quality as additional key indicators. Reassess and potentially adjust carbon emission targets. Investigates factors contributing to consistent 90% progress across multiple impacts. Enhance data collection for more comprehensive environmental monitoring. The action plan timeline is spans from for two years, its insufficient time to capture track the record and monitoring progress. However, this period could be depending on the ongoing conflict in Gaza.

The continue improvement on environmental will only be visible and effectively provide result during post-disaster recovery. But at this point of this research is

conducted, the ongoing conflict in Gaza has yet to be resolved. Therefore, other prioritization is focused over environmental is assessment. Enhanced methods and real-time monitoring systems are planned to collect more data for better outcome. At the same time, it also important to engage with various stakeholders from cross-sector collaboration to identify crucial components of the action plan. From then, humanitarian organization can strategies on securing funding for enhanced monitoring systems. For the details of KPI metric implementation, action plan timeline, recommendations for improvement provided.

Refers to the Appendix 11: Integration of Sustainable Environmental KPI Metrics from the Research Framework with UNEP's Pre-Assessment of Environmental Impact.

6.4.2. Incorporating Ethical Sourcing KPI Metric into The Research Framework

Both mismatches and correlations between the ethical sourcing KPI metric and CONOPS procurement guidelines shows the similarity ethical sourcing for each variable. A higher similarity score indicates a stronger correlation between the two approaches. Transparency has a perfect correlation (similarity score = 1.0), indicating identical treatment in both approaches. Compared to others, other variables such as Environmental considerations and community engagement has no connection variable between KPI metric and CONOPS procurement guidelines, but the data still shows a strong correlations between them, which is not ideal to correlate these variables.

There is some overlap in key areas such as ethical sourcing, transparency, and community engagement, showing alignment in these critical aspects. CONOPS Procurement has a specific focus on environmental considerations and process approach, which is not explicitly captured in the KPI metric Ethical Sourcing framework. KPI metric Ethical Sourcing includes additional variables related to sustainability, social responsibility, and specific measurement approaches (e.g., scenario-based approach, metrics methods) that are not explicitly mentioned in the SOP Procurement variables. Due to this distinct differentiation, it is analysing the implications of these differences address ways to integrate unique variables, evaluate the effectiveness of each approach and develop strategies to align the two frameworks.

The integration of the unique variable shows “Environmental Considerations" is deemed effective in reducing environmental risks and promoting eco-friendly practices, while "Renewable energy" is considered highly effective in reducing carbon footprint and promoting sustainability. It proposed to add underrepresented variables such as risk assessment to unify the variable and to remove ‘deem’ variable that’s doesn’t provide any influence in both KPI metric and CONOPS. But the result when the KPI metric is produced only three variables are strongly corelated which is transparency from ethical perspective, community engagement from social perspective and renewable energy adoption in sourcing from environmental perspective. The CONOPS procurement is a comprehensive guide to the procurement process, while KPI metric focuses more on outcomes and impact areas, such as environmental impact, ethical sourcing, transparency, community engagement, sustainability, social responsibility, and renewable energy. Although other factors may influence for this integration, but the ideal is to adopt KPI metric ethical sourcing it is comprehensive built to fulfil the research objectives. Therefore, the final comprehensive ethical sourcing KPI developed and resulted from both research framework to represent the correlation variable, while underrepresented variables is developed by procurement procedures.

Refer to the Appendix 12: Integration of Ethical Sourcing KPI Metrics from the Research Framework with CONOPS Procurement Guidelines.

7. Recommendation and Conclusion

7.1. Summary of Key Findings

Data analytics tools play a crucial role in aiding humanitarian operations by providing insights into the right sourcing and supply of aid services. These tools help forecast, display, and monitor data information, enabling efficient resource utilization, improved stock management, and enhanced operational levels. They align with logistic challenges in LOG and CONOPS, which are important management poles for operational logistics and strategic coordination.

The Levantine countries have achieved near-universal access to electricity, but there is a significant disparity in the adoption of renewable energy across the region. Israel has the highest CO2 emissions per capita, while the West Bank and Gaza report the lowest. This variation in CO2 emissions reflects differences in energy use and industrial activity. Access to basic drinking water services is generally high across the region, with most countries reporting rates above WHO guidelines. A comprehensive analysis of environmental challenges in Gaza has identified key areas for improvement, including carbon emissions reduction, biodiversity, forest management, waste management, and water quality. Data collection methods and tools need to be enhanced, and real-time monitoring systems should be planned. Engaging with various stakeholders is essential for identifying these as a crucial component of the action plan.

Implementing ethical sourcing practices requires a strong emphasis on transparency, community engagement, and the adoption of renewable energy sourcing. Transparency ensures that all stakeholders, from donors to beneficiaries, have visibility into sourcing decisions, including fair labor practices and the ethical treatment of suppliers. Engaging local communities is crucial for fostering social responsibility and ensuring that sourcing positively impacts local economies and livelihoods.

Implementing long-term sustainable objectives with international humanitarian principles of responsible and ethical sourcing is essential. Operational guidelines and procedures must be integrated into best practices to mitigate the negative effects of humanitarian activities

on the environment. Scenario-based plans for sustainable sourcing in humanitarian operations can improve organizational solidifying and constancy, but they must be embraced and mainstreamed in the overall organizational strategy. Integrating fair working conditions and reasonable prices into humanitarian supply chains management is vital.

Finally, strengthening regulatory compliance is necessary for maintaining ethical standards, including conducting ethical sourcing audits, developing a human rights compliance program, and implementing anti-corruption or fraud measures. Involving cross-key players in sourcing decisions helps understand the needs of materials and resources. Developing KPI metrics and audit findings can help monitor and track supplier performance, while scorecards can help scale suppliers and make informed decisions.

7.2. Recommendation for Practices

Humanitarian organizations must utilize data analytics tools to address logistic gaps in Common Services and Capacity Augmentation, such as cargo consolidation, storage, transportation, and cargo tracking. The Concept of Operations is a live document that will be adjusted and revised as the situation unfolds. The tool will also support key relief actors by providing equipment, services, and technical expertise to enhance logistics capabilities for strengthened services and assistance delivery.

KPI metrics can help organizations address environmental issues in both short-term and long-term recovery planning. Carbon emissions are partly caused by environmental problems, and organizations should push for more meaningful policies towards carbon emissions and promote clean energy initiatives. Integrating new KPI indicators like biodiversity loss, forest, waste, and water resources management into the environmental monitoring framework will ensure effective response to planned interventions. Stakeholder engagement is crucial for the action plan, and organizations should invest in the Humanitarian Carbon Calculator (HCC) to mitigate carbon emissions, encourage sustainable procurement practices, streamline transport and logistics, facilitate joint procurement, and set realistic carbon reduction targets. Potentially to secure funding for enhanced monitoring systems.

Ethical sourcing practices, including transparency, community engagement, and renewable energy sourcing, are essential for humanitarian organizations. Transparency builds trust throughout the supply chain, requires clear communication of sourcing processes, supplier audits, and fair labor practices. Engaging with local communities fosters social responsibility, and adopting renewable energy in the sourcing process reduces environmental impact while reflecting a commitment to sustainability. These practices help create a more ethical, socially responsible, and environmentally friendly supply chain.

