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05 TESIS DOCTORAL

INDUSTRIALES

TESIS DOCTORAL

CONVENING GREEN TO HUMANITARIAN LOGISTICS SCENE A COLLABORATIVE RESEARCH APPROACH FOR EMBEDDING ENVIRONMENTAL SUSTAINABILITY IN HUMANITARIAN LOGISTICS

JUNIO 2020

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TESIS DOCTORAL
PARA LA OBTENCIÓN DEL
TÍTULO DE **DOCTOR**

POLITÉCNICA

UNIVERSIDAD POLITÉCNICA DE MADRID
Escuela Técnica Superior de Ingenieros Industriales

Departamento de Ingeniería de Organización,
Administración de Empresas y Estadística

Programa de doctorado:
European Doctorate in Industrial Management

**Convening Green to Humanitarian
Logistics Scene:**
*A Collaborative Research Approach for
Embedding Environmental Sustainability in
Humanitarian Logistics*

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2020

This research was conducted within the framework of the European Doctorate in Industrial Management—EDIM, which is funded by the Education, Audiovisual and Culture Executive Agency (EACEA) of the European Commission under Erasmus Mundus Action 1 programmes.

Disclaimer:

Some parts of this Ph.D. thesis have already been published as:

- Zarei, Mohammad Hossein; Carrasco-Gallego, Ruth; Ronchi, Stefano; 2019. To greener pastures: An action research study on the environmental sustainability of humanitarian supply chains. *International Journal of Operations & Production Management* 39, 1193-1225.
Available online: <https://doi.org/10.1108/IJOPM-12-2018-0703>
- Zarei, Mohammad Hossein; Carrasco-Gallego, Ruth; Ronchi, Stefano; 2019. On the role of regional hubs in the environmental sustainability of humanitarian supply chains. *Sustainable Development* 27, 846-859.
Available online: <https://doi.org/10.1002/sd.194>
- Zarei, Mohammad Hossein; Carrasco-Gallego, Ruth; Ronchi, Stefano; 2019. Integrating Sustainability into Humanitarian Procurement: A Prioritization of Barriers and Enablers, In: Mangla, Sachin Kumar; Luthra, Sunil; Jakhar, Suresh; Kumar, Anil; Rana, Nripendra P. (Eds.), *Sustainable Procurement in Supply Chain Operations*. CRC Press Taylor & Francis Group, Boca Raton, FL, pp. 279-299.

Abstract

Humanitarian supply chains are more expanded and global than ever before. Humanitarian organizations, alongside their development counterparts, work around the clock to satisfy the needs of beneficiaries, whether it is an armed conflict in the Middle East, a refugee crisis in Europe, or an ongoing drought in Africa. Meeting the ever-growing humanitarian needs entails intense logistics operations from procurement, to transportation, warehousing, last-mile distribution, and reverse logistics. These operations contribute to considerable environmental impact. However, environmental sustainability has been overlooked in humanitarian supply chain research hitherto. The objective of this thesis is integrating humanitarian supply chain management with green supply chain management, two streams within the supply chain management literature which have been growing in isolation from one another.

The thesis builds upon the contingency theory and proposes a theoretical underpinning to distinguish the peculiarities of humanitarian environment and investigate how such peculiarities impact on the adoption, customization, and development of green practices. An action research methodology was used in collaboration with an international humanitarian organization and two and a half cycles of collaboration were conducted to integrate environmental sustainability into their supply chains.

The research reveals four key findings. First, it proposes a greening framework that frames the extant green practices in a suitable form for humanitarian organizations. Second, it unearths the barriers and enablers of greening humanitarian supply chains vis-à-vis intra-organizational management, organizational functions such as procurement, funding environment, as well as other stakeholders such as suppliers, other humanitarian organizations, and country offices. Third, it explores the mechanisms through which humanitarian organizations can deal with or benefit from the identified barriers and enablers viz. *i)* improving the visibility of headquarters over delegations through increased presence of staff and employing information and communication technologies to track products during last-mile distribution, *ii)* developing instructions to minimize scavenging during reverse logistics and disposal, *iii)* promoting cooperation among different implementing partners at each country, and *iv)* raising flexible funding and donors' awareness about sustainability, inter alia. Fourth, a carbon footprinting conducted within the action research showed that humanitarian supply chain designs with hubs replenished periodically outperforms the design with perpetual replenishment through direct shipments from suppliers to country offices in terms of global warming potential.

Moreover, the research offers strong practical contributions by implementing action steps for greening humanitarian supply chains and investigating the success or failure of each step. It also makes methodological contributions to action research by identifying the challenges and opportunities for conducting action research in humanitarian supply chain research.

Keywords

Humanitarian Logistics, Humanitarian Supply Chains, Environmental Sustainability, Green Practices, Contingency Theory, Action Research, Collaborative Management Research, AHP, Humanitarian Supply Chain Design, Mixed-Method Research, Procurement Department, Purchasing and Supply Management.

Resumen

La red de suministro humanitaria es más global y extensa que nunca. Las organizaciones de acción humanitaria, junto con sus socios de desarrollo, trabajan las 24 horas para satisfacer las necesidades de las poblaciones afectadas por un desastre, ya sea un conflicto armado en Oriente Medio, una crisis de refugiados en Europa o una sequía en África. Satisfacer la creciente demanda de necesidades humanitarias implica, cada vez más, un aumento de las operaciones logísticas, que parten del aprovisionamiento del producto hasta el transporte, el almacenamiento, la distribución física y la logística inversa. Estas operaciones contribuyen a un impacto ambiental considerable. Sin embargo, la sostenibilidad ambiental no ha estado por el momento en el foco de los investigadores en redes de suministro humanitarias. El objetivo de esta tesis es integrar la cadena de suministro humanitaria con la cadena de suministro ambientalmente sostenible, dos corrientes en la literatura de gestión de cadenas de suministro que han ido evolucionando de manera independiente.

La tesis se basa en la teoría de contingencia y propone un fundamento teórico para identificar las particularidades del contexto humanitario e investigar cómo dichas particularidades impactan en la adopción, personalización y desarrollo de prácticas medioambientalmente positivas. Para ello, se utilizó una metodología de investigación-acción en colaboración con una organización humanitaria internacional y se realizaron dos ciclos y medio de colaboración para integrar la sostenibilidad ambiental en las redes de suministro.

Esta investigación revela cuatro hallazgos clave. En primer lugar, propone un marco conceptual que enmarca las prácticas medioambientales existentes en las organizaciones humanitarias, orientado a facilitar el trabajo en dichas organizaciones. En segundo lugar, identifica las barreras y las palancas facilitadoras para la introducción de criterios medioambientales en las cadenas de suministro humanitarias en relación con la gestión intra-organizacional, las funciones organizativas como el departamento de compras, los donantes y el sistema de financiación, así como con otros grupos de interés, como proveedores, otras organizaciones humanitarias y oficinas en el terreno. En tercer lugar, explora los mecanismos a través de los cuales las organizaciones humanitarias pueden abordar o beneficiarse de las barreras y palancas identificadas, a saber: *i)* mejorando la visibilidad de las sedes sobre las delegaciones a través de una mayor presencia del personal y empleando las tecnologías de información y comunicación para monitorizar el producto en las entregas de última milla, *ii)* desarrollando instrucciones para minimizar residuos en las fases de logística inversa y eliminación de desechos, *iii)* promoviendo la colaboración entre los diferentes socios implementadores en cada país, y *iv)* aumentando la financiación flexible y la concienciación de los donantes sobre la sostenibilidad, entre otros temas. En cuarto lugar, en el marco de este estudio de investigación-acción se realizó un seguimiento de la huella de carbono. Este seguimiento muestra que, en términos del potencial del calentamiento global, un diseño de red de suministro humanitaria con centros de distribución regionales reaprovisionados periódicamente es preferible a un diseño de envíos directos desde los proveedores a las delegaciones en terreno, con un sistema de revisión continua.

Esta investigación ofrece además varias contribuciones prácticas al implementar acciones para la mejora de la sostenibilidad ambiental de las cadenas de suministro humanitarias y para determinar el éxito o fracaso de cada etapa. También realiza contribuciones metodológicas a la investigación-acción, al identificar retos y oportunidades para llevar a cabo ciclos de investigación-acción en la investigación de la red de suministro humanitaria.

Palabras clave

Logística humanitaria, Cadena de suministro humanitaria, Sostenibilidad ambiental, Prácticas medioambientales, Teoría de la Contingencia, Investigación-acción, Investigación Colaborativa en Gestión, Proceso analítico jerárquico (AHP), Diseño de la cadena de suministro humanitaria, Investigación con métodos mixtos, Departamento de Aprovisionamientos, Gestión de compras y suministros.

Acknowledgement

My Ph.D. journey has offered me many learnings and paved the path for my academic career. I would like to thank the people and organizations who contributed to this research academically and finically.

I would like to thank my sponsors at EU and the EDIM scientific committee. I would like to express my special thanks to the procurement team of the humanitarian organization with whom the collaborative research project reported in this thesis was conducted. Thank you for providing the organizational data and involving in this wonderful academic-practitioner collaboration. Also, my profound thanks go to Prof. Paolo Trucco and Prof. Raffaella Cagliano at Politecnico di Milano for their continuous review and feedback throughout the development of this thesis.

Thanks to my fellow PhD students at EDIM community. I have had a great time and learned a lot from Ed, Marin, Shoaib, Simon, Enes, Isaac, Ebru, Claudia, Roya, Sina, Sara, Raul, and all the other EDIMers I have met. A big thanks to Jose for translating the abstract to Spanish.

Lastly, I express my deepest and sincerest thanks to my lovely family who have always encouraged me to go ahead and provided their unconditional support.

Hossein Zarei

Coventry, UK, June 2020

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List of Acronyms

3PL: third-party logistics
AHP: analytic hierarchy process
CMR: collaborative management research
ECOWAS: Economic Community of West African States
HSC: humanitarian supply chain
ICT: information and communication technology
LRRD: linking relief, rehabilitation and development
NGO: non-governmental organization
RQ: research question

Acronyms related to humanitarian organizations:

OCHA: United Nations Office for the Coordination of Humanitarian Affairs
UNDP: United Nations Development Programme
UNEP: United Nations Environment
UNHCR: The UN Refugee Agency
UNHRD: United Nations Humanitarian Response Depots
WFP: World Food Programme
WHO: World Health Organization

CHAPTER 1

Introduction

1.1. Setting the scene

Each year between 300 million and 500 million fall ill from malaria. In the decade since 2000 alone, 1.1 million deaths from malaria were reported. The United Nations has set up a millennium development goal to combat AIDS, Tuberculosis, and Malaria¹. One of the main mechanisms to fight against Malaria, promoted by humanitarian and development organizations, is the distribution of mosquito nets treated with long-lasting insecticides in the regions highly prone to malaria either free of charge or at a subsidized price.

In Kenya, the ministry of health in collaboration with local NGOs have distributed thousands of long-lasting insecticidal nets among the vulnerable population living by the Lake Victoria, an area with high rate of Malaria spread due to suitable natural situation for the breeding of Malaria mosquito². Coming almost free of charge, the poverty-stricken local population found a new usage for the nets; They used the nets for fishing from the lake and local rivers. Even the nets which were put into the right use could found their way for a secondary application; Used and torn mosquito nets were reused as sheets to dry fish under the sun. The misuse of mosquito nets as fishnets or drying sheets releases considerable amount of toxic insecticides into aquatic ecosystem and enters human body through consumption of dried fish. Had this misuse been foreseen or proper collection and reverse logistics plans were devised, the harm could have been avoided to human and animal lives.

Notes:

1. <http://www.unfoundation.org/what-we-do/partners/organizations/the-global-fund.html>

2. Minakawa, N., Dida, G. O., Sonye, G. O., Futami, K. & Kaneko, S. 2008. Unforeseen misuses of bed nets in fishing villages along Lake Victoria. *Malar J*, 7, 165.

The operations of humanitarian and development organizations are expanding in terms of magnitude of operations and the geographic area they cover. From the armed conflicts in Syria and Yemen, to famine, drought, and hunger in Africa, to frequent occurrence of natural disasters all around the world, humanitarian supply chains (HSCs) to help the afflicted societies have never been more immense. The ever-growing size of HSCs involves global supply chain operations to procure, transport, store, and distribute supplies among the impacted communities, known as beneficiaries.

The increased supply chain operations, however, comes at a cost: the increased environmental impact of HSCs. Much of humanitarian transportation is airborne, the most polluting mode of transport, due to the criticality of time. Global HSCs and the products distributed through these supply chains contribute to a considerable environmental impact. Moreover, HSCs are designed with the forward flow of supplies in mind, i.e. movement of material from the upstream of the HSC where suppliers are towards the downstream of the supply chain where beneficiaries receive the supplies. The reverse flow and what happen to supplies *after* they are distributed been majorly disregarded by both humanitarian organizations and researchers. Piles of packaging and plastic waste left in the field after humanitarian missions, waste management crisis in humanitarian fields and refugee camps, misuse of humanitarian products at their end-of-life for secondary purposes, scavenging of expired products and selling them in black markets are just some of the examples that overlooking environmental sustainability in HSCs can cause.

Past antecedents of humanitarian operations such as the largest outbreak of cholera in recent history in Haiti due to failure in meeting waste treatment standards by humanitarian organizations, over-provisioning of fishing boats and the consequent fishing stock depletion in humanitarian recovery operations in post-tsunami Sri Lanka, and the example of long-lasting insecticidal nets in Kenya mentioned in the opening of this chapter, together with the emissions emanated from humanitarian fleet are all real-world exemplars that suggest environmental sustainability shall be put in the foreground of HSC research. In light of such infamous antecedents and the dearth of research in the HSC literature on environmental sustainability, scholars have emphasized the need for future research on the sustainability of HSCs.

1.2. Objective and Scope of Thesis

The objective of this thesis is investigating environmental sustainability in HSCs and exploring how it can be incorporated into the volatile HSC context, moving the discourse in HSC literature to a new paradigm: *green HSC*. As such, the thesis aims to identify the specificities of HSC that hinder or facilitate the application of practices from green supply chain management. It scrutinizes how green practices should be customized or developed to cope with the identified specificities. Furthermore, a higher objective, less common in academic research, is to implement the customized green practices in real-world humanitarian field and report on the success or failure of the implementation.

The literature of HSC involves two different type of operations: disaster relief and development programs (Pedraza-Martinez and Van Wassenhove, 2016). These two types of operations are different in many aspects: their origins, the organizational focus (humanitarian organizations versus development organizations), and other characteristics of operations such as time criticality and length of operations.

The scope of this thesis, in line with seminal studies in the literature of HSC (see for example, Pedraza-Martinez and Van Wassenhove (2016), Jahre et al. (2016)) includes both types of operations collectively. As the borderlines between these two types of operations is blurring and humanitarian organizations carry out *mixed* operations, this thesis postulates that taking an integrated view contributes to the objective in achieving green HSC. The thesis takes the focal humanitarian organization as the key decision maker and orchestrator of HSC. It approaches the problem from the perspective of the headquarters and investigates how the decisions made at headquarters impact on the overall HSC. Moreover, taking the triple bottom line of sustainability (Elkington, 1998), the key focus of the thesis is on the environmental pillar and how to mainstream it in HSCs. However, the thesis also makes descent contributions to social sustainability by highlighting issues such as local procurement which leads to local community empowerment and employment.

1.3. Research Questions

The thesis attends to the overarching research question as stated in the following.

RQ: How can environmental sustainability be incorporated in HSCs?

This research question is broken down into the following four sub-research questions. The research questions are reiterated at the end of Chapter 2, where they are linked to gaps identified from the survey of literature.

1. *What is the status quo of environmental sustainability in HSC research?*
2. *What are the main causes that negatively contribute to the environmental sustainability of HSCs?*
3. *How can extant green practices in commercial supply chains be suitably framed for HSC context?*
4. *What are the specificities of humanitarian context that impact on implementing green practices in HSCs?*
5. *How can humanitarian organizations adopt/customize/develop green practices to cope with the identified specificities and green their supply chains?*
6. *What are the considerations at supply chain design level (e.g. supply chain configuration) and at functional level (e.g. procurement function) for environmental sustainability of HSCs?*

1.4. The Structure of the Thesis

This thesis is organized as follows. Chapter 1 (current chapter) has set the scene for the thesis by highlighting the importance of environmental sustainability in HSCs and why research should focus on the topic of green HSC. It explained the objective and scope of thesis, resulting in an overarching research questions and a set of sub-research questions.

Chapter 2 is devoted to the survey of literature and responds the first research question about the status quo of sustainability in HSC research. It starts from the history and emergence of HSC research and how it differs from commercial and traditional supply chains. It scrutinizes the issues related to the environmental sustainability of HSCs by providing real-world examples and experiences. Then, it identifies and critically reviews the dominant themes in the literature of HSC. Each theme is reviewed in-depth using a thorough narrative literature review. The review of literature unearths a set of gaps for each theme. These gaps are then linked to the objective and research questions of this thesis. Finally, it reiterates the research questions and discusses the interconnection and imperativeness of each research question to bridge the identified research gaps.

Chapter 3 lays the grounds for the theoretical underpinning of the thesis. It starts from analyzing different theoretical lenses which can satisfy the research objective of the thesis and illustrates why contingency theory fits best to serve the purpose. Then, it identifies the main contextual and organizational factors that can impact on developing, adopting, or customizing green practices for HSCs. Based on that, it develops a theoretical underpinning which makes a fit between organizational and contextual contingency factors as independent variables and green practices as the response variable.

Chapter 4 introduces and explains the methodology of the thesis. It starts from setting the differences between mode 1 versus mode 2 knowledge creation and how different action research methodologies fit for mode 2 knowledge creation. Then, *collaborative management research* as a method in the family of action research methodology is introduced and explained. The appropriateness of action research for this research is explored and justified from different perspectives. Next, other quantitative and qualitative methods used in the thesis, namely, concept-centric literature review, mixed-methods research, focus group, analytic hierarchy process, cause and effect diagram, and carbon footprinting, are described. Finally, the measures taken to ensure methodological quality and rigor are discussed.

Chapter 5, 6, and 7 present the results of the thesis. Chapter 5 presents the action research study, cycles of collaboration, and the findings for the whole HSC. Chapter 6 explores causes of unsustainable HSC and focuses on supply chain configuration as the direct cause. It conducts carbon footprinting for three supply chain configuration scenarios and compares the results. Chapter 7 draws the attention to procurement as the entry point of material into HSC and investigates mainstreaming sustainability in humanitarian procurement by identifying and prioritizing the barriers and enablers of sustainable procurement.

Chapter 8 wraps up the thesis by summarizing the findings of the study and putting forward several propositions. It then provides theoretical, practical and methodological contributions of the research and presents research limitations and future research directions.

The appendix at the end of the thesis introduces the scientific outputs of this Ph.D. thesis. It gives a brief summary of each paper and the outlets in which the papers are published.

Figure 1 illustrates the research flow and presents how each result chapter (Chapters 5, 6, and 7) contributes to address the research questions of this research.

Figure 1: Research flow and contribution of each result chapter to the research questions

CHAPTER 2

Literature Review

This chapter responds to the first research question about the status quo of sustainability in HSC research. It reviews the literature of humanitarian logistics and supply chains to identify the overriding trends and topics of research within the field. Different streams within HSC literature are identified and reviewed in depth. Based on the review, the gaps in the literature that motivate this research are identified. Finally, the research questions to bridge the gaps are presented.

2.1. Humanitarian Supply Chain (HSC) Research: Origins and Evolution

With the increasing trend in natural and manmade disasters and the growing global need to long-term development support, disaster relief and development operations have never been more important. At the heart of humanitarian assistance, is the timely procurement and provisioning of aid to the afflicted population, referred to as *beneficiaries*. Humanitarian supply chain and logistics¹ operations are important not only due to their critical role, but also because of the costs they require. The lion's share of humanitarian aid is related to the supply chain operations involving supply, inventory, transportation, and distribution of aid items, constituting about 80 percent of the whole humanitarian aid costs (Van Wassenhove, 2006). Therefore, the success of any humanitarian organization is directly related to efficient and effective management of its supply chain.

While HSCs share some similarities with commercial supply chains, they are fundamentally different in some key aspects. Kunz et al. (2017) summarize the key differences which are as follows. The objective of HSCs is alleviating the suffering of vulnerable people while commercial supply chains are aimed at maximizing the profit.

¹ In this thesis the terms *humanitarian logistics* and *humanitarian supply chain* are used interchangeably. Oftentimes, the term *humanitarian supply chain* in the abbreviated form of *HSC* is used as an overarching term to denote all the operations within a humanitarian supply chain, not only confined to the physical movement of goods.

HSCs are associated with unpredictability of timing, location, and the severity of next disaster. Due to the unpredictability, HSCs are subject to high time pressure and every hour counts in saving the lives of beneficiaries. Moreover, damaged transportation and telecommunication infrastructure by the disaster compounds the previous challenges. Finally, the beneficiaries in HSCs normally do not have a strong voice to state their needs.

Humanitarian logistics is defined as “*the process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials, as well as related information, from the point of origin to the point of consumption for the purpose of alleviating the suffering of vulnerable people*” (Thomas and Kopczak, 2005, p. 2). Taking a disaster cycle view, the academic literature classifies HSCs into disaster relief and development programs (Pedraza-Martinez and Van Wassenhove, 2016, Holguín-Veras et al., 2012a). In practice, although humanitarian organizations have emerged from different roots as compared to development organization, the borders between these two types of operations is increasingly blurring and humanitarian organizations are moving towards an *operational mix* (Besiou et al., 2014). In keeping with literature and practice, in this thesis, HSC is considered as both disaster relief and development programs.

The attention to HSC research has been increasingly gaining momentum in the past decades. Especially, after 2010 Haiti earthquake and 2011 Japanese tsunami and earthquake, the number of publications has increased exponentially. Inception of a new journal specifically devoted to the field *Journal of Humanitarian Logistics & Supply Chain Management* and special issues in top operations management and supply chain journals such as *Journal of Operations Management*, *International Journal of Production Economics*, *Annals of Operations Research*, and *International Journal of Physical Distribution & Logistics Management*, inter alia, shows the increasing attention devoted to the HSC as a burgeoning field within supply chain management research. Currently, the highest-ranked journals in the field of operations and supply chain management such as *Journal of Operations Management* and *Production and Operations Management* established an editorial department devoted to HSC and disaster relief research.

Another indicative of increased attention to HSC research is the collective number of articles and literature reviews published on HSC. Literature reviews articles on HSC increasingly appear in operations and supply chain management top journals, implying the interest of editorial board and wider community of researchers into the topic. Table 1 summarizes some of the literature review articles on HSC and the scope of their review in order of publication date. Figure 2, adopted from the recent literature review of Behl and Dutta (2019), denotes the steep increase in the number of HSC journal articles published between 2011 and 2017.

Table 1: Literature review articles on HSCs

Author(s) and year	Journal	Scope of review
Overstreet et al. (2011)	<i>Journal of Humanitarian Logistics & Supply Chain Management</i>	HSC research
Kunz and Reiner (2012)	<i>Journal of Humanitarian Logistics & Supply Chain Management</i>	HSC research
Leiras et al. (2014)	<i>Journal of Humanitarian Logistics & Supply Chain Management</i>	HSC research
Habib et al. (2016)	<i>Mathematical Problems in Engineering</i>	Mathematical modeling in HSCs
Jahre (2017)	<i>Journal of Humanitarian Logistics & Supply Chain Management</i>	Review of how humanitarian actors mitigate supply chain risk by using different supply chain strategies
Ahmadi-Javid et al. (2017)	<i>Computers & Operations Research</i>	Review of healthcare facility problem in HSCs
Banomyong et al. (2017)	<i>Annals of Operations Research</i>	HSC research
Behl and Dutta (2019)	<i>Annals of Operations Research</i>	HSC research
(Grange et al., 2019)	<i>Journal of Humanitarian Logistics & Supply Chain Management</i>	Systematic literature review on the evolvement of coordination in HSCs
Agarwal et al. (2019)	<i>Benchmarking: An International Journal</i>	Review of HSC management frameworks
Chiappetta Jabbour et al. (2019)	<i>Annals of Operations Research</i>	HSC research
Sharma and Joshi (2019)	<i>Journal of Humanitarian Logistics & Supply Chain Management</i>	Literature review of big data application for HSC
Gupta et al. (2019)	<i>Annals of Operations Research</i>	Literature review of big data application for HSC
Mishra et al. (2019)	<i>Annals of Operations Research</i>	Literature review of simulation modelling research in disaster relief
Fosso Wamba (2020)	<i>Annals of Operations Research</i>	Bibliometric analysis of HSC research
Sabbaghtorkan et al. (2020)	<i>European Journal of Operational Research</i>	Review of prepositioning assets and supplies in disaster operations management

Figure 2: The increasing trend in the number of journal articles on HSCs between 2011 and 2017

Source: Behl and Dutta (2019)

2.2. Identifying Dominant Themes in HSC Research

Since emergence, the field of HSC has covered a plethora of topics, some of which borrowed from the wider field of supply chain management, operations management, or management science, whereas some other topics emerged from HSC practice due to its specific nature and requirements. Topics such as logistics management or supply chain performance measurement have been adopted from the parent fields and widely used and customized for HSC context. Application of optimization methods to improve the efficiency of humanitarian operations has been widely covered by operations research journals such as *Annals of Operations Research* and *Production and Operations Management*. On the other hand, some themes such as swift trust (Dubey et al., 2019, Lu et al., 2018, Tatham and Kovács, 2010) or disaster phase view studies (Van Wassenhove and Pedraza Martinez, 2012) have emerged from the intrinsic characteristics of HSCs.

The review of Behl and Dutta (2019) identifies 10 prominent themes in HSC research. Moreover, the study of Chiappetta Jabbour et al. (2019) develops a conceptual map consisting of five main streams of literature in HSC research. Building upon these two seminal reviews, 11 themes were extracted as the dominant themes and trends in HSC research, as shown in the following. Theme 1, HSC literature review studies, has already been covered in Table 1. The rest of themes, excluding theme 5, 9, and 10 (which are not relevant to the topic of this thesis) will be reviewed in the following subsections.

1. Literature review studies
2. Disaster phase studies
3. Shift from disaster relief to HSC management
4. Procurement, transportation and inventory management
5. Supply chain resilience

6. Information technology (IT)-related studies
7. Mathematical modeling and optimization
8. Theoretical and methodological studies
9. Performance measurement
10. Big data analytics
11. Coordination and collaboration

2.2.1. Disaster phases and shifting from relief to HSC management

HSC literature distinguishes between different phases of disaster. Different categorizations of phases are offered in the literature, all of which build the phasing on the timing of operations and whether they are carried out before, during, or after the disaster (Kovács and Spens, 2009). Van Wassenhove (2006) suggests considering a minimal distinction between preparation and post-disaster phases would help in better understanding of HSC. Other studies such as Altay and Green (2006) propose a more detailed categorization, including mitigation, preparedness, response, and recovery.

The seminal study of Van Wassenhove and Pedraza Martinez (2012) suggested a more comprehensive categorization of phases which includes almost similar phases as Altay and Green (2006). In addition, they related the phases to development programs and disaster relief operations. They offered a disaster management lifecycle which includes mitigation, preparedness, response, and rehabilitation (see Figure 3). Out of these, mitigation and rehabilitation pertain to development programs, whereas preparedness and response are relief operations. In this thesis, the proposed phases by Van Wassenhove and Pedraza Martinez (2012) is used due to the comprehensiveness.

Figure 3: Disaster management lifecycle

Source: Van Wassenhove and Pedraza Martinez (2012)

Each phase of disaster requires specific type of operations and contains peculiar challenges. For example, in response phase, the speed of operations is the most critical in

delivering aid products, whereas in preparedness the focus may be given to cost-effectiveness. To this end, some studies in HSC literature consider only specific phases of disaster life cycle to address HSC problems. Eftekhari et al. (2014) investigated optimal policy for humanitarian fleet procurement in development program, i.e. mitigation and rehabilitation. Rezaei-Malek et al. (2016) investigated the location-allocation problem of perishable humanitarian products only at preparedness phase. Kunz and Gold (2017) studied sustainability of HSCs only in post-disaster rehabilitation phase. Their study has relevant findings to the objective of this thesis and will be discussed further in this chapter.

Some other studies considered the whole disaster life cycle, but analyzed the problem under investigation separately for each phase of the disaster life cycle. Stauffer et al. (2016) studied building hubs for humanitarian fleet throughout the disaster lifecycle and found out that centralized hub configuration supported by temporary hubs mega disaster locations best satisfies the needs of development programs and disaster relief simultaneously. More recently, Falagara Sigala and Wakolbinger (2019) analyzed outsourcing logistics services in HSCs to logistics providers and concluded the outsourcing process in HSCs is highly influenced by the phase of disaster in terms of *a)* incentives to initiate outsourcing, *b)* partner selection criteria, and *c)* activities to be outsourced.

By and large, successful humanitarian operations should include both pre- and post-disaster phases. Mitigation and preparedness play a vital role in reducing disaster risk and expected impact. Without proper mitigation and preparedness operations such as *prepositioning* humanitarian inventory (Rezaei-Malek et al., 2016) close to disaster-prone areas, quick and efficient response would be almost impossible. Similarly, rehabilitation is a key phase that helps the affected community stand on its own feet again. Upon completing *first emergency response* and initial stabilizing the situation, many humanitarian organizations leave the region, leaving the rehabilitation to local communities and government.

These issues lead to another important theme in HSC research; transitioning from relief to HSC. Adopting a disaster cycle view helps to see the whole picture, but the transition is far from reality both in research and practice. Humanitarian practitioners often address the issue as *linking relief, rehabilitation and development* (LRRD). This has been on the international agenda for decades; yet, there are barriers on making the link. One main barrier is that the mandate of humanitarian organizations define which phase of disaster they should involve (Kovács and Spens, 2009). Some organizations such as World Food Programme (WFP) are mandated to involve in immediate emergency response, whereas some other organizations such as United Nations Development Programme (UNDP) operate mostly in development context. Moreover, with occurrence of a disaster and early emergency response being at the center of attention, less media exposure is given to pre- and post-disaster phases. Donors are also willing to fund more emergency response and development ongoing operations often receive less funding.

The literature of HSC includes studies that address LRRD and tackle these challenges. The findings of Bealt and Mansouri (2018) suggest that local collaborative aid networks, which is founded in local community participation, can provide a long-term approach to disaster management. Such approaches continue long after emergency response and have the capability to mitigate the challenges associated LRRD. Lai et al. (2015) addressed LRRD for sanitation system of a Muslim community by developing frameworks about latrine design, human waste treatment, sanitation promotion strategy, and ecological services for sanitation services. Crisp (2001) reviewed United Nations High Commissioner for Refugees (UNHCR) programs to link refugee and returnee assistance to long-term development programs and criticized UNHCR for conceptual and practical flaws in its LRRD within the refugees' context.

Despite the efforts made in research and practice to transition from disaster response to wider HSC, the research is heavily skewed towards single response phase view. Little interest exists in ongoing humanitarian operations such as development programs and few studies focus on phases other than response such as rehabilitation (Kunz and Reiner, 2012). This gap in HSC research calls for studies that include a more holistic view of the disaster lifecycle. With the borders between disaster relief and development programs increasingly blurring, scholar need to account for both operations and their interrelationships. Besiou et al. (2014) have referred to the joint consideration of development programs and disaster relief as *operational mix* and encouraged moving towards a coupled perspective in future HSC research; a call that was responded in seminal studies such as Jahre et al. (2016) and Stauffer et al. (2016). By the same token, this thesis addresses its research objectives while adopting a joint slant.