7.3. Future research opportunities

The literature review highlights the need for further research on how technology can enhance sustainable and ethical sourcing in humanitarian situations. Future studies should examine technologies like blockchain, AI, machine learning, and quantum computing, as well as IoTs' functional abilities to improve sustainability in remote or difficult locations. These technologies can aid in tracking and tracing, predictive analytics, and automating logistics processes. Deploying humans, robots, UAVs, or drones for aid delivery can provide benefits in areas with conflict or difficulty in reaching. These tools can convey supplies quickly and minimize emergency response time while mitigating risks for aid workers. Combining quantum computing with AI can help address environmental sustainability and ethical procurement in humanitarian supply chain management.

Identifying vulnerabilities in logistics supply chains susceptible to environmental disruptions, such as natural disasters or climate change impacts, is crucial. Adaptive strategies, such as diversifying supply sources, implementing flexible logistics networks, and using renewable energy sources, can enhance supply chain resilience. Rapid response and recovery frameworks can be developed, including contingency plans and emergency logistics hubs. Sustainability practices can be integrated into logistics operations to enhance resilience, such as reducing carbon emissions, optimizing resource use, and promoting circular economy principles. Future research should focus on comparative analysis of sustainable sourcing strategies across humanitarian organizations, long-term impact assessment of sustainable sourcing practices on environmental sustainability and humanitarian outcomes and identifying barriers to implementing sustainable sourcing practices in emergency response situations. Prioritizing technology and community

involvement can contribute to advancing sustainable and ethical sourcing practices in humanitarian work.

7.4. Conclusion

Based on the framework development from the study produced it can conclude leveraging business analytics is a trailblazer for future data innovation in humanitarian logistics and supply chain management, driving improvements in efficiency, responsiveness, and resource allocation. The trend in data patterns from the visualizations strongly aligns with actual operational challenges, particularly in logistics. Bottlenecks, such as limited access and stock shortages of essential materials, as well as long delivery lead times due to cargo clearance delays, have hindered aid distribution. These delays have had significant impacts on people affected by casualties, damaged infrastructure, and environmental issues that threaten human health and safety, leading to increased internal displacement. Moreover, this data correlates closely with various case studies conducted by humanitarian actors. Incorporating the research framework through KPIs on environmental and ethical sourcing can offer substantial benefits to humanitarian organizations, enabling them to adapt the framework for monitoring and evaluation. This approach supports continuous improvement, bridging strategic decision-making with effective execution at the operational level.

With the help of real-time data analysis, organizations can ensure that their sourcing process is open, hence enhanced accountability in the entire supply chain. This method is also beneficial to community involvement in that it addresses the issues of sourcing in relation to the local context and promotes awareness of social accountability in humanitarian activities. Suppliers' compliance with ethical norms is important, and the incorporation of scorecards for supplier evaluation will address this concern on supplier compliance with ethical and environmental standards. The multi-faceted approach not only enhances operations efficiency but more importantly guarantees that moral and ecological aspects are addressed in the entire value chain. These tools provide data-driven insights for sustainable decision-making, helping minimize environmental impact, reduce waste, and ensure ethical procurement processes. In doing so, business analytics supports a more responsible, transparent, and efficient approach to humanitarian operations, benefiting both people in need and the planet.

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List of Software and AI Tool with Versions

Software/tool	Description
Tableau Desktop 2024.2	Data visualization tools for interactive dashboards and reporting development
Tableau Cloud	Tableau on the cloud for workbook publishing
Tableau Pubic	Workbook public platform
Tableau Mobile	Mobile application that allows interactive dashboard in mobile devices
QGIS Desktop 3.264	
The Office 365 suite	Excel, PowerPoint, and Words.
Julius AI 1.0.52	Tool designed for data analysis and visualization.
OpenAI's GPT-4	Language understanding and generation capabilities for interpreting and responding to complex queries related to data processing and analysis.
Pandas.	Python library used for data manipulation and analysis
NumPy	Numerical calculations and to generate random scores for suppliers in the evaluation example.
Matplotlib	Applied to create and develop KPI Metric performance and metrics for different suppliers.
Graphviz	Generate visual flow diagrams of processes, such as the ethical sourcing KPI metric flow.
Jupyter Notebook	The environment for running Python code and scripts, facilitating interactive data analysis and visualization.
XlsxWriter	Exporting data manipulation results into Excel spreadsheets for reporting, complete with visual enhancements and chart integrations.
Retrieval Augmented Generation (RAG) Tools	Enhanced text data retrieval and generation capabilities that helped in processing large data files.

List of Appendix

Appendix 1

Researcher-Constructed Questionnaires and Final Response Count

Summary result and questionnaires can be access through the link mentioned in the table.

Type of Data	Description and access link to the source
Notes	Summary result of Research Questionnaires Sample of the answered questionnaires

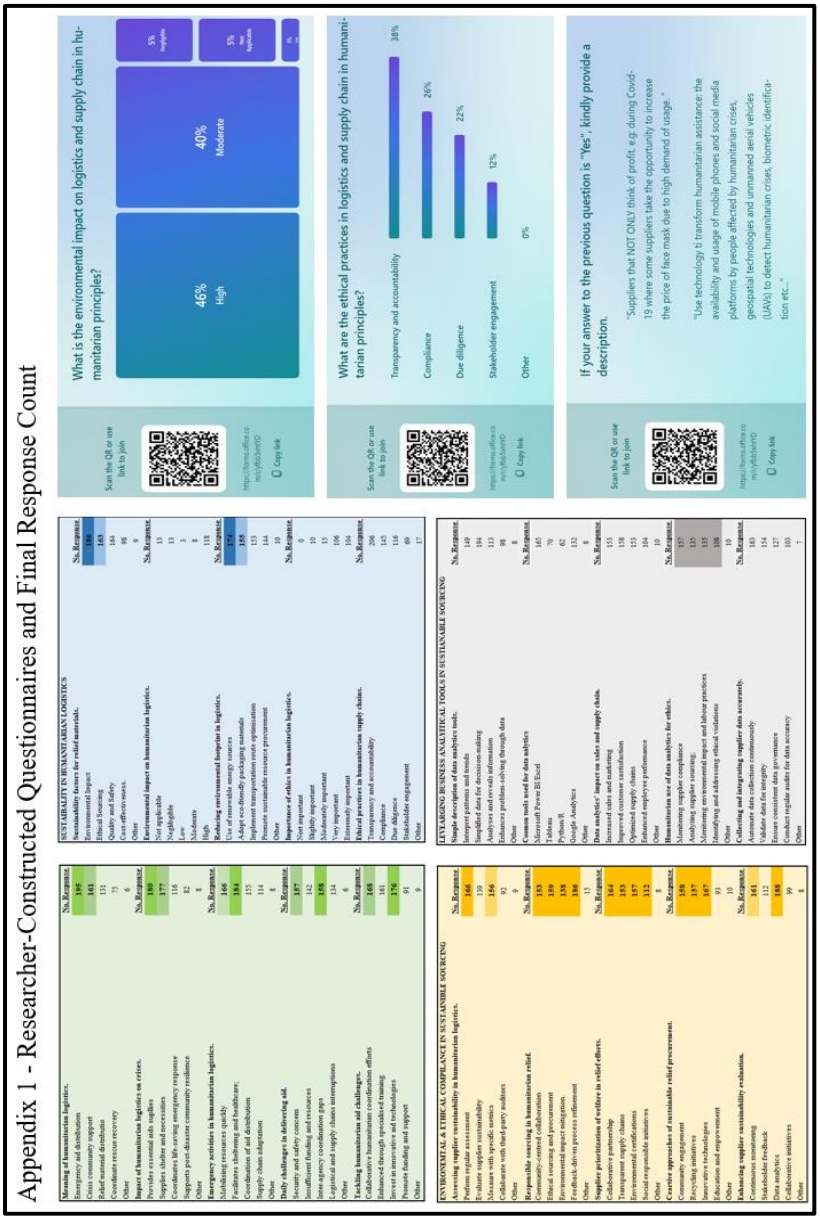


Figure 1: Final count result of research questionnaires and audience response note.