2.2.2. Procurement, transportation, and inventory management

Procurement, transportation, and inventory management are at core of HSC to a facilitate effective, efficient, and timely response. A large body of HSC literature is devoted to studies related to procurement, inventory and warehouse management, and transportation and delivery of humanitarian goods. Starting from procurement, the body of knowledge on humanitarian purchasing and procurement is growing rapidly. Two reasons support the growth; firstly, there is a mature body of literature formed around purchasing and supply management in commercial supply chains, which share some similarities with humanitarian procurement (Lamenza Arthur Abreu da et al., 2019). These similarities allow adoption of commercial procurement learnings for humanitarian context. Secondly, since humanitarian items are largely procured before the strike of disaster, time-pressure is less and room for improvement opportunity is more, as compared to the response phase. Since purchasing and supply management is a key focus of this thesis, the literature on procurement in HSC is scrutinized in more detail in the following.

The first stream of procurement adopts concepts from commercial supply management literature such as purchasing models and frameworks regarding purchasing strategy, bidding, and contracting for humanitarian setting. Lamenza Arthur Abreu da et al. (2019) have developed the well-known purchasing portfolio matrix, also known as Kraljic

matrix, for application in humanitarian procurement and showed that it is a useful tool to adopt appropriate humanitarian purchasing strategies. Other studies in humanitarian procurement investigate improving the bidding and contracting processes. Falasca and Zobel (2011) suggested a two-stage procurement decision model to tackle the uncertainty of disaster relief operations. Ertem et al. (2010) proposed a procurement auctions-based framework for humanitarian procurement which involved announcement, construction, and evaluation of bids. Later, they developed their study in Ertem et al. (2012) and focused on the announcement phase of their framework. They introduced substitution and partial fulfillment options to diversify suppliers and include suppliers with fewer inventories. Bagchi et al. (2011) proposed an auction mechanism for supplying food in emergencies that decreased the possibility of gaming through a uniform price option. Their mechanism led to higher participation of actors and increased delivered food aid volumes. Trestrail et al. (2009) developed a mixed-integer program decision tool to enhance ocean carrier and food supplier bid pricing strategy. Finally, Balcik and Ak (2014) modeled the supplier selection problem for a humanitarian organization with framework agreements. Their findings reveal that the supplier selection and subsequent costs are sensitive to contract agreement terms in situations with high-impact disasters.

Another stream of literature on humanitarian procurement focuses on inter-organizational cooperation for purchasing humanitarian items. Vaillancourt (2017) studied the procurement consolidation in HSCs and concluded that inter-organizational collaboration for consolidated purchasing leads to reduced costs and higher quality of procured items. Herlin and Pazirandeh (2012) studied the impact of nonprofit and humanitarian organizations on shaping the market and the dominance over suppliers. Later, in Herlin and Pazirandeh (2015), they expanded their previous study and developed a framework for successful cooperative purchasing. Interestingly, they also addressed the pitfalls that might impede cooperative inter-organizational purchasing in humanitarian context. In another study (Pazirandeh and Herlin, 2014), they approached the cooperative purchasing from the buyer's perspective and studied how cooperative purchasing impacts on buyer's purchasing power. The study generated insights about the reasons that cooperative purchasing might fail due to inappropriate procurement strategy. More recently, Nikkhoo et al. (2018) addressed the issue of coordination of relief items procurement through a quantity flexibility contract in multi-echelon HSC. Their proposed model decreases losses of relief procurement and improves the satisfaction level of the affected area.

The third stream of procurement focuses on sustainable procurement. This stream, although limited, is growing rapidly. Most of the works in this stream address the social pillar of sustainability, especially through ethical procurement. Schultz and Søreide (2008) delved into the problem of corruption in humanitarian emergency procurement. Their study revealed that internal agency control mechanisms, conflict-sensitive management, and the need for common systems among operators can be appropriate mechanisms to prevent corruption. The study of Wild and Zhou (2011) explicated ethical procurement strategies for humanitarian aid organizations. The results of their study expressed that concerns about ethical risks in HSCs are different from commercial ones. Van Kempen et al. (2017) considered all aspects of sustainability in humanitarian

procurement. They conducted life cycle sustainability assessment to compare different humanitarian procurement strategies in terms of sustainability. Their results show that local sourcing is more environmentally and socially sustainable than international sourcing.

The fourth stream of procurement is local sourcing in HSCs. The study of Matopoulos et al. (2014) and more recently Piotrowicz (2018) investigated and proposed deploying local sourcing in HSCs. Matopoulos et al. (2014) deployed a resource-based view of the firm to investigate the resources required for local and global procurement strategies. The study empirically showed that local resources has a positive effect on the overall HSC performance. However, persistent challenges concerning scarcity of local resources may hinder the success of local sourcing. Similarly, the findings of Piotrowicz (2018) supported implementation of local procurement in middle-income urbanized humanitarian settings, where infrastructures and operational markets exist. The results of Van Kempen et al. (2017), as mentioned above, also advocated local sourcing in humanitarian context and showed its favorability in terms of environmental and social impact.

In addition to the four streams of procurement reviewed, other topics covered by previous research on humanitarian procurement are: e-procurement (Walker and Brammer, 2012), advanced purchasing and prepositioning of relief items (Duran et al., 2013), joint procurement and inventory decision (Hu et al., 2017, Torabi et al., 2018), supplier partner selection (Venkatesh et al., 2018), and the role of power in supplier-buyer relationship in humanitarian setting (Siawsh et al., 2019).

Next, inventory and warehouse management in HSC is a pivotal operation. A common practice is procuring humanitarian items prior to occurrence of a disaster and prepositioning them close to disaster-prone areas. Since in prepositioning humanitarian items, purchasing and storage are two consecutive operations, most of papers (for example, Duran et al. (2013), Hu et al. (2017), Torabi et al. (2018), as reviewed earlier) address them simultaneously. Balcik et al. (2016) have conducted a comprehensive literature review on humanitarian inventory management. They classified the literature based on disaster cycle view, showing what are the main objectives and scope of studies in pre- and post-disaster situations. Their findings indicate that most of inventory management studies in HSC use mathematical modeling approaches. In addition, minimizing the cost is found the main objective both in pre- and post-disaster inventory studies, with pre-disaster studies focusing on prepositioning of inventories in critical locations. The basic questions of where/when/how much to store are prominent concerns in HSC context that may not be directly answered using existing inventory models in commercial supply chains and hence, developing humanitarian-specific inventory models and empirical studies are encouraged.

Two comprehensive literature review articles on humanitarian inventory have recently appeared in leading operations research journals. The first one, Sabbaghtorkan et al. (2020), conducts a systematic literature review on prepositioned inventories and classifies extant literature to three classes of location, allocation, and location-allocation studies.

The second article by Ye et al. (2019) aims to identify the gaps between research and practice of humanitarian inventory management. The article develops a framework which accounts for *who* responds to disaster relief inventory calling, *where* to locate the inventory, and *how* to control it. Based on the review of the literature, it expresses that sustainability issues in humanitarian inventory management is a gap between humanitarian research and practice which should be filled by future research. In practice, some wide-scope measures have been taken to efficiently and effectively manage humanitarian inventory. Among others, The United Nations Humanitarian Response Depot (UNHRD) are large storage spaces in strategic locations around the globe which hold prepositioned inventory. Humanitarian organizations can avail of these depots to store their inventories to be used in upcoming disasters.

Finally, transportation in HSCs involve the movement of goods and resources from the upstream of supply chain where suppliers are located, to international and local inventories, reaching to beneficiaries in the downstream of the supply chain through last-mile delivery. Excessive transportation activities throughout an HSC require deploying different means of transport. Ertem et al. (2017) reviewed transportation articles in HSCs and developed matrixes involving disaster type/phase and transportation mode. Their review show that most of humanitarian transportation is carried out via road. Moreover, multimodal transport in HSCs is a common practice, yet, it has not received enough attention from researchers and practitioners. Gralla and Goentzel (2018) investigated humanitarian transportation planning and expressed that using heuristic approaches facilitates more efficient planning and prioritization of vehicles to transport humanitarian aid to affected areas. Shavarani and Vizvari (2018) stated that, in an HSC, not only transportation of aid items is important, but also transportation of injured people is a critical issue which requires attention from scholars. They developed and tested a genetic algorithm approach for transporting high number of seriously injured people following a disaster.

Many of transportation-related studies investigated the last leg of humanitarian transportation, known as last-mile delivery or last-mile distribution, as a topic where most challenges exist. Balcik et al. (2008) was among the pioneers of studying last-mile distribution. They developed a mixed integer programming model to determine the delivery schedule and routes between local distribution centers and beneficiaries. Battini et al. (2014a) extended routing model from commercial logistics to last-mile humanitarian delivery and investigated total distribution cost and shortages. More recent studies of last-mile delivery focused on pressing humanitarian issues and novel methods. Material convergence is the movement of humanitarian supplies from donors to distribution centers, which presents various challenges such as bottlenecks due to stock pileup. Suzuki (2019) studied the impact of material convergence on last-mile delivery and showed how choosing the right material convergence strategy can contribute to the effectiveness of last-mile delivery. Rabta et al. (2018) investigate the use of unmanned aerial vehicles, also known as drones, for last-mile delivery in disaster-affected areas with damaged road infrastructure. Their study found that drones can be very effective to

deliver multiple packages of light-weight relief items such as vaccine and water purification tablets to remote or inaccessible areas.

2.2.3. Information and communication technologies (ICT)-related studies

One of the main inherent differences of HSCs as compared to their commercial counterparts is that the needs of beneficiaries are not known, they do not have a voice to state their needs, and more critically, it is not possible to assess the real demand due to time shortage and humanitarian field characteristics such as accessibility (Kunz et al., 2017). ICT can be a promising tool in HSCs to address these challenges. Prompt and transparent information shared throughout HSC offers visibility to supply chain managers and facilitates making timely decisions in situations where every second counts. Pamukcu and Balcik (2019) proposed numerical solutions for multi-cover routing problem to plan rapid needs assessment under different information-sharing settings. They showed that the time of operations is critically dependent on the availability of ICT in post-disaster setting for rapid needs assessment.

Other emerging technologies such as blockchain and concepts such as big data can be applied to humanitarian context to increase the efficiency and improving the visibility of HSCs. Sharma and Joshi (2019) reviewed the literature to find the challenges of using big data in humanitarian logistics. They highlighted the benefits while also warned about the challenges of digital humanitarianism for relief operations. Baharmand and Comes (2019) explored partnership with logistics service providers using blockchain technologies. Their results reveal blockchain-based smart contracts can facilitate automation, transparency, and efficiency in partnership with logistics service providers, especially when trust between parties is low and swift trust is required. They identified the barriers and challenges of utilizing blockchain for smart contracts with logistics service providers.

2.2.4. Mathematical modeling and optimization

Mathematical modeling and optimization studies constitute a large part of humanitarian logistics literature. Various optimization numerical techniques have been used by different scholars to identify the best value for the variables under scrutiny. Habib et al. (2016) conducted a comprehensive literature review on mathematical models in HSCs and classified the extant studies into three categories: facility location, network design and relief distribution, and mass evacuation.

Facility location problem, often accompanies by allocation assignment, is by far the most investigated problem in the literature. The objective functions for the facility location studies are mainly minimization of operations and setup costs, minimization of unsatisfied demand, minimization of distance travelled to and from facility, and minimization of stock shortages. The study of Balcik and Beamon (2008) is the most cited article about facility location HSCs. They developed and applied a model to determine the number and location of distribution centers as well as the amount of relief supplies to be stored at each centre to maximize meeting beneficiaries' needs considering

budgetary and capacity constraints. Ahmadi-Javid et al. (2017) conducted a thorough review on healthcare facility location problem in HSCs and highlighted research gaps for future research.

Network design, similar to facility location, have been heavily investigated by many studies with little variation in HSC literature. Widely used constraints in the modeling are transportation capacity constraint, fleet composition, and number of depots. By and large, the objective functions target maximizing the responsiveness and cost efficiency. Tofighi et al. (2016) is the highest cited article on network design. Based on a possibilistic-stochastic programming approach, they addressed a two-echelon humanitarian logistics network problem which includes multiple warehouses and distribution centers.

Thirdly, mass evacuation of beneficiaries and injured people during disaster has received considerable attention from operations research scholars. It has been investigated from three main perspectives: modeling evacuation transport, urban area evacuation planning, and no-notice (or short-notice) evacuation modeling. The majority of literature falls within the first class focusing on public transport for evacuation. For example, Swamy et al. (2017) proposed a transit planning framework using public transport for hurricane evacuation of car-less people using simulation approaches. It is noteworthy that since many mathematical models were not empirically tested, use of simulation approaches is widespread for simulate real-world situations and test the applicability of developed models. Readers are directed to the literature review of Mishra et al. (2019) on the current trends in disaster management simulation modelling research.

2.2.5. Theoretical and methodological studies

HSC is an applied field of research and as such, it has been criticized for limited theory development and excessive theory borrowing from other fields (Tabaklar et al., 2015). Most of the borrowed theories are similar to the theories applied in the field of supply chain management, solidifying HSCs as a primarily supply chain field. Limited theory development and high level of theory borrowing indicate that HSC research is still at its early stages of development. Most research papers on HSC started to appear on late 90s and early 2000s, and even then, the field suffered from studies with lack of theoretical foundations. Within the past two decades, however, the quality and quantity of research output turned the tides. Devoted journals such as *Journal of Humanitarian Logistics & Supply Chain Management* have emerged, and other high-impact journals in operations management and supply chain management have started to disseminate HSC research with stronger theoretical focus. Use of theories and frameworks have been steadily rising, from 17 percent of articles including a theory or framework in 1995-1999 to 51 percent in 2010-2014 (Tabaklar et al., 2015).

Hitherto, most studies have used middle-range theories such as inventory control theory, systems theory, stakeholder theory and resource-based view, with limited applications of grand theories, grounded theory, and theory development (Tabaklar et al., 2015). Oloruntoba et al. (2019) expressed that theory development through combining,

contrasting, and extending current theories is vital to developing managerial insight as well as deepening scholars' understanding of complex issues in HSC research. Specifically, they found that humanitarian operations have not been explored through the lens of internationalization, behavioral, or organizational theories. Thus, they proposed and showcased theories to fill the theoretical gap in these categories: *i)* internationalization, illustrated by internationalization theory, *ii)* behavioral, illustrated by social exchange theory, and *iii)* organizational economics, illustrated by transaction cost theory. In the same vein, Glenn Richey (2009) developed an eclectic theoretical framework for disaster and crisis logistics. He integrated four major existing theoretical perspectives to for grounding future HSC research. The framework was a pyramid which was built upon resource-based view of the firm, communication theory, competing values theory, and relationship management theory. He encouraged authors to conduct more theoretically founded research using different organizational and management theories to advance the field of HSC research. Chapter 3 further explores different theories in HSC research and elaborates the suitable theoretical underpinnings to satisfy the research objectives of this thesis.

Another theoretical gap in HSC research is that most theoretical models and frameworks are used in disaster response phase, with little theoretical focus drawn to preparedness and specifically reconstruction phase (Tabaklar et al., 2015). This is in line with the trend identified in section 2.2.1 about disaster cycle and the number of studies pertaining to each phase of disaster. Therefore, theoretical studies are needed that consider all phases of disaster cycle and both types of operations in HSCs, i.e. disaster relief (preparedness and response) and development programs (mitigation and reconstruction) (Van Wassenhove and Pedraza Martinez, 2012). The importance of holistic look toward disaster life cycle and the need for theory building for all phases of disaster have been resonated through concepts such as LRRD and operational mix, as discussed in section 2.2.1.

Coming to methodologies used in HSC research, the field has seen application of diverse methodologies. However, the following impediments restrict the access of researchers to humanitarian data (Kovacs et al., 2019).

- Difficulty of access to disaster and conflict zones, and even after access, the difficulties of data collection due to damaged roads, transport systems, and telecommunication
- Rapid obsolescence of data and the fickle state of humanitarian context
- Ethical concern about data collection from vulnerable people
- Security concerns
- Lower response rate of humanitarian organizations as compared to other sectors

These hurdles, among others, encourage researchers to use secondary data accessible from humanitarian organizations' websites and organizational reports. The commitment of humanitarian organizations to funders, governments, and society to publish their performance reports further supports use of secondary data for HSC research. Although specific measures have been proposed to increase the quality of secondary data and big

data collected from humanitarian repositories (see for example, Gupta et al. (2019)), the field requires innovative methodologies to tackle the aforementioned challenges. That is why recently *Journal of Humanitarian Logistics & Supply Chain Management* published a special issue on research methods in HSC, where the editors highlighted the need for innovative methods in HSC research (Kovacs et al., 2019). The special issue introduces and illustrated the applications of some of such innovative methodologies, namely social network analysis (Tacheva and Simpson, 2019), quantitative content analysis (Kunz, 2019), Delphi method (Gossler et al., 2019), gaming (Lukosch and Comes, 2019), and collaborative research (Sabri et al., 2019).

A dire need for HSC research is using methodologies which are collaboratively conducted by humanitarian researchers and practitioners. The field suffers from dearth of collaborative and empirically-based research as “*researchers tend to shy away from implementation*” (Kovács and Spens, 2011, p. 41) due to the inherent challenges of the humanitarian context. Adopting methodologies with weak empirical links have resulted in abundance of conceptual models with low practical relevance (Pedraza-Martinez and Van Wassenhove, 2016). Kunz et al. (2017) postulated that the increasing number of publications in HSC has not resulted in a proportional impact on practice. They suggested that future research should include partnerships with humanitarian practitioners to conduct *research with* them, rather than *research on* an issue of HSC. Using collaborative research methodologies ensures that researchers are responsive to the needs of humanitarian community, higher relevance is brought to users, academics, and practitioners, and enhances relationships and trust (Kovacs et al., 2019). The application of collaborative research in HSC has been very limited but growing. Prominent examples are Sabri (2018), Sabri et al. (2019), Khoury (2019), Zarei et al. (2019c), Wagner and Thakur-Weigold (2018), Chang et al. (2010). Different terms are used to refer to the specific collaborative methodology applied, such as action research, design science, participant observation, engaged scholarship. These methods differ based on the objectives they follow and the extent of researcher’s involvement in making organizational change. However, they all share similar characteristics in terms of role of researcher and the type of knowledge they create. Chapter 4 illustrates collaborative research methodologies, their foundations, characteristics, and their appropriateness for HSC research.

2.2.6. Coordination and collaboration

The benefits of supply chain collaboration and coordination have long been known to business managers. Firms increasingly look outside to find assistance in meeting their customers’ needs and achieve a better performance (Peter et al., 2017). In the HSCs, inter-organizational collaboration offers even higher rewards as the goal is not competing with peers to attract more customers, but to alleviate the suffering of afflicted people to the greatest extent possible. This inherently different objective from commercial supply chains gives way to inter-organizational collaboration in HSCs. However, while humanitarian organizations do not compete on customers (beneficiaries), the competition

is fierce for securing funding and donations, negatively impacting on coordination (Van Wassenhove and Pedraza Martinez, 2012). Other characteristics of humanitarian context such as damaged telecommunication channels and unorganized presence of various humanitarian organizations in disaster affected areas have made coordination the most emphasized challenge in HSC (Kovács and Spens, 2009).

Balcik et al. (2010) comprehensively reviewed the coordination mechanisms, challenges, and opportunities in HSCs and expressed that collaborative operations such as joint procurement, warehousing, transportation, as well as collaborating with for-profit actors such as logistics service providers leads to higher efficiency and lower costs for humanitarian organizations. Another literature review on this topic was recently conducted by Wankmüller and Reiner (2019) who defined coordination, cooperation and collaboration in HSCs and showed that the importance of these is increasingly among HSC research communities. The third literature review by Grange et al. (2019) provided a pathway for collaboration in HSCs. They showed that humanitarian organizations moved from coordination, where a minimal inter-organization link is made, to orchestration, where a single centralized agent coordinates the interactions among the different organizations, and finally to choreography, where each organization knows independently manages the interactions with other collaborators while the whole supply chain is synchronized. As the three abovementioned literature reviews revealed, collaboration and coordination have been at the center of HSC attention. They have been studied for different humanitarian operations from different perspectives. Some examples are collaborative preposition of humanitarian inventory (Balcik et al., 2019), collaboration with business actors (Nurmala et al., 2018), and specifically with logistics service providers (Bealt et al., 2016), and collaboration from organizational culture perspective (Prasanna and Haavisto, 2018), *inter alia*.

However, not all humanitarian organizations may collaborate; Moshtari and Gonçalves (2017) showed that three categories of factors that facilitate or hinder inter-organizational collaboration;

1. Contextual factors such as location and timing of disaster, political environment, security, and uncertainty of demand, supply, and funds
2. Inter-organizational factors such as strategic and operational compatibility, competition, power balance among partners, and coordination process
3. Inner-organizational factors such as bureaucracy, availability of resources and capabilities

Further, Moshtari (2016) showed inter-organizational collaboration is likely to form among organizations with resource complementarity and relationship management capability, while compatibility of mission, vision, and values is not a significant determinant for collaboration. Size and locality of humanitarian organizations would not impact on the success of collaboration. Based on the findings of Salem et al. (2019), international humanitarian organizations which promote cooperation between local and expat groups in a humanitarian field can achieve better performance. Despite the considerable number of studies about collaboration in HSCs, no study could be found that

investigates whether and how inter-organizational collaboration impacts on the sustainability of HSCs.

2.3. Environmental Sustainability in HSCs: Antecedents from Research and Practice

2.3.1. Research on environmental sustainability in HSCs

As the thorough review of literature in previous section revealed, extant literature has clearly expressed the need of future HSC research to focus on environmental sustainability (Sarkis et al., 2012, Haavisto and Kovács, 2014, Abrahams, 2014, Kunz and Gold, 2017, Laguna-Salvadó et al., 2018, Van Kempen et al., 2017). Sarkis et al. (2012) stated that HSC should adopt green supply chain principles and the perceived sense of *urgency* should not overshadow the importance of greening. Haavisto and Kovács (2014) conducted a content analysis on the annual reports of several major humanitarian organizations to find out how they address different expectations concerning sustainability. The study revealed that very little could be found in the annual reports regarding green supply chains, logistics, and green products. They concluded that future research needs to understand how humanitarian organizations address greening initiative in their procurement decisions and transportation. Abrahams (2014) identified the barriers of environmental sustainability in post-disaster supply chains and confirmed that the perception of urgency within the disaster response sector is the main barrier on the way of implementing environmental sustainability. His results highlight that negligence of environmental sustainability leads to the promotion of unsustainable behavior in HSCs whose results are instantly visible after the disaster.

Van Kempen et al. (2017) used life cycle assessment to show that local sourcing is preferred to international sourcing in terms of environmental sustainability. Next, the work of Kunz and Gold (2017) combined sustainable supply chain management and HSC management by considering external contingencies and beneficiaries' needs in disaster rehabilitation. One of the major outcomes of their study is that to minimize the ecological impact of HSC during the operation, long-term requirements of beneficiaries should be primarily considered in supply chain design. The study of Laguna-Salvadó et al. (2018) expressed that environmental sustainability is the taken-for-granted aspect in humanitarian decision-making and proposed a framework of sustainable decision support system for HSC planning. Despite the calls, environmental sustainability has not received enough attention from scholars.

2.3.2. Antecedents from practice

Practice validate the recommendations of HSC literature on the importance of environmental sustainability. Negligence of environmental sustainability has led to catastrophic consequences in the past. Some of such antecedences are as follows.

- Unsustainable extraction of sand from mountains for shelters following the 2010 earthquake in Haiti making the mountains prone to land slide and erosion and leaving a visible mark on the mountains (Abrahams, 2014)
- The largest outbreak of cholera in recent history in Haiti due to failure in meeting waste treatment standards by humanitarian organizations (Cravioto et al., 2011)
- Over-provisioning of fishing boats and the consequent fishing stock depletion in humanitarian recovery operations in post-tsunami Sri Lanka (Joint UNEP/OCHA Environment Unit, 2014)
- Long-lasting insecticidal nets distributed in Kenya to fight against Malaria used by locals as fish nets at the end of their life releasing hazardous material to aquatic life (Minakawa et al., 2008)
- Destruction of livelihoods and deforestation as a result of brick production for humanitarian operations in Darfur Lanka (Joint UNEP/OCHA Environment Unit, 2014)
- Dried up wells due to over-drilling for water by humanitarian organisations in Afghanistan

2.3.3. The way forward

The evidence from the literature and antecedents of practice go hand in hand in expressing that overlooking environmental sustainability can lead to significant damage to the ecological environment. While humanitarian and development organizations are dealing with ecological emergencies such as drought in parts of Africa or hurricanes due to global warming on a daily basis, they can't be contributors to adverse environmental impact through their own supply chains and products. The 17 Sustainable Development Goals set by the United Nations to transform the world by 2030 (United Nations, 2018) entails the humanitarian and development organizations as well. Hence, both academic literature and experience from practice lead to a main gap that motivates this research: the need for making HSCs more environmentally sustainable.

2.4. Identifying Research Gaps in HSC Research

Review of dominant themes in HSC shows that the field is growing quickly, and many concepts, theories, methodologies, and practices were adopted from the parent field of supply chain management and logistics. Topics and concepts such as management of transportation, inventory, and procurement, mathematical modeling for optimal allocation of resources, performance measurement, and collaboration have been adopted and fitted for application in HSC. The transfer of knowledge was bidirectional and commercial supply chain management has also benefited from HSC research, although to a lesser extent.

The field has shown to grow quickly in some topics, such as coordination or mathematical optimization, whereas some topics have not been discussed at all or have not received

enough attention. In the following, the research gaps arising from the survey of the literature are discussed.

Gap 1: First and foremost, the literature of HSC bears little with regards to the environmental sustainability. Taking the triple bottom line model of sustainability (Elkington, 1998), HSCs by nature contribute to social sustainability since their prime objective is helping vulnerable people impacted by a crisis or disaster. The environmental pillar, however, has been lost in the midst of efforts for responsiveness and delivering aid items as quickly and cost-efficiently as possible. Looking at the scope and magnitude of humanitarian operations, it is surprising to see that this aspect has been overlooked both in research and in practice. Humanitarian organizations carry out global logistics operations with immense magnitudes of transportation, warehousing, procurement, and last-mile delivery. These operations have significant impact on the ecological environment and contribute to greenhouse gas emission and global warming, among other impact categories. However, studying the environmental sustainability of HSCs is largely overlooked in almost all the streams of literature reviewed. Since this is the key gap that motivates this research, it will be discussed in further detail in section 2.4.

Gap 2: Dearth of empirical research with low relevance for humanitarian practitioners is another major drawback of the HSC research. *“The success is not only being able to publish the result but it is also that there is a difference in the actions of the organization and the impact on the beneficiaries”* Christophe Hambye, Deputy Director, Department for Financial Resources and Logistics, International Committee of the Red Cross - ICRC) (Kunz et al., 2017, p. 1592). The research published by humanitarian scholars means little for humanitarian practitioners. HSC research suggests the application of different concepts and models from other fields, but remains merely at conceptual level (Tabaklar et al., 2015). Therefore, there is dire need to move from conceptual models to evidence-based research which contribute to real-world HSC problems.

Gap 3: HSC is an applied field of research, and as such, practitioners should be also playing a role in research by collaborating with practitioners and bringing their insight into HSC research. However, the review of HSC literature shows very little about researcher-practitioner collaboration. Using collaborative research methodologies which bring researchers and practitioners together for collective problem solving is scarce (Sabri et al., 2019). This also contributes to the previous gap about little evidence-based research in HSC research.

Gap 4: Theory-wise, theory development, elaboration, and testing in HSC research is insufficient and immature. The field requires more studies that extend organization management theories and test them for HSC problems (Oloruntoba et al., 2019). Extending such theories deepens our understanding of complex issues such as sustainability in HSCs and leads to generating new theoretical insights.

Gap 5: From disaster life cycle viewpoint, most of studies take a narrowed view to investigate issues during the response phase while humanitarian operations in pre- and post-response phases have not received much attention. The dominance of response phase was observed in all the streams of HSC reviewed. In the same vein, the literature contains

little studies which consider the whole disaster life cycle and operational mix of disaster relief and development programs. As humanitarian organizations increasingly involve in all phases of disaster and the borders between disaster relief and development programs are blurring, research needs to take a more holistic view (Jahre et al., 2016), as many issues in humanitarian context may not be addressed only upon the occurrence of crises.

Gap 6: The review of humanitarian procurement identified different several streams of research within humanitarian procurement. In general, more research on humanitarian procurement, as an organizational function that impact the whole HSC, is required. Amongst the identified streams, sustainable procurement and local procurement are the most under-researched ones, as compared to other streams focusing on cost minimization and improving procurement efficiency. If an HSC is to account for sustainability, procurement would be the steppingstone due to lower urgency at the time of procurement (e.g. during prepositioning) and the impact it has along the HSC until the downstream and disposal. For example, purchasing a humanitarian product with biodegradable packaging for refugees can contribute to the ecological environment around refugees' camps when the packaging is disposed of by refugees. In the same vein, local procurement can empower local communities and contribute to their employment while decreasing overseas transportations and avoiding the greenhouse gas emissions emanating from the transport. Despite the calls from research for sustainable and local procurement (Schultz and Søreide, 2008, Wild and Zhou, 2011, Van Kempen et al., 2017, Matopoulos et al., 2014, Piotrowicz, 2018), , HSC literature scants such studies. Therefore, research is required on how procurement, as an organizational function, plays a role in mainstreaming sustainability in HSCs and what are the barriers and enablers it might face.

Gap 7: The role of ICT is another nascent topic in HSCs. It is known that use of ICT in commercial supply chains lead to higher supply chain visibility (Garcia-Torres et al., 2019). It is also known that HSCs are criticized for low visibility, specifically the visibility of headquarters over their field operations (Eftekhar and Van Wassenhove, 2016). However, there is a void in the literature about whether and how ICT lead to higher visibility, and subsequently sustainability, in HSCs.

Gap 8: The review literature about HSC design and configuration shows that the problem has been amply analyzed using mathematical modeling and optimization methods. Moreover, although the configuration of HSC, such as location of inventory facilities has a significant impact on the overall emissions emanating from the HSC, environmental sustainability impact assessment during supply chain design has remained untouched (Habib et al., 2016). Therefore, research is required on assessing the sustainability impact of different HSC design scenarios to ascertain more environment friendly designs.

Gap 9: The review of literature on collaboration and coordination showed that although inter-organizational collaboration received significant attention in HSC literature, the link between collaboration and sustainability of HSCs has been overlooked.

2.5. Research Questions

Based on the survey of literature and unearthing research gaps, the overall question of this thesis is as follows:

RQ: How can environmental sustainability be incorporated in HSCs?

The answer to this overarching research question entails breaking it down to its constituents. First, it is crucial to understand the *status quo* of environmental sustainability in HSC research, as reviewed through a thorough literature review in this chapter. It is also important to identify the main causes that negatively contribute to sustainability in HSCs. Then, an appropriate theoretical lens and methodology to look into the context of *green HSC* are required. The theoretical underpinning and methodology should be capable of distinguishing the *specificities* of humanitarian context to generate relevant results. The starting point for greening an HSC is synthesizing the extant green practices in supply chain and operations management, as a more mature field of research, in a useful way for HSCs. Next, the green practices should be adopted or customized for implementation in HSCs. Where it is not possible, new green practices should be developed. Throughout the process of adopting/customizing/developing green practices and their subsequent implementation, the specificities of humanitarian context are unearthed. More importantly, the research should identify how humanitarian organizations *cope with* these specificities to green their HSCs. It is also important to investigate green HSC not only from a holistic supply chain perspective, but also from the perspective of critical functions and processes such as procurement or supply chain design. Hence, the following sequence of research questions form a whole to respond to the main research question of the thesis:

1. *What is the status quo of environmental sustainability in HSC research?*
2. *What are the main causes that negatively contribute to the environmental sustainability of HSCs?*
3. *How can extant green practices in commercial supply chains be suitably framed for HSC context?*
4. *What are the specificities of humanitarian context that impact on implementing green practices in HSCs?*
5. *How can humanitarian organizations adopt/customize/develop green practices to cope with the identified specificities and green their supply chains?*
6. *What are the considerations at supply chain design level (e.g. supply chain configuration) and at functional level (e.g. procurement function) for environmental sustainability of HSCs?*

CHAPTER 3

Theoretical Underpinnings

3.1. Theory in HSC Research

Supply chain management is not fully considered as a scientific *discipline* yet because suffers from inadequate theory building and is criticized for borrowing theories from other fields, especially management discipline (Harland et al., 2006, Halldórsson et al., 2015). The framework of Harland et al. (2006) identifies four distinct phases for evaluation of a discipline, viz. *i*) no discipline and little theoretical considerations, *ii*) progress towards a discipline debate, *iii*) an emerging discipline, and *iv*) a respected established discipline. Due to quality of coherence, academic journal quality, and impact, supply chain management falls under the third phase, i.e. an emerging discipline. Moving its way towards the fourth phase, a respected established discipline, it requires further coherence in discipline-debate and theory building, elaboration, and testing. De facto, supply chain management, as an applied field of research, has the capacity to not only develop and advance theory, but also it can contribute to theorizing in other fields of research, especially at inter-organizational level (Halldórsson et al., 2015).