Appendix 2

List of Data Visualizations Depicting Basic Commodities Received as Humanitarian Aid in Gaza.

The dashboard and data sources can be accessed via the links provided.

Type of Data	Description and access link to the source
Dashboard	Dashboard of commodity distribution by cargo category. Dashboard of the top 10 most received commodities. Dashboard for fuel and gas distributions in humanitarian operations. Dashboard showing the amount of fuel (petrol and diesel) and the number of permits required for approval.
Data Source	The original data source includes a list of basic commodities and fuel supply and dispatching tracking, which was collected randomly.

Appendix 3

List of Data Visualizations Depicting Demand and Supply for Medical and Healthcare Items Received as Humanitarian Aid in Gaza.

The dashboard and data sources can be accessed via the links provided.

Type of Data	Description and access link to the source
Dashboard	Dashboard of demand and supply for healthcare consumable items. Dashboard of demand and supply for medicines. Dashboard of demand and supply of medical and healthcare by category
Data source	Demand and Supply for medical and healthcare items

Appendix 4

List of Data Visualizations Depicting Internal Displacement and Count of Attack Incidents.

The dashboard and data sources can be accessed via the links provided.

Type of Data	Description and access link to the source
Dashboard	Dashboard of internally displaced persons. Dashboard on attack incident for residences, healthcare, and education facilities.
Data source	Data source for internally displaced persons by number of capacity shelters.

Appendix 5

List of Data Visualizations Depicting Damaged Infrastructure in Gaza and Environmental Impact in the Levant Region.

The dashboard and data sources can be accessed via the links provided

Type of Data	Description and access link to the source
Dashboard	Dashboard The Gaza Strip's damaged infrastructure dashboard. Dashboard of gas emissions in the Levant region. Dashboard of water and energy consumption in the Levant region. Dashboard of air pollution and biodiversity threats in the Levant region
Data source	Different dataset for environmental

Figure 2: Damaged croplands recorded from June 28, 2024, to July 28, 2024

Figure 3: Damaged sites recorded from June 28, 2024, to July 28, 2024.

Appendix 6

Framework Development for Sustainable Environmental Metrics and Data Tracking.

The dashboard and data sources can be accessed via the links provided

Type of Data	Description and access link to the source
Dashboard	Dashboard of sustainable metrics of environmental assessment Dashboard of environmental trends and analysis of each Levantine countries
Data source	A dashboard of water and energy consumption in the Levant region.

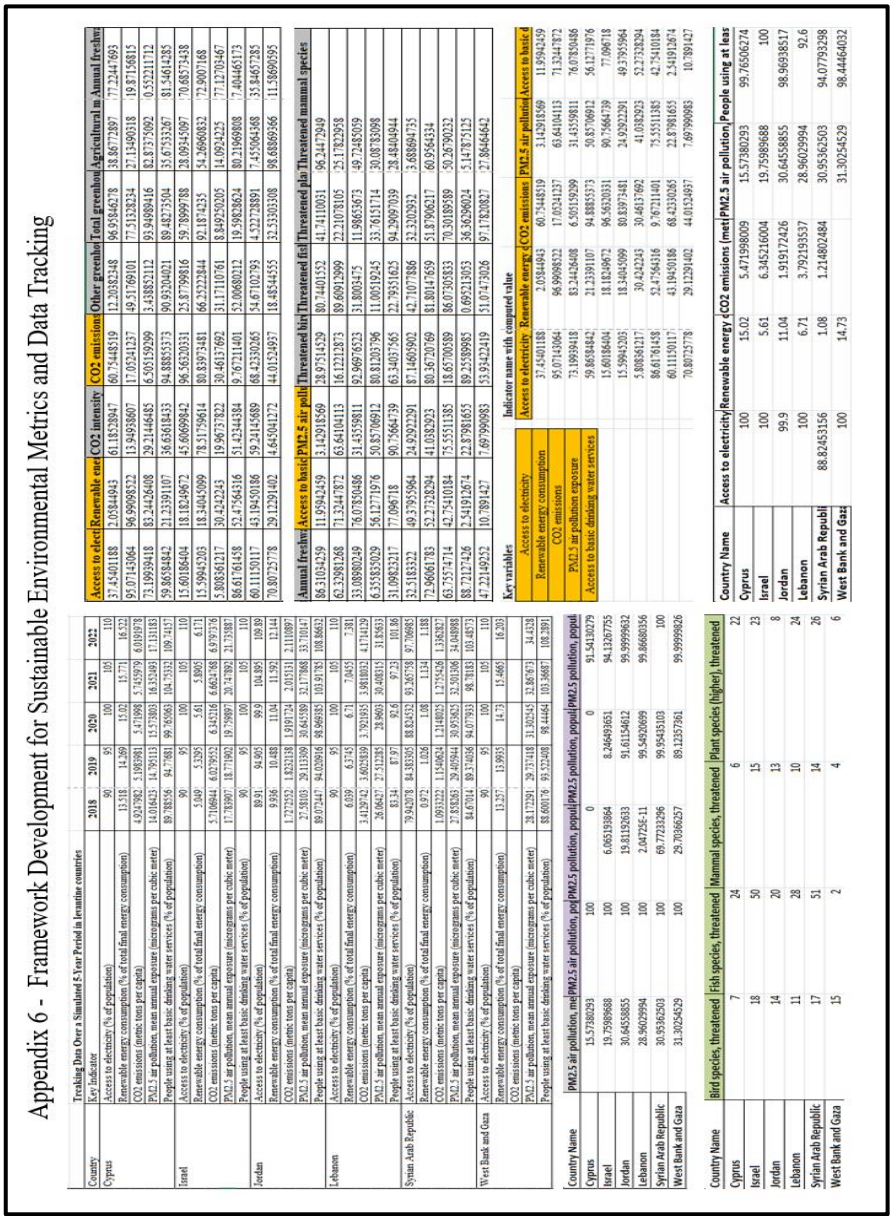


Figure 5: Varius dataset for environmental

Appendix 7

Framework Development for Ethical Sourcing Using Scenario Management.

The dashboard and data sources can be accessed via the links provided

Type of Data	Description and access link to the source
Dashboard	Dashboard of Matrix and System Grid
Data Source	Data of relevance and influence matrix with system Grid

Figure 6: Structured data file and matrix

Appendix 8

Development of Sustainable Environmental KPI Metrics for Monitoring Continuous Improvement.

The KPI Metric and data sources can be accessed via the links provided.