HSC is a nascent area of research within supply chain management. As such, it suffers from the same shortcomings of supply chain management while its freshness compounds the issues with the level of theoretical maturity. Hence, theory building and applications in the HSC research is limited but growing. HSC mostly borrows theories from other fields of research such as supply chain management, operations management, and operations research (Tabaklar et al., 2015). Hitherto, the majority of theories applied to HSC research have been middle-range theories such as inventory control theory, stakeholder theory, resource-based view, and contingency theory. The field has also benefited from framework and model development to advance theory (Tabaklar et al., 2015).

3.2. Contingency Theory as the Right Lens for Green HSC

Embedding environmental sustainability in HSC, as the main objective of this thesis, requires a theoretical lens that accounts for the inherent differences between HSCs and other field of research to enable contextualization of green practices according to the specificities of HSCs. In search for theories, one possibility is the application of stakeholder theory to understand how each of the involved stakeholders in the HSC (e.g. suppliers, country offices, other humanitarian organizations) are motivated to adopt and implement green practices. Another possible approach was forming the theoretical framework around the disaster cycle view of mitigation, preparedness, response, and recovery (Van Wassenhove and Pedraza Martinez, 2012) to study green practices specific to each disaster phase.

While both of these theoretical views seem capable of investigating environmental sustainability in HSCs, they could not fully attend to the research objective of the thesis. Stakeholder theory would have generated interesting insights about how each of the internal or external stakeholders, based on their interests, could engage in the greening the operations, but it would not capture how the stakeholders transfer and contextualize green practices based on the specificities inherent in humanitarian context. By the same token, disaster cycle view would have been beneficial, especially because the humanitarian organizations involved in the action research of this thesis were operating in all phases of the disaster cycle, but the theoretical view suffered from the same shortcoming of the stakeholder theory to address the objective of this research.

In order to address the research objective and questions of this thesis, contingency theory was selected since it contributes to our understanding about the transfer of sustainability knowledge from other fields of research as well as exploring how the transferred knowledge can be contextualized for the application in HSCs. It is also capable of distinguishing the differences between humanitarian and traditional supply chains at supply chain level (e.g. supply chain configuration), organizational level (inter- and intra-organizational relationships), and functional level (e.g. purchasing and procurement function). Moreover, the utility of contingency theory for studying sustainability in HSCs has been proven by the studies of Haavisto and Kovács (2014) and Kunz and Gold (2017).

At its rudiment form, contingency theory posits that there is no single best model of organizational management, structure, or decision making that inherently works better than all others. Simply put, *one size does not fit all*. Rather, different organizations are contingent upon various factors in their internal and external environment known as contingent factors. As such, the theory asserts that organizational variables should be at *fit* with the organizational operating environment to achieve the best performance (Tosi and Slocum, 1984). The theory has been frequently applied in the fields of strategic, operations, and supply chain management to understand how different organizations/systems/contexts construct the fit with their surrounding context to improve their performance. In strategic management, the comprehensive review of Boyd et al. (2012) on contingency hypotheses concluded that such hypotheses are central to the development of strategic management field as they facilitate the transition from the

Taylorist *one best way* mindset to the contingency view of *it depends*. The study of Sousa and Voss (2008) synthesizes the applications of contingency theory in operations management and expresses that the theory is essential for operation management scholars to study the process of selecting the best practices. In the same vein, Buttermann et al. (2008) identified *fit* as a gestalt concept to supply chain management and showed how supply chain managers can avail of it.

Coming to HSC research, contingency theory has been used to deepen the understanding of humanitarian contingencies. Jahre et al. (2015) used contingency theory to examine the appropriateness of standard global tools in humanitarian logistics. Haavisto and Kovács (2014) and Kunz and Gold (2017) applied the theory to integrate and advance the theory for sustainability in HSCs. Along the same line, this thesis builds upon contingency theory and develops a theoretical underpinning to view the process of investigating the body of knowledge in sustainable supply chain management from the field of commercial supply chain management and customizing the adopted green practices or developing new ones to meet the specificities of humanitarian field.

3.3. The Proposed Theoretical Underpinning

This thesis develops a theoretical underpinning based on the contingency theory. The framework posits that organizational (internal) and contextual (external) contingent factors to humanitarian organizations play a major role in embedding environmental sustainability into the HSC. Upon identification of contingent factors, green practices from sustainable supply chain management and logistics can be adopted, abandoned, or contextualized for HSC context, building a *fit* between the practices and the identified contingencies. Moreover, humanitarian organizations can *develop* new green practices considering humanitarian contingency factors.

The notion of *fit* is pivotal to the contingency theory. The theory postulates that organizations achieve high performance by maintaining a fit between their structures and changing contextual factors in the environment they operate (Donaldson, 2001). The fit is conceptually the line that links each of the values in a set of organizational variables to a particular value of the contingency (Donaldson, 2001). Basically, three forms of fit can exist (Sousa and Voss, 2008), namely *selection*, *interaction*, and *system*. In the *selection* form, the fit matches organizational context and a response variable in the organization. The *interaction* fit considers performance as a resulting effect between the organizational context and response variable. In *system* fit, the relationship among multiple contextual factors and response variables and their resulting effect on multiple performance criteria are addressed simultaneously.

In this thesis, exploring the relationship between the humanitarian organizational and operational context and greening practices is sought. While improving environmental sustainability is the main objective, we do not focus on measuring the improvement in absolute numbers for all the adopted practices, although Chapter 6 reports on the conceptual improvement through carbon footprinting for supply chain configuration.

Rather, we are interested in exploring the fit between contingency factors and greening practices, making *selection* the suitable form of fit for our theoretical perspective. The insights generated from this type of fit can be used for developing contingency propositions to be tested with performance dimension being incorporated in future studies (Sousa and Voss, 2008). These propositions are put forward in Chapter 8.

The theoretical underpinning is shown in Figure 4. The framework is composed of three main constituents; organizational and contextual contingencies as independent variables and green practices as the response variable. While humanitarian organizations encounter both internal and external contingencies affecting their organizational behavior and adoption of different practices, little research has been done taking into account combined contingencies (Bradshaw, 2009). By the same token, contingency theory literature has continuously advised that the simple sequence of *contextual contingencies-to-organization* neglects the role of organizational contingencies and that theoretical models should include contingencies account for both external organizational context and intra-organization contingencies (Zajac et al., 2000, Miller, 1981). Hence, the theoretical underpinning of this thesis considers both organizational and contextual contingencies.

Figure 4: The proposed theoretical underpinning

In line with most classic contingency theory studies (Tosi and Slocum, 1984, Morgan, 1986), *organizational structure* and *organizational subsystems* were selected as the main organizational contingencies. As for contextual contingencies, the specific external contingencies influencing nonprofit organizations as developed by Cornforth (2003) were chosen: *field of activity*, *stakeholders*, and *funding environment*. The *field of activity* is translated into the humanitarian environment while the external supply chain *stakeholders* are suppliers and third-party logistics, country offices, other humanitarian

organizations, and beneficiaries. These stakeholders were influential in developing the greening framework, presented in Chapter 5.

The theoretical framework considers not only the influence of organizational and contextual contingencies on the adoption and customization of green practices, but also a subsystem in the organizational environment can influence on contextual contingencies. For example, the procurement department can influence on the level of funds raised from the donors or the level of stakeholders' engagement. This is shown by a double-headed arrow between contextual and organizational contingencies in Figure 4. As such, the thesis does not disregard the mutual influence of contextual and organizational contingencies on one another and investigates the interactions between them in its analysis of case outcomes.

Based upon the theoretical underpinning, the unit of analysis is defined as the supply chain of the humanitarian organization under scrutiny. As such, this study analyses the HSC to identify contingency factors and to investigate how the HSC is influenced by interventions from headquarters.

3.4. Reflection of the Theoretical Underpinning in the Results

The theoretical underpinning to satisfy the research objectives and provides an overarching theoretical foundation for the thesis. As such, it is applied and reflected in the whole research process. This section explains how the theoretical underpinning is employed in each of the result chapters (Chapter 5, 6, and 7).

Chapter 5 assesses the utility of the theoretical underpinning by presenting the cycles of collaboration with a United Nations organization, as the humanitarian partner of the collaborative research project. This collaboration was the main source of data for the whole thesis. The chapter breaks down the supply chain under scrutiny into four main areas of intervention viz. *supply chain configuration*, *inventory and warehousing management*, *transportation and shipment management*, and *packaging and product specifications*. The chapter develops a comprehensive synthesis of greening practices through a concept-centric literature review for each of the four areas. Then, according to the theoretical underpinning, it looks at each area and decides whether to adopt, abandon, customize the synthesized green practices or develop new ones considering the identified organizational and contextual contingencies to construct a fit between the contingency factors and the way green practices are employed.

Chapter 6 deploys a mixed-methods research derived from a collaborative research project with the United Nations. In line with the theoretical underpinning, the investigation of the case starts from identifying the key contingency factors in the organization under scrutiny that negatively impact on the environmental sustainability of HSC. The chapter refers to contingency factors as *(sub-)causes* and continues to prioritize and select the key causes which impact the most on greening HSC. With *supply chain configuration* selected as the most important cause category, the chapter contends to propose greening solutions to deal with the contingency factors of supply chain

configuration. One of the contingency factors was identified as *long distance of suppliers from beneficiaries* which imposes long-haul transports and increases the emissions emanating from the transports. The chapter discusses that due to poor economic and humanitarian situations in Africa, building manufacturing plants is not the optimum option. Another contingency factor is *uncertainty of demand and where it is needed*; leading to excess or shortage of supplies in African countries. To address these contingency factors, among other, building hubs is proposed as a greening solution. The chapter investigates two conceptual supply chain configurations with hubs in east and west Africa and concludes that configurations with hubs can address the identified contingency factors and outperform the current supply chain configuration in terms of global warming potential, while at the same time improves the responsiveness of the HSC. Through individual follow up interviews, the chapter identifies further potential contingency factors that impact on building and deploying the hubs.

Chapter 7 deep dives into the purchasing and supply management and unearths humanitarian contingency factors in form of *barriers* and *enablers* that hinder or facilitate green procurement. Sustainable and green procurement is a developed area of research within sustainable supply chain management. Many studies in commercial setting have been conducted to identify the barriers and enablers of green procurement. Walker and Brammer (2009) and the special issue in the *Journal of Purchasing and Supply Management* (Walker et al., 2012) are among the most-cited references about sustainable procurement with more papers and special issues emerging on other supply chain and operation management journals. By and large, procurement plays an overriding role on institutionalizing sustainability into supply chain since it is the entry point of raw material and products. Hence, taking (in)appropriate sustainability measures for the procurement can influence the whole supply chain from the upstream to downstream. However, greening humanitarian procurement is an under-researched area within HSC research as shown in Chapter 2. It has just been recently that green procurement in HSCs has attracted the attention of research community (Van Kempen et al., 2017). To address this gap, Chapter 7 elicits the ideas of several humanitarian experts to identify the contingency factors (in form of barriers and enablers) in green humanitarian procurement. The contingency factors are classified into six main categories including *local procurement*, *contextual factors*, *intra-organizational*, *inter-organizational* and *supply chain*, *funding*, and *supplier relationship*. Finally, the chapter prioritizes the identified contingency factors within each category and discusses the implications of prioritization for green humanitarian procurement.

Table 2 presents an overview on the application of contingency theory and the proposed theoretical underpinning in the result chapters. It also summarizes the identified contingency factors and the proposed greening solutions to deal with the identified contingency factors, as presented in each chapter.

Table 2: An overview of contingency theory perspective in the result chapters

Chapter	Application of the theoretical underpinning	Contingency factors referred to as	Supply chain area of focus	Key contingency factors identified	Main greening solutions proposed
Chapter 5 <i>Results (i)</i>	Explicit	Contingency factors	Whole supply chain	<ul style="list-style-type: none"> - Short-term funding - Earmarked funding - Donors' limited awareness about environmental sustainability - Strict national requirements and customs clearance especially for development products - Established inter-organizational coordination mechanisms for joint warehousing and procurement (+) - The need for close supervision during inventory, transportation, and disposal of waste to prevent scavenging - Different packaging need and perception of beneficiaries in humanitarian context (+) - Inadequate management and cooperation at intra-departmental level 	<ul style="list-style-type: none"> - Pooling resources at national level between governments, NGOs, and other humanitarian organizations - Joint outbound logistics, warehousing, and last-mile distribution with other humanitarian and development organizations - Improving the visibility of headquarters over field operations using information communication technologies - Developing a standard operating procedure for reverse logistics - Collaborating with suppliers to redesign secondary packaging
Chapter 6 <i>Results (ii)</i>	Implicit	Causes	Supply chain configuration	<ul style="list-style-type: none"> - Use of unsustainable material in humanitarian products - Poor recycling capabilities in areas with humanitarian need - Long distance of suppliers from beneficiaries - Poor inventory management system at humanitarian delegations - Import/export barriers in humanitarian borders 	Developing two hubs in east and west Africa and revising the inventory management system (conceptual)
Chapter 7 <i>Results (iii)</i>	Implicit	Barriers and enablers	Procurement	Barriers: <ul style="list-style-type: none"> - Damaged infrastructure in countries impacted by disasters and crises hampering local procurement - Lower quality, lower production capacity, and higher price of local suppliers - Volatility of humanitarian context requires more packaging - Limited training of procurement staff - Autonomous purchase of local humanitarian offices at low prices - Short-term supplier relationships in humanitarian context 	-

				<ul style="list-style-type: none"> - Low purchasing power of humanitarian organizations over critical suppliers - Difficulty in tracking indirect suppliers - Corruption in purchasing <p>Enablers:</p> <ul style="list-style-type: none"> - Reduced transportation emissions and empowering local communities through local procurement - Recent introduction of ISO 20400 on sustainable procurement - Similarity of humanitarian items procured by different organizations - Benchmarking in HSCs 	
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CHAPTER 4

Research Design and Methodology

This chapter describes the methods that have been used in the thesis and presents the justifications on the selection of methods. The chapter starts from the collaborative management research as the main methodology of the thesis and continues to the presentation of other applied methods. This thesis is the result of a collaborative project with a United Nations agency along three years. A collaborative methodology was used during all stages of the project for academic-practitioner interactions, data collection, and analysis of results. As such, the collaborative research method is the overarching method of this thesis. Therefore, this chapter scrutinizes the appropriateness of action research from different perspectives, e.g. link to research objective, theory, and humanitarian context before it describes other methods that were used within the collaborative research project. Finally, the chapter assesses the methodological quality of the applied methods.

4.1. Action Research

4.1.1. *Mode 1 versus mode 2 research*

The relevance of academic management research to practitioners has been an evolving concern and raised critiques about the applicability of management research (Shani et al., 2004, MacLean et al., 2002). This discrepancy, sometimes labeled as “*the relevancy gap in management research*” (Starkey and Madan, 2001), has motivated researchers to produce knowledge that does not merely target scientific community, but is useful for managers and organizations. In response to this valid concern, a new mode of research has emerged. Unlike conventional mode of research (mode 1), mode 2 is capable of tackling the *double hurdles* of delivering practitioner relevance and scholarly excellence simultaneously (MacLean et al., 2002, Starkey and Madan, 2001) and thus mitigating the risks of *epistemic drift* and *academic fundamentalism* (Tranfield and Starkey, 1998).