Type of Data	Description and access link to the source
Data Source	[Data and KPI Metrics of environmental assessment]

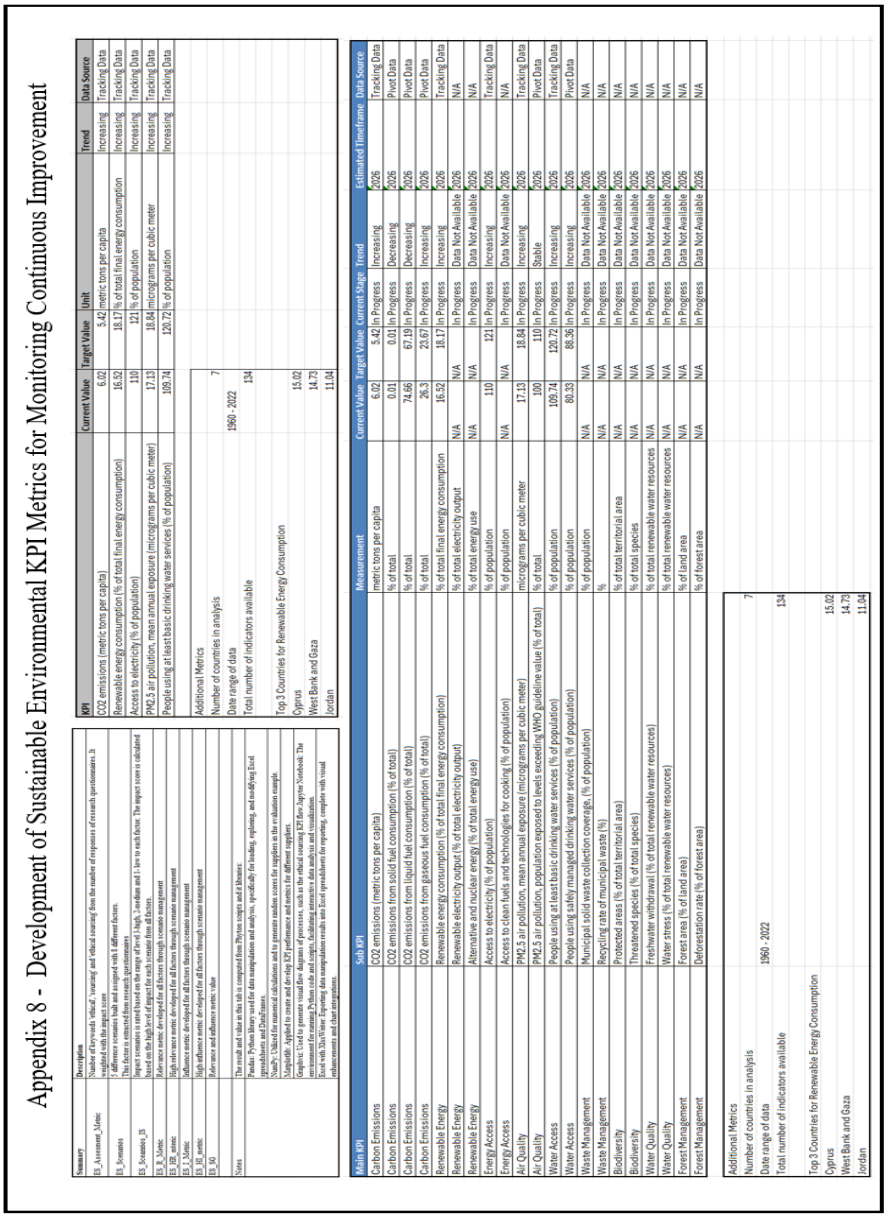


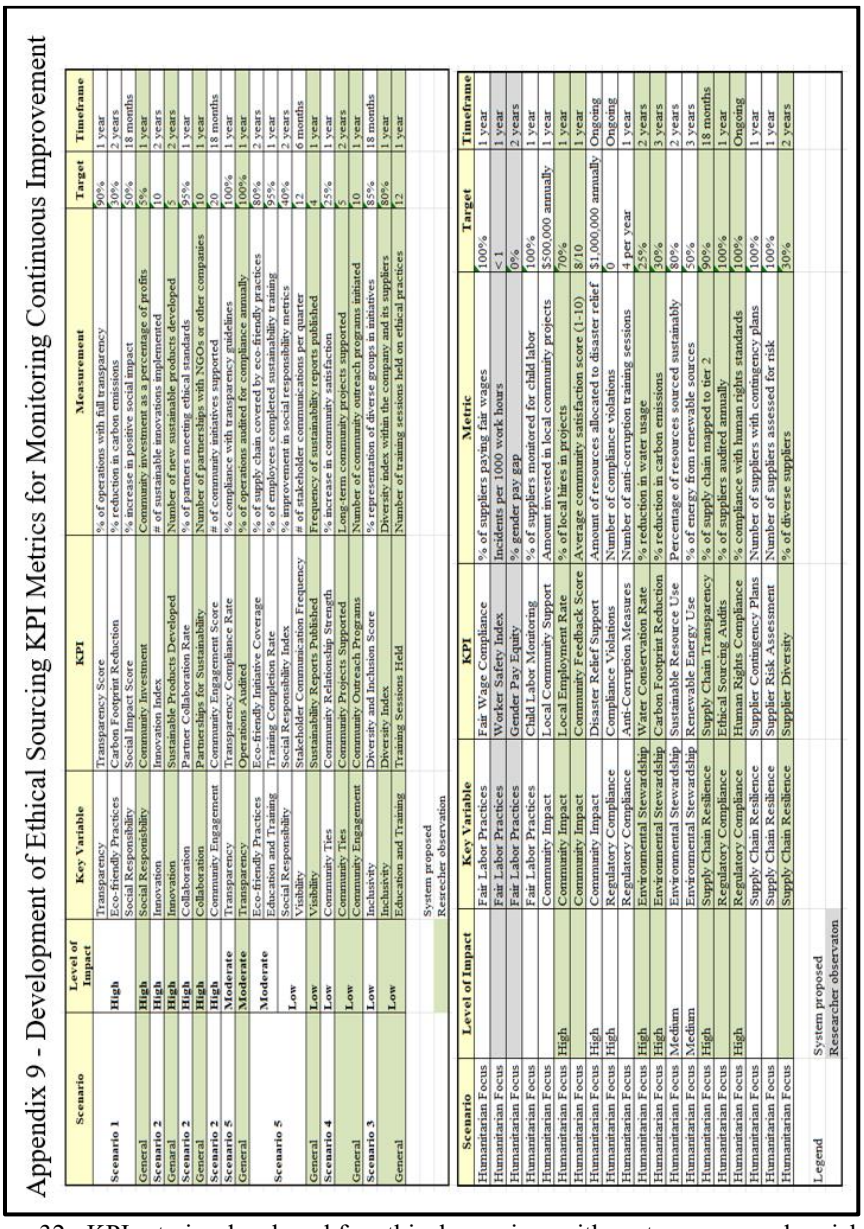
Figure 7: Environment KPI metrics

Appendix 9

Development of Ethical Sourcing KPI Metrics for Monitoring Continuous Improvement.

The KPI metric and data sources can be accessed via the links provided.

Type of Data	Description and access link to the source
Data Source	Data and KPI metric of ethical sourcing



Appendix 9 - Development of Ethical Sourcing KPI Metrics for Monitoring Continuous Improvement

Scenario	Level of Impact	Key Variable	KPI	Measurement	Target	Timeframe
Scenario 1	High	Transparency	Transparency Score	% of operations with full transparency	90%	1 year
		Eco-friendly Practices	Carbon Footprint Reduction	% reduction in carbon emissions	30%	2 years
		Social Responsibility	Social Impact Score	% increase in positive social impact	50%	18 months
General	High	Social Responsibility	Community Investment	Community investment as a percentage of profits	5%	1 year
Scenario 2	High	Innovation	Innovation Index	# of sustainable innovations implemented	10	2 years
General	High	Innovation	Sustainable Products Developed	Number of new sustainable products developed	5	2 years
Scenario 2	High	Collaboration	Partner Collaboration Rate	% of partners meeting ethical standards	95%	1 year
General	High	Collaboration	Partnerships for Sustainability	Number of partnerships with NGOs or other companies	10	1 year
Scenario 2	High	Community Engagement	Community Engagement Score	# of community initiatives supported	20	18 months
Scenario 5	Moderate	Transparency	Transparency Compliance Rate	% compliance with transparency guidelines	100%	1 year
General	Moderate	Transparency	Operations Audited	% of operations audited for compliance annually	100%	1 year
Scenario 5	Moderate	Eco-friendly Practices	Eco-friendly Initiative Coverage	% of supply chain covered by eco-friendly practices	80%	2 years
		Education and Training	Training Completion Rate	% of employees completed sustainability training	95%	1 year
	Low	Social Responsibility	Social Responsibility Index	% improvement in social responsibility metrics	40%	2 years
		Visibility	Stakeholder Communication Frequency	# of stakeholder communications per quarter	12	6 months
General	Low	Visibility	Sustainability Reports Published	Frequency of sustainability reports published	4	1 year
Scenario 4	Low	Community Ties	Community Relationship Strength	% increase in community satisfaction	25%	1 year
Scenario 5	Moderate	Transparency	Transparency Compliance Rate	% compliance with transparency guidelines	100%	1 year
General	Low	Community Ties	Community Projects Supported	Long-term community projects supported	5	2 years
	Low	Community Engagement	Community Outreach Programs	Number of community outreach programs initiated	10	1 year
Scenario 3	Low	Inclusivity	Diversity and Inclusion Score	% representation of diverse groups in initiatives	85%	18 months
	Low	Inclusivity	Diversity Index	Diversity index within the company and its suppliers	80%	1 year
General		Education and Training	Training Sessions Held	Number of training sessions held on ethical practices	12	1 year

Scenario	Level of Impact	Key Variable	KPI	Metric	Target	Timeframe
Humanitarian Focus		Fair Labor Practices	Fair Wage Compliance	% of suppliers paying fair wages	100%	1 year
Humanitarian Focus		Fair Labor Practices	Worker Safety Index	Incidents per 1000 work hours	< 1	1 year
Humanitarian Focus		Fair Labor Practices	Gender Pay Equity	% gender pay gap	0%	2 years
Humanitarian Focus		Fair Labor Practices	Child Labor Monitoring	% of suppliers monitored for child labor	100%	1 year
Humanitarian Focus		Community Impact	Local Community Support	Amount invested in local community projects	$500,000 annually	1 year
Humanitarian Focus	High	Community Impact	Local Employment Rate	% of local hires in projects	70%	1 year
Humanitarian Focus		Community Impact	Community Feedback Score	Average community satisfaction score (1-10)	8/10	1 year
Humanitarian Focus	High	Community Impact	Disaster Relief Support	Amount of resources allocated to disaster relief	$1,000,000 annually	Ongoing
Humanitarian Focus	High	Regulatory Compliance	Compliance Violations	Number of compliance violations	0	Ongoing
Humanitarian Focus		Regulatory Compliance	Anti-Corruption Measures	Number of anti-corruption training sessions	4 per year	1 year
Humanitarian Focus	High	Environmental Stewardship	Water Conservation Rate	% reduction in water usage	25%	2 years
Humanitarian Focus	High	Environmental Stewardship	Carbon Footprint Reduction	% reduction in carbon emissions	30%	3 years
Humanitarian Focus	Medium	Environmental Stewardship	Sustainable Resource Use	Percentage of resources sourced sustainably	80%	2 years
Humanitarian Focus	Medium	Environmental Stewardship	Renewable Energy Use	% of energy from renewable sources	50%	3 years
Humanitarian Focus	High	Supply Chain Resilience	Supply Chain Transparency	% of supply chain mapped to tier 2	90%	18 months
Humanitarian Focus		Regulatory Compliance	Ethical Sourcing Audits	% of suppliers audited annually	100%	1 year
Humanitarian Focus	High	Regulatory Compliance	Human Rights Compliance	% compliance with human rights standards	100%	Ongoing
Humanitarian Focus		Supply Chain Resilience	Supplier Contingency Plans	Number of suppliers with contingency plans	100%	1 year
Humanitarian Focus		Supply Chain Resilience	Supplier Risk Assessment	Number of suppliers assessed for risk	100%	1 year
Humanitarian Focus		Supply Chain Resilience	Supplier Diversity	% of diverse suppliers	50%	2 years

Legend: System proposed; Researcher observation

Figure 32 : KPI mterics developed for ethical sourcing with system proposed variables and additional variables from researcher's observations.

Appendix 10

Development of a Scorecard for Supplier Assessment and Evaluation.

The chart and data sources can be accessed via the links provided.

Type of Data	Description and access link to the source
Data Source	Data and chart developed of a scorecard