In the seminal book “*The New Production of Knowledge*”, Gibbons et al. (1994) described mode 2 research as *the new production of knowledge* characterized by five chief features, namely *i)* knowledge production in the context of application, *ii)* transdisciplinarity, *iii)* heterogeneity and organizational diversity, *iv)* social accountability and reflexivity, and *v)* satisfaction of diverse interests by the quality of knowledge produced. These features necessitate moving from traditional management approaches towards more *participative and collaborative management approaches*. The roots of collaborative research can be traced back early works of John Collier and Kurt Lewin that have led to the inception of *action research* approach (Lewin, 1946).

Different terms such as participatory research (Park, 1999), collaborative research (Shani et al., 2004), engaged scholarship (Van De Ven and Johnson, 2006), and action research (Lewin, 1946) have been used to refer to the methodologies pertaining to mode 2 of research. While some variations and differences are present among the aforementioned methodologies, they all share similar fundamental characteristics which distinguish them from conventional methodologies, namely:

- They lead to creation of mode 2 research and addresses the relevance gap in management research (Starkey and Madan, 2001, Van De Ven and Johnson, 2006)
- There is *true partnership* and two-way learning in *research teams* composed of intervener-researchers and reflective-practitioners (Shani et al., 2004)
- The goal is cogenerating *actionable scientific knowledge* using *scientific-based methods* (Pasmore et al., 2008a, Shani et al., 2018)
- The inquiry is from the inside rather than outside (Coughlan, 2011)
- Unlike mode 1 in which the researcher is a mere observer detached from the living environment of the organization, in participatory research, the researcher is an actor and agent of (organizational) change involved and immersed in the joint understanding and interpretation of management issues; *Research on* vs. *research with* (Coughlan and Coughlan, 2002, Näslund et al., 2010)
- Unlike mode 1 in which the data is collected according to a prior theory to uncover a *universal knowledge*, participatory research leads to production of a *contextual knowledge* (Coughlan and Coughlan, 2002)

4.1.2. Action research in HSC research

Due to the capabilities in addressing contextual problems and creating results with high practical relevance, the applications of participatory research is sharply increasingly in operations and supply chain management (Näslund et al., 2010). It has shown its capability to address areas such as purchasing and supply management (Maestrini et al., 2016, Meehan et al., 2016) and sustainable supply chain management (Touboullic and Walker, 2016). Top tier journals in management science and supply chain/operations management increasingly publish articles which applied participatory research. For

example, *Journal of Operation Management*, the most prestigious journal in the field has established a department called *Intervention-based Research Department* devoted to dissemination of mode 2 research.

In the same line with general operations and supply chain management literature, HSC research has increasingly applied action research to address HSC problems. Action research is particularly suitable for HSC research as *context* is of paramount importance in humanitarian world. An earthquake in the United States require a fundamentally different relief supply chain compared to an earthquake in Pakistan. The differences involve different supply chain actors, infrastructure, needs of beneficiaries, and cultural and socio-economic differences. Due to creating *situational* and *contextual* knowledge (as opposed to universal knowledge creation in mode 1), action research can serve as a suitable methodology to attend to the specificities of the context in which HSCs operate.

Applications of action research methodologies in humanitarian context, despite the scarcity of such studies, have shown to bring fruitful results for academics and practitioners. Sabri (2018) and later Sabri et al. (2019) provided an in-depth analysis on the suitability, implementation challenges, and considerations of applying action research in HSC research. They have developed a framework for action research in HSC which illustrates the phases of application, responsibilities of researchers and practitioners, and quality assessment criteria. Action research has been applied to address critical issues such as adopting and adapting technology for humanitarian organizations (Chang et al., 2010), designing global tools for humanitarian logistics (Jahre et al., 2015), involving people with disabilities in humanitarian research (Tanabe et al., 2018), improving the efficiency of humanitarian logistics (Manikas et al., 2017), collaboration in HSCs (Wagner and Thakur-Weigold, 2018), providing healthcare to rural areas (Prasad et al., 2018), and performance measurement of HSCs (Abidi et al., 2020). The track of publication in leading journals suggests that, despite being at early stages of maturity, application of action research to supply chain and operations management in general, and HSCs in specific is burgeoning.

4.1.3. Collaborative Management Research as the research methodology

Among different forms and variation of participatory research methodologies, this thesis takes *Action Research* as the overarching participatory methodology of mode 2 research. Different methods exist under the umbrella of action research each of which differ slightly in some respects, for example, the level of researcher's involvement. Readers are directed to Shani et al. (2004) for the comparison of some of these methods.

In this thesis, Collaborative Management Research (CMR) is used as the specific method within the action research family of methods. CMR is defined as “*an effort by two or more parties, at least one of whom is a member of an organization or system under study and at least one of whom is an external researcher, to work together in learning about how the behavior of managers, management methods, or organizational arrangements*

affect outcomes in the system or systems under study, using methods that are scientifically based and intended to reduce the likelihood of drawing false conclusions from the data collected, with the intent of both improving performance of the system and adding to the broader body of knowledge in the field of management”(Pasmore et al., 2008a, p. 20). From here on, this thesis uses the term *action research* to refer to general participatory methodologies, including CMR, in mode 2 research. CMR is used to refer to the specific method applied for this research. In the following, I scrutinize and justify the use of CMR as the fitting method for this research.

CMR has roots in early 1900s, evolving by the time and motion studies of Frederick Taylor, and later, the collaboration between Harvard researchers and AT&T in 1930s, and the collaboration between Tavistock Institute of London and British coal mines (Pasmore et al., 2008a). Thereafter, the application of CMR has steeply increased in management research, especially in the last 20 years. The basic argument of CMR is that if management and researchers are brought together, they can progress faster in addressing organizational issues such as innovation, growth, and organizational change than if either of them approach the issue separately. The role of researchers in a CMR team is to provide academic knowledge, which is not readily available to managers, from scientific sources or by gathering and analyzing observations.

4.1.4. Appropriateness of CMR for the research objective perspective

The choice of methodology is a one of the most important elements of research design. I discuss the suitability of CMR for this research from the perspectives of research *objective*, *theory*, and *context* in this section and the following two sections. The objective of thesis, simply put, is greening HSCs. The survey of literature shows that prior research for the fulfillment of this objective is scarce. Also, in the world of humanitarian practitioners, the question of *how to green our supply chains?* is a very new, yet urgent, question. When I started the collaborative project reported in this thesis as an academic researcher, I was expecting the humanitarian organization to suggest a clear agenda, deliverables, and roadmap. Interestingly, the organization was having similar expectations from us! My recent interview with a senior humanitarian practitioner (not included in this thesis) confirmed the widespread bewilderment in other humanitarian organizations: “*We’ve realized the importance of sustainability issues and we want to put it into our agenda. But we really don’t know where to start from...*” stated the senior supply chain program manager.

Certainly, using a mode 1 research methods such as case study would have not created insightful knowledge because firstly, the extant literature was not helpful in the research design, and secondly, the practitioners have not had much expertise and knowledge to offer on the topic of investigation. Therefore, methodologies were required that *i)* allow researcher to involve actively in the change process (Shani et al., 2018) *ii)* create knowledge as actions are taken (learning in the process) (Shulha et al., 2016), and *iii)* be specific to the context of application (Coghlan, 2011); All of which are the inherent characteristics of mode 2 methodologies.

The next step was choosing the right mode 2 research methodology. As mentioned, Shani et al. (2004) and later, Shani et al. (2012) defined and distinguished the differences between different action research methods. These methods differ from each other in their technical roots, theory building, role of researcher and his/her level of involvement in collaboration, time, and interpretation and analysis of data. We reviewed all the methods to find the most suitable one for our research. Our responsibilities in the collaborative research project, as the research team, involved collecting and reviewing organizational data, finding relevant greening proposals, and suggesting them in joint meetings held with the humanitarian organization. The suggestions were collectively reviewed in the meetings and if they were approved, the senior manager was responsible to put them into action. As such, our duties were more *collaboration and intervention*, rather than *action and intervention*, as defined for other action research methods (Shani et al., 2012). Moreover, the senior procurement and supply chain manager at the humanitarian organization was the key decision maker in steering the project, adopting green practices, and communication with other departments. Considering our responsibilities and the role of managers in the collaborative research project, CMR was selected as the most fitting mode 2 method for the research.

4.1.5. Appropriateness of CMR from theoretical perspective

From the viewpoint of contingency theory, several reasons justify the application of CMR. First, CMR as collaborative research method produces *practical knowing* which differs from *scientific knowing* in that it is *particular* and *situational* derived from *contextually-embedded* data (Coghlan, 2011). In moving from one setting to another, CMR determines what modifications are needed and decides how to react to new contingencies (Shani et al., 2012), making it consistent with the choice of contingency theory.

Second, past research on contingency theory showed that even organizations with high level of maturity in the implementation of operations management practices can deviate from the fit in the long-term (Ketokivi and Schroeder, 2004, Sousa and Voss, 2008). Therefore, before providing any recommendations to steer organizations into fit, it is crucial to fully understand the underpinnings of deviations from organizational contingency-determined patterns; an effort that has been largely absent in operations management research hitherto (Sousa and Voss, 2008). To achieve such an understanding, one is required to principally assimilate the process of selection of practices by organizations (e.g. decision on the adoption, maintain, or discontinue the use of a practice) and follow them in the long-run leading to current state of practices and the following performance outcome (Sousa and Voss, 2008). CMR provides the opportunity to researchers to embark on such a journey to participate, observe, and understand the reasons behind adopting or discontinuing practices (green practices in our case) through time. This ensures that organizations are in the right path and that the adopted practices are at *fit* with the contingencies in the organizational environment.

Third, the fruit of a CMR is *actionable steps*. They are a set of recommendations prepared for the implementation in the specific organization being studied to deal with a certain managerial challenge or problem (Shani et al., 2012). Use of contingency view is appropriate from this aspect since one of the main objectives of applying the theory is generating advices on the specific practices and solutions that propels the organization to achieve fit (Sousa and Voss, 2008).

Finally, since the literature on the topic of environmental sustainability in HSC was limited, it was not possible to unearth from the literature the specificities of humanitarian context that influence on the sustainability implementation. Instead, by embarking on the explorative nature of CMR, the specificities were identified through active engagement and perception in the humanitarian environment.

4.1.6. Appropriateness of CMR from the perspective of humanitarian context

HSC research have always been criticized for *shying away from implementation* (Kovács and Spens, 2011), dearth of evidence-based research (Pedraza-Martinez and Van Wassenhove, 2016, Kunz et al., 2017), and too much conceptual modeling research studies. The recent paper of Kunz et al. (2017) merges the ideas of HSC scholars and practitioners about the relevance of HSC research. They listed eight main barriers on the way of relevant HSC research and concluded that almost all these barriers can be addressed through researcher-practitioner collaboration.

Partly, the reason for limited empirical research is the difficulty in gathering data from humanitarian field due to peculiar situations of humanitarian context. But also, use of traditional research methods are to be blamed for marginalizing researchers and detaching them from having a *touch* on HSC practice. Hence, the right choice of methods in HSC research is a critical issue to advance the field. The special issue *Research Methods in Humanitarian Logistics* published in *Journal of Humanitarian Logistics and Supply Chain Management* published in 2018 encourages application of participatory research methods to produce research with higher practical relevance. The papers published in the special issue as well as other papers reviewed in section 4.1.2 suggest that deploying action research methods can address the rigor and relevance gap and increase the methodological quality of HSC research.

4.2. Other Methods Used within the Collaborative Research Project

4.2.1. Concept-centric literature review

In order to satisfy the research objectives of the thesis, a conventional literature review on environmental sustainability of HSCs was not sufficient due to the paucity of sustainability knowledge in the HSC research. Based on the theoretical framework introduced in Chapter 3, a systematic review of commercial supply chain and logistics management literature was essential to identify and synthesize key green practices. These green practices were then adopted or customized for the application in HSC.

To this end, a *concept-centric literature review* based on Webster and Watson (2002) was conducted to synthesize the green practices in form of a *greening framework*. Chapter 5 explains the details of conducting the concept-centric literature review. In general, the steps involve selecting several relevant outlets based on the relevance and impact. Next, the publications in the selected outlets are reviewed in a specific period of time using predefined keywords related to the topic. The titles and abstracts of the returned result are reviewed to find out if they are relevant to the research topic. Finally, for the selected articles, backward and forward searches on the citations and citing articles are performed.

4.2.2. Analytic hierarchy process (AHP)

AHP is multiple-criteria decision making (MCDM) method introduced by Saaty in 1972 which breaks down a problem into several constituent sub-problems, solves each sub-problem, and then aggregates them to solve the main problem (Saaty, 1990). The results offer a prioritized list of criteria from which the best one(s) can be selected. The main steps to perform AHP are as follows: 1) *defining the goal and hierarchy*, 2) *making pairwise comparisons*, 3) *normalization and synthetization*, and 4) *consistency check*. For the sake of simplicity, the details of each step and the mathematical formulas are not described here. Readers are directed to the Zarei et al. (2019a) appended to the thesis for details.

AHP has shown to be a suitable tool for group decision-making (Ishizaka and Labib, 2011). Group AHP is an extension of AHP that combines the preferences and pairwise comparisons elicited from several participants. This thesis deploys group AHP to prioritize barriers of sustainability in humanitarian procurement.

4.2.3. Mixed-methods research

In order to quantify the environmental impact of the case under scrutiny and investigate the following managerial implications, a mixed-methods research was deployed. According to Johnson et al. (2007) mixed-methods research is defined as “*the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration*”. It is located between the extremes of quantitative and qualitative research attempting to benefit and respect fully the wisdom of both of these viewpoints (Johnson et al., 2007). It is important to distinguish between mixed-method, as a distinct methodology, and a multi-method approach, as merely compilation of several methods: In multi-method, each method is stand-alone in satisfying the objective of the study independent from the other method(s), while in mixed-methods research, each method alone is insufficient in meeting research objectives *per se* and should be considered together with the other methods (Morse and Cheek, 2014). The methods used within the mixed-methods research are briefly

introduced in the following. Chapter 6 illustrates the data collection and results of the mixed-methods research.

4.2.3.1 Focus group

Focus group is a group discussion arranged to examine a specific set of topics (Beck et al., 1986, Kitzinger, 1995). The main objective of focus group is understanding a specific issue from the viewpoint of a selected group of people (participants) by knowing about their interpretations and perceptions on the issue (Liamputtong, 2011). The essence of focus group is explicitly deploying group *interactions* to generate data and insights that would otherwise be impossible to achieve via orthodox methods such as interviews (Morgan and Spanish, 1984, Wilkinson, 1998). It means that instead of the researcher asking questions, participants are encouraged to talk to *each other* and exchange comments on each other's experience and viewpoints (Kitzinger, 1995). A *moderator*, usually a researcher, takes the lead on directing and facilitating the discussion among participants, audiotaping, and transcribing (Wilkinson, 1998, Liamputtong, 2011). Group discussions are held among four to 10 participants (Morgan and Spanish, 1984). Upon transcription of dialogues, the moderator analyzes the content of focus groups. Focus group transcripts can be analyzed with the same techniques used for the analysis of one-to-one interviews such as coding the transcripts (Wilkinson, 1998).

In this thesis, a focus group consisted of four participants, three humanitarian practitioner and one researcher as the moderator was conducted. The objective of the was to identify the possible causes that adversely impact on green HSC. The participants reached a consensus by the end of the session on the main and underlying causes impacting on green HSC.

4.2.3.2. Cause-and-effect diagram

Cause-and-effect diagram, also known as Ishikawa diagram or fishbone diagram, is a quality control tool that presents the result of team brainstorming on a specific topic (Sarazen, 1990). This thesis deployed the diagram to illustrate the results of the focus group in form of causes and sub-causes of unsustainable HSC.