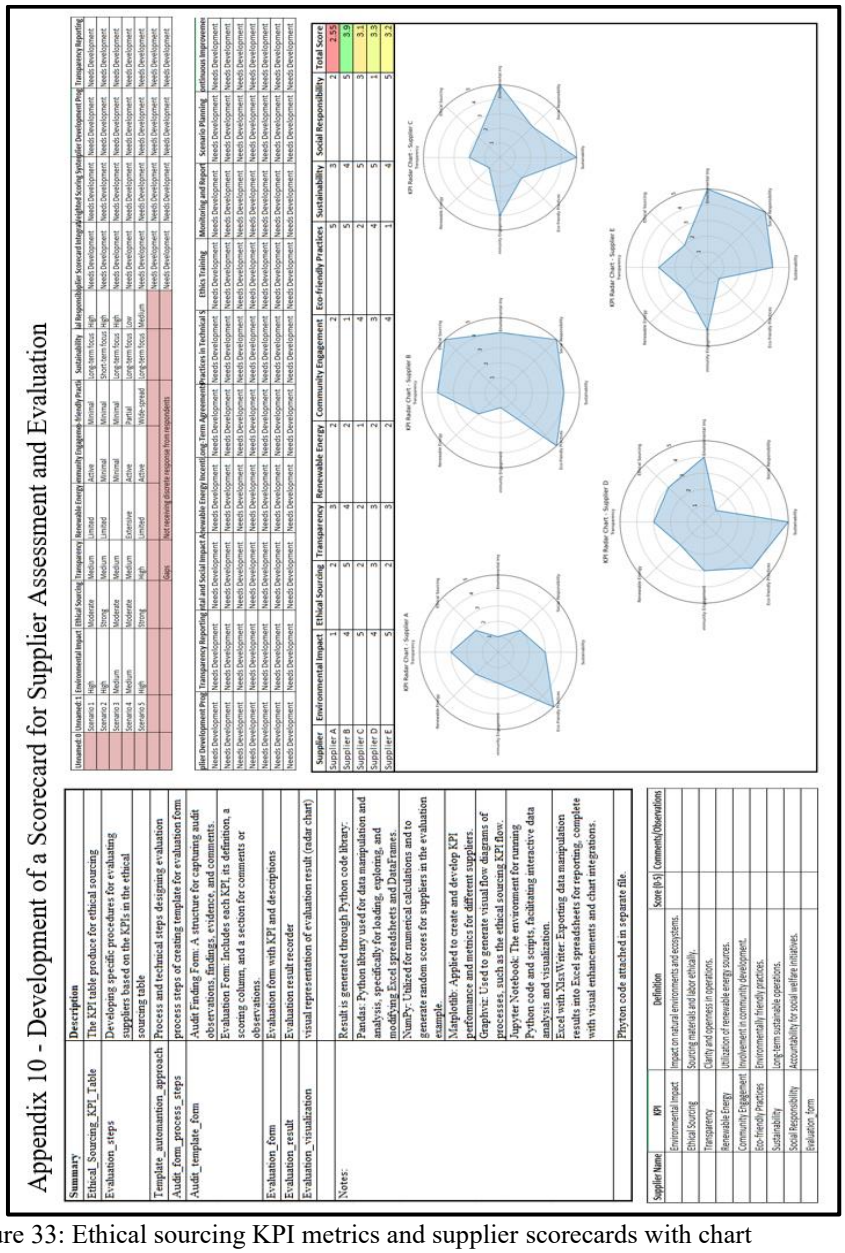


Figure 33: Ethical sourcing KPI metrics and supplier scorecards with chart

Appendix 11

Integration of Sustainable Environmental KPI Metrics from the Research Framework with UNEP's Pre-Assessment of Environmental Impact

The KPI metrics and data sources can be accessed via the links provided.

Type of Data	Description and access link to the source
Data Source and metric	Data and extended KPI metric for environmental assessment

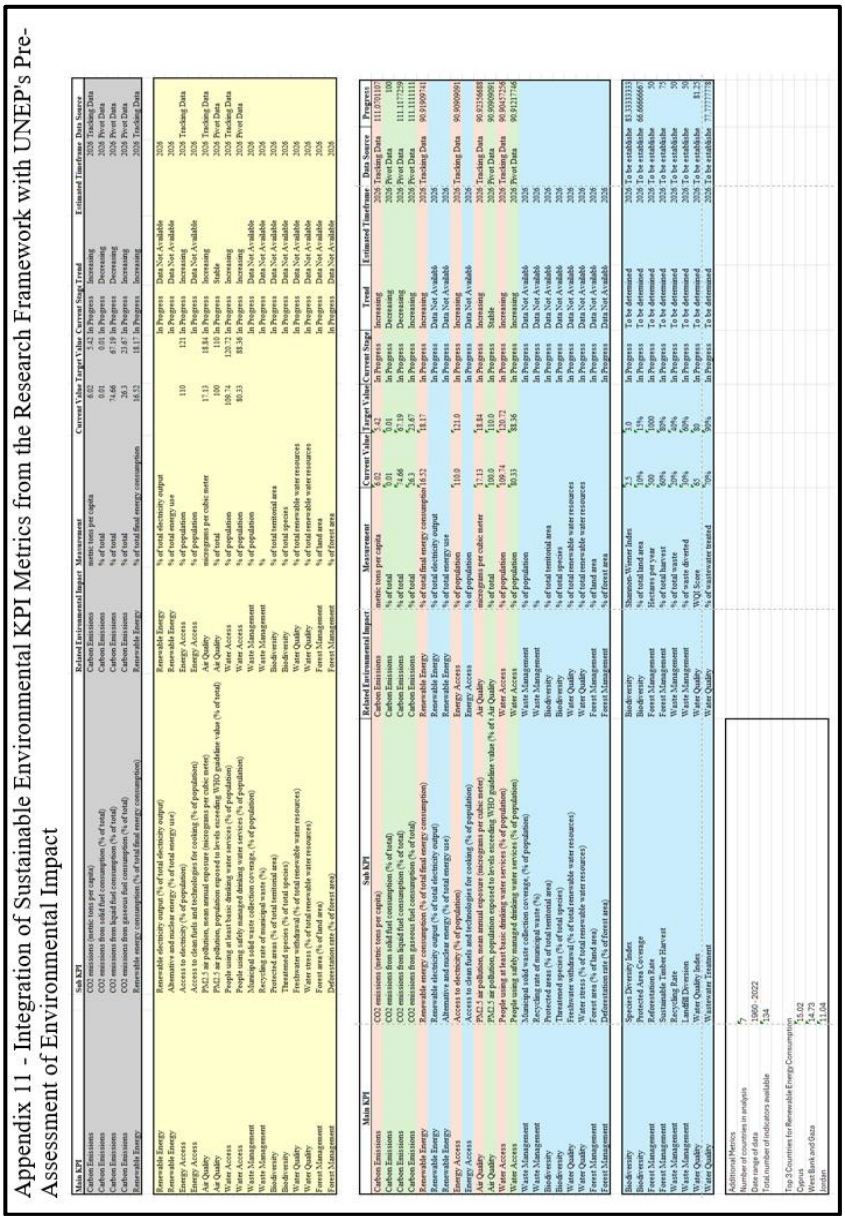


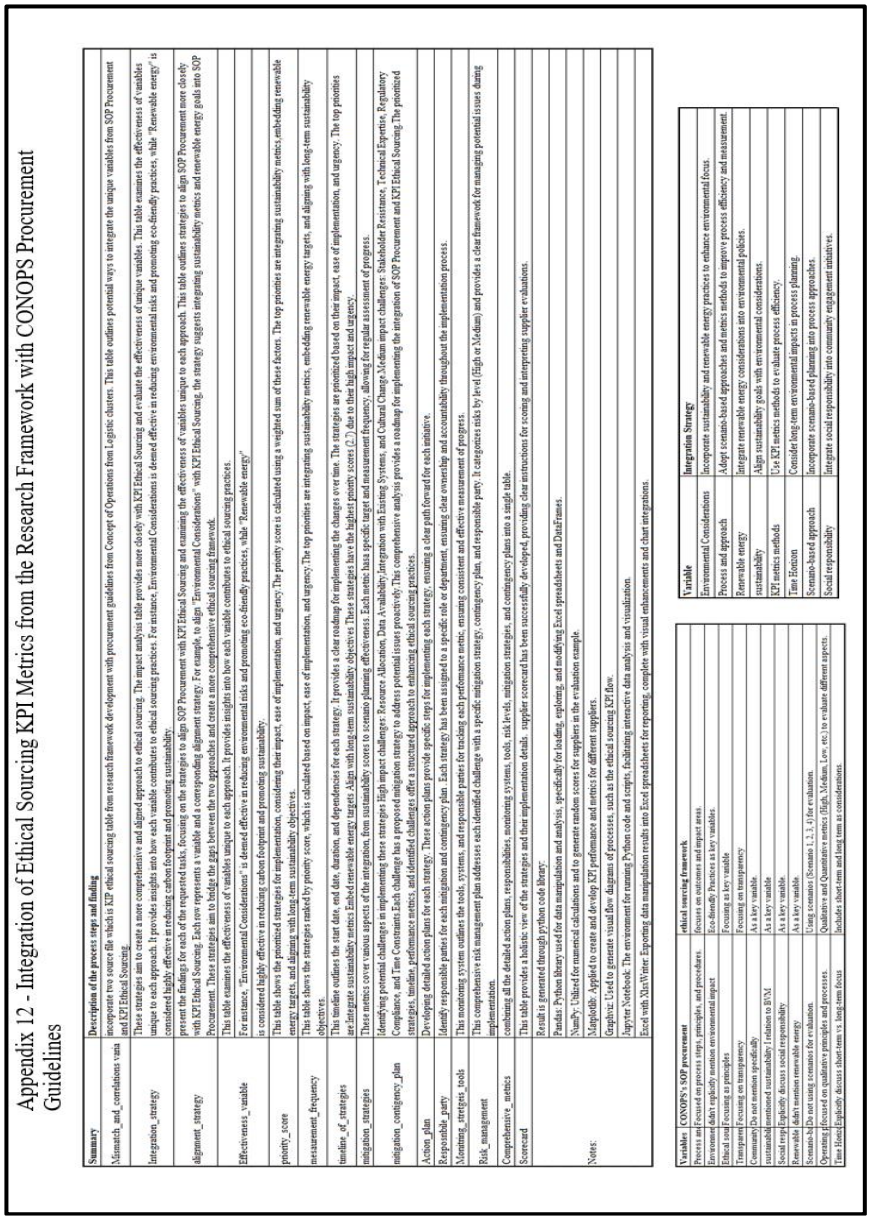
Figure 35: Comprehensive KPI metrics developed to incorporate a research framework and pre-assessment from UNEP.

Appendix 12

Integration of Ethical Sourcing KPI Metrics from the Research Framework with CONOPS Procurement Guidelines.

The KPI metric and data sources can be accessed via the links provided.

Type of Data	Description and access link to the source
Data Source and metric	Data and KPI metrics for ethical sourcing



Appendix 12 - Integration of Ethical Sourcing KPI Metrics from the Research Framework with CONOPS Procurement Guidelines

Summary	Description of the process steps and finding
Mismatch_and_correlations_vasia	incorporate two source file which is KIP ethical sourcing table from research framework development with procurement guidelines from Concept of Operations from Logistic clusters. This table outlines potential ways to integrate the unique variables from SOP Procurement and KPI Ethical Sourcing.
Integration_strategy	These strategies aim to create a more comprehensive and aligned approach to ethical sourcing. The impact analysis table provides more closely with KPI Ethical Sourcing and evaluate the effectiveness of unique variables. This table examines the effectiveness of variables unique to each approach. It provides insights into how each variable contributes to ethical sourcing practices. For instance, Environmental Considerations is deemed effective as reducing environmental risks and promoting eco-friendly practices, while "Renewable energy" is considered highly effective in reducing carbon footprint and promoting sustainability.
alignment_strategy	present the findings for each of the requested tasks, focusing on the strategies to align SOP Procurement with KPI Ethical Sourcing and examining the effectiveness of variables unique to each approach. This table outlines strategies to align SOP Procurement more closely with KPI Ethical Sourcing. Each row represents a variable and a corresponding alignment strategy. For example, to align "Environmental Considerations" with KPI Ethical Sourcing, the strategy suggests integrating sustainability metrics and renewable energy goals into SOP Procurement. These strategies aim to bridge the gaps between the two approaches and create a more comprehensive ethical sourcing framework.
Effectiveness_variable	This table examines the effectiveness of variables unique to each approach. It provides insights into how each variable contributes to ethical sourcing practices. For instance, "Environmental Considerations" is deemed effective in reducing environmental risks and promoting eco-friendly practices, while "Renewable energy" is considered highly effective in reducing carbon footprint and promoting sustainability.
priority_score	This table shows the prioritized strategies for implementation, considering their impact, ease of implementation, and urgency. The priority score is calculated using a weighted sum of these factors. The top priorities are integrating sustainability metrics,embedding renewable energy targets, and aligning with long-term sustainability objectives.
measurement_frequency	This table shows the strategies ranked by priority score, which is calculated based on impact, ease of implementation, and urgency. The top priorities are integrating sustainability metrics, embedding renewable energy targets, and aligning with long-term sustainability objectives.
timeline_of_strategies	This timeline outlines the start date, end date, duration, and dependencies for each strategy. It provides a clear roadmap for implementing the changes over time. The strategies are prioritized based on their impact, ease of implementation, and urgency. The top priorities are:Integrate sustainability metrics Embed renewable energy targets Align with long-term sustainability objectives These strategies have the highest priority scores (2.7) due to their high impact and urgency.
mitigation_strategies	These metrics cover various aspects of the integration, from sustainability scores to scenario planning effectiveness. Each metric has a specific target and measurement frequency, allowing for regular assessment of progress.
mitigation_contingency_plan	Identifying potential challenges in implementing these strategies High impact challenges: Resource Allocation, Data Availability,Integration with Existing Systems, and Cultural Change.Medium impact challenges: Stakeholder Resistance, Technical Expertise, Regulatory Compliance, and Time Constraints Each challenge has a proposed mitigation strategy to address potential issues proactively. This comprehensive analysis provides a roadmap for implementing the integration of SOP Procurement and KPI Ethical Sourcing.The prioritized strategies, timeline, performance metrics, and identified challenges offer a structured approach to enhancing ethical sourcing practices.
Action_plan	Developing detailed action plans for each strategy. These action plans provide specific steps for implementing each strategy, ensuring a clear path forward for each initiative.
Responsible_party	Identify responsible parties for each mitigation and contingency plan . Each strategy has been assigned to a specific role or department, ensuring clear ownership and accountability throughout the implementation process.
Monitring_strategies_tools	This monitoring system outlines the tools, systems, and responsible parties for tracking each performance metric, ensuring consistent and effective measurement of progress.
Risk_management	This comprehensive risk management plan addresses each identified challenge with a specific mitigation strategy, contingency plan, and responsible party. It categorizes risks by level (High or Medium) and provides a clear framework for managing potential issues during implementation.
Comprehensive_metrics	combining all the detailed action plans, responsibilities, monitoring systems, tools, risk levels, mitigation strategies, and contingency plans into a single table.
Scorecard	This table provides a holistic view of the strategies and their implementation details. supplier scorecard has been successfully developed, providing clear instructions for scoring and interpreting supplier evaluations.
Notes:	Result is generated through python code library: Pandas: Python library used for data manipulation and analysis, specifically for loading, exploring, and modifying Excel spreadsheets and DataFrames. NumPy: Utilized for numerical calculations and to generate random scores for suppliers in the evaluation example. Matplotlib: Applied to create and develop KPI performance and metrics for different suppliers. Graphviz: Used to generate visual flow diagrams of processes, such as the ethical sourcing KPI flow. Jupyter Notebook: The environment for running Python code and scripts, facilitating interactive data analysis and visualization. Excel with XlsxWriter: Exporting data manipulation results into Excel spreadsheets for reporting, complete with visual enhancements and chart integrations.

Variables	CONOPS's SOP procurement	ethical sourcing framework
Process and	Focused on process steps, principles, and procedures.	focuses on outcomes and impact areas.
Environme	didn't explicitly mention environmental impact	Eco-friendly Practices as key variables.
Ethical sou	Focusing as principles	Focusing as key variable
Transparen	Focusing on transparency	Focusing on transparency
Community	Do not mention specifically.	As a key variable.
sustainabil	mentioned sustainability) relation to $O\backslash M$	As a key variable
Social resp	Explicitly discuss social responsibility	As a key variable
Renewable	didn't mention renewable energy	As a key variable
Scenario-b	Do not using scenarios for evaluation.	Using scenarios (Scenario 1, 2, 3, 4) for evaluation.
Operating s	focused on qualitative principles and processes.	Qualitative and Quantitative metrics (High, Medium, Low, etc.) to evaluate different aspects.
Time Horiz	Explicitly discuss short-term vs. long-term focus	Includes short-term and long-term ai considerations.