4.2.3.3. Carbon footprinting

Carbon footprinting was implemented within the mixed-methods research to evaluate the global warming potential of the HSC under scrutiny. Carbon footprinting is defined as “A *measure of the total amount of CO₂ and CH₄ emissions of a defined population, system or activity, considering all relevant sources, sinks and storage within the spatial and temporal boundary of the population, system or activity of interest. Calculated as CO₂e using the relevant 100-year global warming (GWP100)*” (Wright et al., 2011). Since it was shown that carbon footprinting is a good estimator of supply chain environmental impact by presenting global warming potential (Montoya-Torres et al., 2015), it was used

to evaluate the environmental impact of different supply chain configuration scenarios and served as a basis for comparison and decision-making on the right supply chain configuration.

4.3. Methodological Quality

4.3.1. Methodological quality of CMR

It is of paramount importance that the applied methodologies are assessed for their quality. Since the main methodology of this thesis is CMR, this section delves into the evaluation of CMR quality in detail. Then, the methodological quality of other methods is briefly reported at the end of the section.

In order for a CMR to be valuable to both researchers and managers, Pasmore et al. (2008b) asserted that it should be rigorous, reflective, and relevant. They have proposed and defined a set of sub-criteria for rigor, reflectiveness, and relevance. Table 3 introduces these criteria and presents the tactics used in this research to elevate the research quality under each criterion. In addition, based on the recommendation of Kunz et al. (2017), the final drafts of manuscripts were sent to and approved by the United Nations involved in the collaborative research project to increase the validity of the findings.

Table 3: Quality elements of a rigorous, reflective, and relevant CMR (adopted from Pasmore et al. (2008b)) and the pertaining tactics used during the research

Quality Criterion	Elements	Definition in CMR (Pasmore et al., 2008b)	Tactics used in this research
Rigor	Data Driven	Well supported by objective sources of data, preferably both qualitative and quantitative, that tie behaviors or practices to organizational performance.	Multiple sources of data were used for conducting the CMR including quantitative and qualitative procurement data driven from purchase orders, organizational reports, physical and online meeting, soliciting experts' ideas and intra-organizational observations. The findings were then tied and evaluated in terms of sustainability performance of the humanitarian organization.
	Multiple methodologies	A combination of experimental and unobtrusive methodologies provides the most rigorous explanation for behaviors in natural settings.	Experimental tests have been conducted to generate viable solutions leading to actionable steps. Also, indirect elicitation of organizational data through observation was performed occasionally.
	Reliability Across Settings	Test-retest studies in different organizations are especially valuable in confirming the generalizability of results.	This is the first study of its kind and it has not been put to test in other organizations. However, the greening framework was framed based on the insight of procurement and supply chain managers from several humanitarian organizations followed by a deductive literature search. Therefore, it can serve as a steppingstone to retest the study in other organizations with similar supply chain design.
	Co-evaluation	The immediate collaborative interpretation of data to determine findings. Scientists aren't immune to bias in their observations; using independent co-researchers or even managers to review data and conclusions supports rigor.	First, the organization's data were reviewed individually by the researchers. Then, the interpretations were reflected in joint meeting to arrive to a <i>shared understanding</i> before proceeding to more in-depth analysis and generation of actionable steps. After the completion of CMR cycles, the whole research was presented in form of complete written reports to two professors at Politecnico di Milano who were not a CMR team member. The research was discussed and revised based on their comments.
	Causality	Using experimental or quasi-experimental methods, the existence and directionality of the link between independent and dependent variables should be established.	The theoretical framework identified independent (organizational and contextual contingencies) and dependent (adopting/customizing/developing green practices) factors and the causality between them was sought in form of making a fit. Delving into details, for each specific problem, different causes were sought, brainstormed and then confirmed during collaborative sessions. For example, for the problem of <i>high ratio of air shipment</i> , the identified causes were mainly rooted in supply chain design problem including regional warehouse management, location planning, inappropriate ordering procedure, and poor inventory policies such as safety stock. Where the causes were diverse and multi-level, a fishbone diagram was used.
	Underlying Mechanisms	In addition to verifying that certain behaviors or practices are related to	Using the theoretical framework and the greening framework helped to understand the reasons behind poor sustainability performance. As in the previous example for causality, the <i>high ratio</i>

		organizational performance, it is often important to understand why the link exists, as in understanding that lung cancer is the mechanism underlying the link between smoking and mortality rates.	<i>of air transport</i> was the underlying factor causing low sustainability performance (performance variable) due to poor organizational policies (dependent variable) originated from organizational and contextual contingencies (independent variable).
	Publishable	Academic standards for publication do help scientists conform to practices that support rigor, such as describing the methodology used to conduct the research in detail, making data public, and subjecting their analysis to objective reviewers.	Three papers were critically peer-reviewed and published in top-tier international journals and a book in the field of supply chain and operations management.
Reflective ness	Referential	Built on past research/theory; recognizing and building upon the contributions of others; adding weight to current conclusions through the pattern of previous findings.	The research has explored the literature to conceptualize, structure, and contextualize the already existing theoretical/practical knowledge existing in the fields of sustainable supply chain management. The theoretical framework is built upon the contingency theory, as a widely accepted theoretical lens in operations and organization management. The greening framework systematically draws upon the pertinent literature and frames it in a form that is usable for humanitarian organizations.
	Historical impact	Observing the long-term impact of interventions; following through on the effects of previous efforts; understanding what did/didn't endure.	Although palpable results were produced after the development of the greening framework and the first cycle of the collaboration (about two years), the authors decided to engage in a second cycle of collaboration (one more year) in order to further measure the impact of intervention on sustainability performance of the humanitarian organization. According to Pettigrew et al. (2001), a three-year intervention is a sufficient time frame to produce valuable insights on the transitionary and permeant effects of an intervention. Yet, many of the generated actionable steps were halfway through of implementation when the collaborative research project ended whose results are not reflected in this thesis.
	Co-interpretation	The collaborative reflection on events and outcomes over time to assess impact and formulate theory; coauthoring accounts to ensure balanced representation in historical interpretations.	During each cycle, the researchers at university, articulated and compared their interpretation of the outcomes achieved in the project before it was put into further discussion in joint meetings with organizational managers. The multiple interpretation of green interventions and the following outcomes by researchers and organization managers, extended out over the time of conducting the study, ensured the high degree of reflectiveness.
	Community of practice	Dialogue among groups of scholars and practitioners with similar interests leading to repeated experiments using different methodologies in different settings, and ultimately to joint reflection leading to the formulation of new theories.	The outcomes of the study were put into discussion among different humanitarian organizations after the completion of the first and second cycle. Many of their insights were extremely helpful for the managers of the humanitarian organization under scrutiny and researchers of the CMR team to benchmark and advance in greening the supply chain of male condoms. An example was bio-degradable packaging and inks for printing leaflets benchmarked by two other organizations. As for the dialogue among scholars, the results of the first and second cycle were

			presented and discussed in EurOMA 2017 conference in the special track of humanitarian logistics.
	Collection	Publishing collections of studies on similar topics with the intention of reflecting on consistencies/inconsistencies or patterns that advance understanding of the dynamics involved; meta-analysis of results.	The thesis has led to publication of three papers, all on the similar topic of green HSC.
	Repeated application	Learning about underlying mechanisms from repeated application of an intervention or methodology in different organizational settings; using collaborative approaches to bring together networks of practitioners and researchers to derive deeper understanding from comparing results achieved in different settings.	The thesis presented contingency factors found in an international humanitarian organization and its operating environment. After the completion of the project, the author of this thesis has initiated collaborating with other humanitarian organizations on the same topic using the same methodology.
Relevance	Return on investment (ROI)	The approach has demonstrated returns that make the collaborative effort worthwhile.	The objective of this thesis was not contributing to economic pillar of sustainability. However, since the inception of the study, the managers of the humanitarian organization expressed that greening the supply chain should not come at the cost of increased expenses for the organization or its suppliers. Therefore, the CMR team focused on more financially practical solutions. For example, using electric vehicle for last-mile distribution in an underdeveloped country with poor basic infrastructure, although contributes to environmental sustainability, is financially (and probably practically) infeasible. On the other hand, many of the proposed solutions, contributed to cutting costs, in line with the view of <i>green as the new lean</i> . Examples are consolidation of last-mile distribution and joint inventory with other humanitarian organizations which reduced logistics costs.
	Practical	The interventions/studies can be supported economically and carried out in a straightforward fashion within a reasonable timeframe.	This study was not funded by the humanitarian organization and it was conducted based on the mutual interest that existed between the organization and academia. It was carried out in a reasonable time frame for an action research study.
	Codetermined	The research goals, design, and ultimate impact are jointly conceived and aligned with the issues that leaders and other stakeholders care the most about.	Improving the environmental sustainability was a matter of high interest by the humanitarian organization. Developing platforms such as Joint UNEP/OCHA Environment Unit reflect the importance of the topic from organizational perspective. As described in the methodology, this study was co-designed and jointly conducted by the managers of an international humanitarian organization and the researchers throughout the whole research process.

	Reapplicable	The approach is generalizable to a broader array of organizations or settings; the theories have relevance to a broader set of issues governed by similar dynamics.	From theoretical point of view, adopting a contingency theory perspective, as an inclusive and widely accepted theoretical lens, allows for logical reasoning about organizational characteristics of humanitarian organizations and explore the organizational decisions in response to contextual and organizational contingencies to adopt or abandon greening practices. Arising from our theoretical framework is the deductive greening framework which owes its generalizability to incorporation of the ideas of managers from different humanitarian organizations and also a holistic concept-centric literature review to find and classify greening practices.
	Teachable	The method/approach can be taught to others in a reasonable amount of time and eventually carried out by the average person with the proper training and guidance.	After project completion, examples from the project were used as teaching cases in a postgraduate module titled <i>supplier relationship management lab</i> at Politecnico di Milano (academic semester I 2015-2016) and later in an undergraduate module titled <i>supply chain management strategy</i> at Coventry University (academic year 2019-2020). Later in the exam, one question with almost similar approach was asked from the students. The results showed that the majority of students were able to assimilate the methodology and the lessons learnt appropriately.
	Face valid	The approach is sensible and appropriate, taken at face value, for addressing the issue; it is neither too simple nor too complex.	The issue of face validity was addressed in this research during collaborative meetings. As explained in the methodology, reaching a <i>shared understanding</i> by all group members was a prerequisite to move to the next steps such as discussing potential actionable steps. This guaranteed that the approach was neither too complicated for managers nor too simplistic that became incompetent in addressing the issue under study.
	Interesting	The approach promises a new solution to a longstanding issue; the approach is simpler, cheaper, more effective or has some other performance-related quality that makes it more attractive than the current approach.	The issue of environmental sustainability in HSCs has been a longstanding issue with little solutions available in research or practice to address it. The CMR study showed how humanitarian organizations can effectively address the issue.
	True significance	The importance of results is not inflated.	The results were presented as they were achieved in implementation. Many of the action steps failed to work. The study reports on such unsuccessful action steps as well.
	Specific	The approach has demonstrated relevance to a specific situation, industry, type of organization, or geography.	The case of male condoms has shown a successful situational application for greening the supply chains of other humanitarian organizations.

4.3.2. Methodological quality of other methods

Coming to the quality of focus group, as the main method of mixed-method methodology, several tactics were used to ensure the validity and accuracy of the results. First, having standards for reporting improves the quality and validity of focus group results. The standards include designing and communicating questions upfront, determining the size of the group, and the role of each participant (Bloor et al., 2001), all of which were performed for this study before holding the session. Second, the whole focus group session was audio recorded which improves the accuracy of transcription and subsequent systematic analysis of the discussion (Bloor et al., 2001) although caution should be taken so that the recording does not limit interviewees from comfortable and free expression of their ideas. Finally, the results of the focus group session (drawn in form of fishbone diagram) were sent to and approved by the participants. Finally, AHP involves an internal mechanism for consistency check in the final step of application which was performed for each decision-maker and was found to be above the minimum satisfactory threshold.

CHAPTER 5

Results (i): A Framework for Environmental Action in Humanitarian Supply Chains

This is the first of three chapters presenting the results of the thesis. It specifically addresses research question 3 about framing extant green practices from commercial supply chain literature, research question 4 about the specificities of humanitarian context that impact on green practices, and research question 5 about adopting, customizing, or developing green practices to cope with the identified specificities in HSCs.

The chapter start with description of the collaborative research project. The project was the main source from which the results of this thesis (including the results in the next two chapters) were generated. It introduces the actors involved in the project, the elements of CMR methodology in the project, and three cycles of collaboration conducted between researchers and the humanitarian organization throughout the project and the generated results.

5.1. Description of the Collaborative Management Research Case

The collaboration project was focused on the supply chain of male condoms procured by a world leader international humanitarian organization, hereafter referred to as *Alpha*. Alpha's main focus is on maternal, sexual, and reproductive health. In addition to its large-scale development operations in over 150 countries, Alpha is actively engaged in various relief operations. Provisioning sexual and reproductive health during emergencies is recognized as an indispensable human right (Sphere Association, 2018). Within the first hours of an emergency, Alpha delivers sexual and obstetric care to protect pregnant women and prevent sexually transmitted infections and unwanted pregnancies. Alpha's relief operations are associated with the Sustainable Development Goals (United Nations, 2018) – specifically with goals 3 (good health and well-being) and 5 (gender equality) to reduce child and maternal mortality (targets 3.1 and 3.2), eradicate the epidemic of AIDS (target 3.3), ensure universal access to sexual and reproductive healthcare and family

planning services (targets 3.7 and 5.6), and eliminate female genital mutilation (target 5.3).

The rationale for choosing male condoms was twofold. First, Alpha is one of the biggest procurers of male condoms in the world, spending millions of dollars every year to purchase condoms. This confers a privileged position on Alpha in the HSC of prophylactics in leading other supply chain actors towards sustainability. In turn, employing an action research methodology allowed for exploiting this leverage to make impactful interventions and address the gap on the need for empirical research with greater relevance to humanitarian practitioners. Second, male condoms epitomize a product that shares the characteristics of both relief and development supply chains and, thus, addresses the research gap on operational mix. Relief products supply chains are characterized by unpredictability and lack of information on demand, non-structured decision-making, and urgent requests for supplies (Holguín-Veras et al., 2012a). In order to deal with such specifications, humanitarian organizations principally rely on preparing and prepositioning *kits* to ensure a rapid emergency response that meets the needs of afflicted populations. Alpha maintains stocks of around 20 different essential reproductive health kits, condoms being one of the major kits. On the other hand, the supply chains of development programs, include products with less uncertainty in demand, more structured decision-making, and steadier patterns of requesting supplies (Holguín-Veras et al., 2012a). Anew, male condoms are widely distributed in developing countries through public distribution programs (e.g. campaigns), in health centres and clinics, and by direct delivery (e.g. to vulnerable beneficiaries and sex workers). Thus, the knowledge gleaned from greening the condom supply chain can be extrapolated to both relief and development supply chains.

5.2. Elements of the CMR Case

In a CMR study, several aspects need to be outlined, viz. objective, collaborative relationships, CMR cycles, and outcomes (Shani et al., 2018). The objective of collaboration was to improve the environmental sustainability of male condom supply chain at Alpha from the perspective of the procurement department at headquarters. Therefore, this study analyses the *HSC* to identify contingency factors and to investigate how it is influenced by interventions from headquarters. The collaboration was conceived from the mutual interest of both parties without Alpha funding. Alpha was already involved in inter-agency dialogues for sustainable procurement with the intent of extending it to the whole supply chain. The researchers were interested in the topic of green HSCs given their practical and academic relevance and appeals from previous research. The *study team* was composed of three researchers and *the management team* comprised six Alpha managers; referred to collectively as the *CMR team*. The composition of the study team was:

- A Ph.D. researcher in green HSCs with a background in operations management and industrial engineering (the author of this thesis);
- An associate professor with expertise in sustainable supply chain management and reverse logistics;
- A full professor of purchasing and supply management;

The management team consisted of:

- The *head of procurement and supply division* (hereafter, division head) responsible for steering the CMR team, granting the study team access to organizational data, and approving action steps devised by the CMR team to implement in the HSC;
- A *supply chain specialist* to help the CMR team with logistics management and coordination with country supply chain officers;
- Two *regional procurement managers* to support the CMR team in collaborating with suppliers and country offices, especially in development programs;
- A *project coordinator* to help with field projects and relief operations;
- A *contract associate* to support the team on contractual and legal issues;

Physical meetings took place at Alpha's European headquarters with many additional virtual meetings, conversations, and email exchanges in between. The collaboration lasted over three years from late 2014 to early 2018, and two-and-a-half cycles of CMR were completed. The first half-cycle focused on developing a greening framework as a point of departure for implementation. The second and third cycles aimed at implementing action steps derived from the greening framework.