Variable	Integration Strategy
Environmental Considerations	Incorporate sustainability and renewable energy practices to enhance environmental focus
Process and approach	Adopt scenario-based approaches and metrics methods to improve process efficiency and measurement
Renewable energy	Integrate renewable energy considerations into environmental policies.
sustainability	Align sustainability goals with environmental considerations.
KPI metrics methods	Use KPI metrics methods to evaluate process efficiency.
Time Horizon	Consider long-term environmental impacts in process planning.
Scenario-based approach	Incorporate scenario-based planning into process approaches.
Social responsibility	Integrate social responsibility into community engagement initiatives.

Figure 37: Comprehensive KPI metrics developed to incorporate a research framework procurement guideline from CONPS.

Appendix 12 - Integration of Ethical Sourcing KPI Metrics from the Research Framework with CONOPS Procurement Guidelines

	risk_level	mitigation_strategy	contingency_plan	responsible_party
Resource Allocation	High	Secure budget and allocate dedicated team	Identify alternative funding sources and cross-train existing staff	Chief Financial Officer
Stakeholder Resistance	Medium	Engage stakeholders early and communicate benefits	Develop targeted communication plans for resistant groups	Change Management Lead
Data Availability	High	Invest in data collection and management systems	Develop manual data collection processes as interim solution	Chief Information Officer
Integration with Existing Systems	High	Conduct thorough system analysis and plan phased integration	Develop workarounds for incompatible systems	IT Integration Manager
Regulatory Compliance	Medium	Stay updated on regulations and involve legal team	Establish relationships with regulatory bodies for guidance	Legal Compliance Officer
Cultural Change	High	Implement change management program	Identify and empower change champions within the organization	Chief Human Resources Officer

	level	Mitigation strategy	Contingency plan	Responsible party
Resource Allocation	High	Secure budget and allocate dedicated team	Identify alternative funding sources and cross-train existing staff	Chief Financial Officer
Stakeholder Resistance	Medium	Engage stakeholders early and communicate benefits	Develop targeted communication plans for resistant groups	Change Management Lead
Data Availability	High	Invest in data collection and management systems	Develop manual data collection processes as interim solution	Chief Information Officer
Technical Expertise	Medium	Provide training and consider external consultants	Establish partnerships with academic institutions for expertise	Human Resources Director
Integration with Existing Systems	High	Conduct thorough system analysis and plan phased integration	Develop workarounds for incompatible systems	IT Integration Manager
Regulatory Compliance	Medium	Stay updated on regulations and involve legal team	Establish relationships with regulatory bodies for guidance	Legal Compliance Officer
Cultural Change	High	Implement change management program	Identify and empower change champions within the organization	Chief Human Resources Officer
Time Constraints	Medium	Prioritize tasks and consider extending timeline if necessary	Develop accelerated implementation plan for critical components	Project Manager

Criterion	Metric	Weight	Score	Weighted Score
Sustainability Integration	Percentage of sustainability m	0.2	80	16
Renewable Energy Adoption	Percentage of energy from ren	0.15	65	9.75
Long-term Sustainability Alignme	Degree of alignment with indu	0.15	80	0.6
Risk Management	Effectiveness of risk mitigatio	0.1	60	0.3
KPI Adherence	Percentage of relevant KPIs re	0.1	90	9
Long-term Planning	Quality and depth of long-tern	0.1	80	0.4
Social Responsibility	Impact and scope of social res	0.1	80	0.4
Scenario Planning	Robustness of scenario-based	0.1	60	0.3

	responsible_party	risk_level
Resource Allocation	Chief Financial Officer	High
Stakeholder Resistance	Change Management Lead	Medium
Data Availability	Chief Information Officer	High
Technical Expertise	Human Resources Director	Medium
Integration with Existing Systems	IT Integration Manager	High
Regulatory Complia	Legal Compliance Officer	Medium
Cultural Change	Chief Human Resources Officer	High
Time Constraints	Project Manager	Medium

	system	tools	responsible
Sustainability Integration	Sustainability Dashboard	Tableau, Power BI	Sustainability Manager
Renewable Energy Adoption	Energy Management System	Energy Star Portfolio Manager	Energy Efficiency Specialist
Long-term Objective Alignment	Strategic Alignment Tracker	Balanced Scorecard	Chief Sustainability Officer
Risk Management Effectiveness	Risk Dashboard	RiskWatch, Risk Management Software	Risk Management Team Lead
KPI Metrics Adoption	KPI Dashboard	Google Data Studio	Data Analytics Manager
Long-term Planning Integration	Strategic Planning System	Microsoft Project	Strategic Planning Director
Social Responsibility Impact	CSR Impact Tracker	CSRHub, Impact Reporting Software	Corporate Social Responsibility Manager
Scenario Planning Effectiveness	Scenario Planning Tool	WhatIf Analysis Tools	Business Strategy Analyst

Figure 38: Comprehensive KPI metrics developed to incorporate a research framework procurement guideline from CONPS.

Appendix 13

List of additional reference sources, including source codes, technical documents, and procedures.

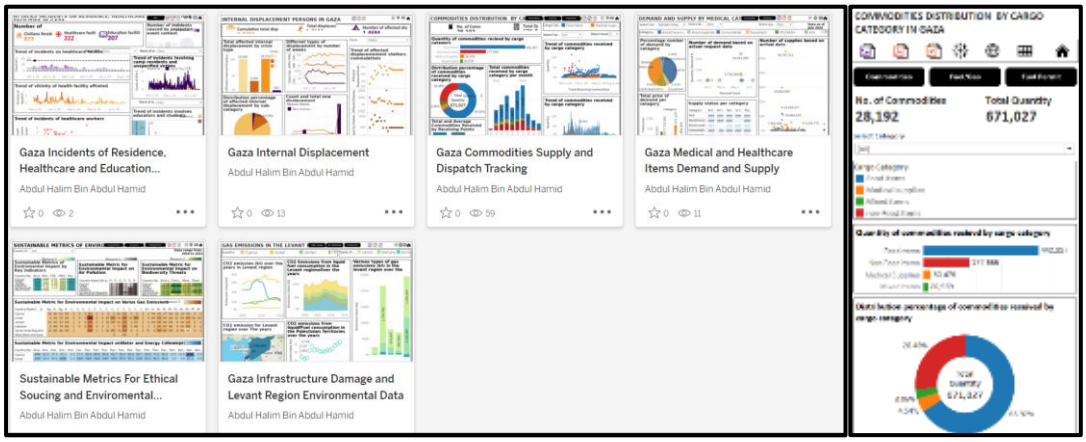
Relevant source and documents can be accessed via the links provided.

Type of Data/documents	Description and access link to the source
Source code	Series of python code developed to produce research result and framework
Operating procedures	Logistics Operating Guidelines CONOPS Procurement Guidelines
Framework	CONOPS Sustainable logistic framework
Framework	CONOPS Monitoring and evaluation framework
Report	UNEP environmental pre-assessment

Appendix 14

List of Interactive Dashboards Published on the Online Platform with User Guide

1. Interactive dashboards available at online platform in Tableau public. Please click here .
2. Dashboard re available in desktop, tablet and mobile version.



3. Navigation steps
   3.1. Click the icon /legend to filter and click again to unfillets

   3.2. Click drop downlist allows to navigate trends

   3.3. Click these buttons to access other dashboards

   3.4. Click these buttons to export the dashboard. The dashboard can be exported as a PDF, image, or PowerPoint file.

   3.5. Click to access the data sources, main dashboard, data owner (contributor), and software provider(s).