At each joint meeting, the study team proposed several green practices based on self-development or the greening framework. The practices were placed in *collective inquiry* where the contingency factors that might impact implementation were investigated. The CMR team discussed how to customize the proposed practices or develop new ones to address the contingency factors. When a *shared understanding* was reached, revised green practices – in the form of action steps – were communicated to the pertinent Alpha staff by the division head. The utility of implemented action steps was continually assessed. Oftentimes, during implementation, new contingency factors arose that necessitated re-customization of green practices in subsequent meetings. The study team was engaged in data collection, reviewing that data, creating a shared meaning from the data, and identifying possible action steps – which were then implemented by the management team. The study team co-monitored the implementation, planning further action steps and devising corrective actions based on implementation results.

By way of clarification, three basic concepts frequently used in this CMR study are highlighted: green practices, contingency factors, and action steps. Green practices were raw recommendations derived from the greening framework and developed by the study team to improve the environmental sustainability of the HSC. Contingency factors pertained to the organizational (internal) or contextual (external) environment of the

humanitarian organization that either hindered or enabled the implementation of green practices. Finally, action steps were revised green practices, introduced to cope with the contingency factors identified.

5.3. Cycle 1 (Developing A Greening Framework)

As a point of departure for the collaborative project, the study team developed a greening framework by synthesizing extant green practices for humanitarian organizations. This synthesis of the literature relates to a principal role of researchers in CMR: providing academic knowledge, not readily available to practitioners, from scientific sources (Pasmore et al., 2008a) and serving as an essential first step in a collaborative research project (Edmondson, 2011). Generally, each CMR cycle involves *design* of the research process, *inquiry*, and *results implementation* (Shani et al., 2018). Since this cycle sought to develop a greening framework for the whole project and did not include implementation, it is referred to as a half-cycle.

A comprehensive synthesis of extant green practices tailored to HSCs was required. The study team decided to develop a framework since no sustainability framework for HSCs could be found in the literature. To ensure the inclusiveness of the framework, the management team put the study team in contact with supply chain and procurement specialists from two other international humanitarian and development organizations.

The study team started with supply chain mapping to identify key supply chain actors, activities, and their interrelations. In an operational mix-based HSC, a focal international humanitarian organization (headquarters) orchestrates supply chain operations. In the humanitarian organization, the procurement department often takes responsibility for logistics management in addition to its purchasing and supply management responsibilities. That is commonplace when some logistics activities are outsourced or implemented by other actors, such as implementing partners, under the supervision of headquarters. Hereafter, *procurement department* refers to the organizational subsystem managing both procurement and logistics operations.

Humanitarian organizations involved in an operational mix often keep limited prepositioned stocks at headquarters supply centres for emergency first response whilst most stock is held by prequalified suppliers. For relief operations, in addition to the prepositioned stocks at headquarters, suppliers may preposition extra stocks to guarantee a certain level of relief inventory and update humanitarian organization regularly with relief stock positions. For development programs, national delegations estimate demand from the field data, historic demand, and future programs or campaigns, and send it to the procurement department at headquarters. The department processes the demand and forwards purchase orders to suppliers. After local inspection, the products are directly dispatched to the listed destinations either by suppliers or third-party logistics provider (3PL) (contracted by supplier or humanitarian organization). The carrier delivers the

items to national delegations who then store them in local distribution centres with responsibility for last-mile distribution and reverse logistics. During last-mile distribution and reverse logistics, other humanitarian organizations may interact with development and relief operations. Figure 5 depicts the supply chain mapping of the HSC described.

Figure 5: Mapping of an operational mix-based HSC orchestrated by a focal humanitarian organization

According to the supply chain mapping, four main activities emerged: *Inbound logistics* which involves flows into supplier plants, *outbound logistics* from suppliers to destination countries, last-mile distribution from local distribution centres to beneficiaries, and *reverse logistics* concerning the flow of items for reuse, recycling, and disposal. Moreover, four main supply chain actors were identified; *suppliers*, *3PLs*, *implementing partners*, and *other humanitarian organizations*. The procurement department harmonizes each actor vis-à-vis its corresponding activities: suppliers and 3PLs for inbound, outbound and reverse logistics, and implementing partners and other humanitarian organizations for outbound, last-mile distribution and reverse logistics.

In developing the greening framework, procurement department responsibilities concerning suppliers and 3PLs were considered *conventional* responsibilities while those concerning implementing partners and other humanitarian organizations were considered *sector-specific* responsibilities. Conventional purchasing and supply management responsibilities were adopted from Van Weele (2005). For sector-specific responsibilities, combinations of supply chain actors and their corresponding activities were incorporated into the framework. After defining the procurement department responsibilities concerning, the supply chain areas of intervention were decided. Inspired by the classification of green supply chain management areas by Srivastava (2007) as

well as the recommendations of supply chain and procurement specialists from the aforementioned humanitarian organizations, the main supply chain areas of intervention were decided as *i) supply chain configuration*, *ii) inventory and warehouse management*, *iii) transportation and shipment management*, and *iv) packaging and logistics-related product specifications*. Due to the diversity of academic knowledge in sustainable supply chains, a concept-centric literature review based on Webster and Watson (2002) was conducted, as introduced in Chapter 4. Table 4 presents the steps to conduct the concept-centric literature review.

As the result of the literature review, 75 papers were selected and included in the development of the framework (stage 5). Table 5 shows the green practices identified from the concept-centric literature review. To improve the utility of the framework, the repetitive or overlapping green practices were merged and themes from green practices were unearthed (stage 6). Finally, the greening framework was verified by the management team and three procurement staffs from the aforementioned humanitarian organizations at the end of half-cycle 1 (stage 7). Table 6 shows the finalized greening framework. The lateral row presents the conventional (in white) and sector-specific (in grey) responsibilities. The first column on the left shows the main supply chain areas of intervention. The data in Table 6 present green practices that correspond to the intersecting responsibility and supply chain area of intervention. Cycle 1 took around six months.

Table 4: Stages of concept-centric literature review for the greening framework

Stage	Details of procedure and criteria
Stage 1: Journal selection	<ul style="list-style-type: none"> • Journals in the categories <i>Operations Research & Management Science</i> and <i>Management in InCites Journal Citation Reports</i> were considered. • Journals not covering supply chain management topics and sustainability practices were excluded. • After internal discussion, the research team selected an initial list of 10 journals based on relevance and 2014 <i>Journal Impact Factor</i> (the most current <i>Impact Factor</i> available at cycle 1), as follows: <ul style="list-style-type: none"> - <i>Journal of Operations Management</i> - <i>International Journal of Production Economics</i> - <i>Omega – International Journal of Management Science</i> - <i>European Journal of Operational Research</i> - <i>International Journal of Production Research</i> - <i>Production Planning & Control</i> - <i>Production and Operations Management</i> - <i>International Journal of Physical Distribution & Logistics Management</i> - <i>Supply Chain Management: An International Journal</i> - <i>Decision Sciences</i>
Stage 2: Initial keyword search	<ul style="list-style-type: none"> • Combined keywords from the responsibilities and supply chain area of intervention, for example, <i>supplier selection</i> and <i>inventory/warehousing</i> • Search database: The selected journals • Search space: Title, abstract, and keywords • Time range: 2005 to 2015 (current time at cycle 1)
Stage 3: Review and selection	<ul style="list-style-type: none"> • The title and abstract of each result were reviewed to find out if the article offers any green practices. • To ensure objectivity of the selection process, green practices were defined as practices/recommendations that could be implemented to improve the environmental sustainability of supply chain. Therefore, articles that investigated the following topics were excluded: <ul style="list-style-type: none"> ○ Literature reviews ○ Theorization about sustainability ○ Evaluating interrelationships among sustainability-related factors ○ Articles investigating sustainability and firm performance ○ Articles investigating merely social sustainability ○ Articles not relevant to HSCs such as sustainability and pricing <i>Example of an excluded result: “The relationship between dynamic firm capabilities and sustainability performance”</i> • Some of the results were specific to HSCs. These results were reviewed carefully to identify any implications for environmental sustainability; <i>Example: “joint warehousing of relief and development aid (Jahre et al., 2016)”</i>. • Green practices found from the shortlisted results were assigned to the corresponding position in the greening framework, i.e. the intersection of the responsibility and the supply chain area of intervention.
Stage 4: Backward and forward search	<ul style="list-style-type: none"> • For the shortlisted results in stage 3, backward and forward searches on the citations and citing articles were conducted using similar keywords. • On the results of backward and forward search, a similar procedure to that in stage 3 was followed.
Stage 5: Constructing the framework	<ul style="list-style-type: none"> • A total of 75 articles were identified in stages 3 and 4. All the identified green practices were inserted into the greening framework. • If no relevant result was found, the corresponding part in the greening framework was left blank.
Stage 6: Synthesis and identification of themes	<ul style="list-style-type: none"> • Some of the identified green practices were fragmented, repetitive, or overlapping. All the green practices were synthesized, and the emerging themes were used in the greening framework.
Stage 7: Verification and update	<ul style="list-style-type: none"> • The relevance of the selected practices was reviewed by each member of the study team individually. • The greening framework was verified by the management team and three procurement staffs from the other aforementioned humanitarian organizations at the end of half-cycle 1. • Green practices were updated at the beginning of cycle 2 and cycle 3 with relevant recent articles.

Table 5: The green practices identified from the concept-centric literature review

Table 5(a): Supply chain configuration

Defining purchase specification	
Supplier selection	Selecting suppliers closer to the point of consumption and raw material (Bonney and Jaber, 2011, Enarsson, 1998), Local procurement (Taylor, 2012, Matopoulos et al., 2014, Van Kempen et al., 2017)
Contract management	
Ordering, expediting, and evaluation	
With other HOs* for outbound	
With other HOs for LMD*	
With country office for LMD	Building LDCs closer to beneficiaries rather than country offices (Sphere Association, 2018), Use of local resources for warehouse construction (Joint UNEP/OCHA Environment Unit, 2014)
With other HOs / Country office for RL*	Considering reverse flow of aid for facility location planning: national and regional hubs (LDCs) (Battini et al., 2016), Optimizing the locations of distribution centers and recycling facilities considering the reverse flow of products as well as interconnecting logistics (Accorsi et al., 2015)

Table 5(b): Inventory and warehousing management (excluding warehouse location)

Defining purchase specification	
Supplier selection	Considering the environmental impact of inventory decisions on supplier selection (Palak et al., 2014), Integrated inventory management and supplier selection (Konur et al., 2017)
Contract management	Negotiating vendor-managed inventories (Van Wassenhove and Pedraza Martinez, 2012)
Ordering, expediting, and evaluation	Emission reduction by reducing shipment frequency and adjusting inventory level (Tang et al., 2015), Greener ordering and inventory management and policies (e.g. environmental considerations in order lot-sizing, EOQ, ELS, and safety stock) (Bonney and Jaber, 2011, Arıkan et al., 2014, Battini et al., 2014b, Hovelaque and Bironneau, 2015, Hua et al., 2011, Bouchery et al., 2012), Integrated inventory and transport management (Konur, 2014, Konur and Schaefer, 2014), Integrated ordering and warehousing management (Fichtinger et al., 2015)
With other HOs for outbound	Haulage sharing for inventory replenishment (Andriolo et al., 2015)

With other HOs for LMD	Joint warehousing with other humanitarian organizations (Balcik et al., 2010, Mallidis et al., 2012), Joint warehousing of relief and development aid (Jahre et al., 2016), Collaborative inventory management of pharmaceuticals (Bhakoo et al., 2012)
With country office for LMD	Use of integrated electronic logistics management information system by country offices and humanitarian organizations for inventory management and monitoring (Supply Chain Management Systems, 2015), Energy efficient storage area design considering refrigeration, insulation, heating, and humidity control (Bonney and Jaber, 2011), Use of green energies for warehousing, generating green energy from warehouse activities, warehouse waste management, local sourcing of material, and acquiring green warehousing standards (e.g. BREEAM, LEED, GREENSTAR, CASBEE, and DGNB) (Baker and Marchant, 2015)
With other HOs / Country office for RL	Inventory control systems considering returned products turning recoverable inventory into serviceable inventory (Difrancesco and Huchzermeier, 2016)

Table 5(c): Transportation and shipment management

Defining purchase specification	
Supplier selection	Selecting suppliers & 3PLs with higher vertical and horizontal collaboration with other suppliers & 3PLs (Abbasi and Nilsson, 2016), Selecting suppliers or 3PLs with stronger ICT resources such as onboard vehicle monitoring systems, intelligent transportation, track-and-trace systems, and computerized vehicle scheduling system (CVSR) (Abbasi and Nilsson, 2016, Baumgartner et al., 2008), Selecting suppliers with higher capability in return load management (Enarsson, 1998), Strategic and operational SC integration and collaboration from upstream to downstream to manage RL (Clifford Defee et al., 2009), Competitive dialogue procedure with shortlisted suppliers (Uttam and Le Lann Roos, 2015), Reviewing the adequacy of sustainable criteria for 3PL selection prior to contractual agreement (Kudla and Klaas-Wissing, 2012)
Contract management	Incorporating environmental logistical legislation and standards in contracts of suppliers and 3PLs (e.g. ISO 14001, EMAS certification, Sulfur emission and ballast water legislation by IMO), Acquiring and complying with sustainable procurement standard ISO20400 for contract and supplier management, Including reverse logistics terms such as buyback and return, revenue sharing, etc. in the contracts with suppliers and 3PLs (Guo et al., 2017), Considering return flow to the supplier in the contracts (Department for Transport (DfT), 2004), Incentivizing (through contracts) shift to greener modes or intermodal transport (Eng-Larsson and Kohn, 2012, Colicchia et al., 2017)

Ordering, expediting, and evaluation	Collaborating with carrier for modal shift to greener mode or intermodal transport (Hoen et al., 2014, Bask and Rajahonka, 2017, Woodburn and Whiteing, 2010), Integrating outbound and return routes by supplier or 3PL (Department for Transport (DfT), 2004), Use of multiple criteria decision making (MCDM) and decision support systems (DSS) for supplier evaluation and management (Govindan et al., 2015, Zimmer et al., 2016), Consolidation from one or more suppliers to close destinations (Balcik et al., 2010, Tacken et al., 2014), Joint deliveries – spatial pooling / temporal pooling (Wang et al., 2015), Monitoring and evaluation of sustainability in indirect suppliers (Wilhelm et al., 2016, Grimm et al., 2016), Employing empty running backhauls vehicles for packaging reverse flow (Wu and Dunn, 1995, Twede and Clarke, 2004)
With other HOs for outbound	Use of collaborative ICT based platforms to increase consolidation and integrated fleet management (Wang et al., 2011), Platforms such as teleroute.com (one of the first online freight exchange in EU) is an example of collaborative electronic platforms, Joint procurement with other humanitarian organizations, joint use of 3PLs, joint outsourcing of outbound to 4PLs (Balcik et al., 2010, Abrahams, 2014)
With other HOs for LMD	Fleet consolidation (Pedraza Martinez et al., 2011, Balcik et al., 2010), Use of internet for identifying mutual (with other humanitarian organizations) backhaul opportunities (So and Sun, 2010)
With country office for LMD	Fleet management by optimum vehicle assignment and usage, replacing old and oversized vehicles (Pedraza Martinez et al., 2011, Eftekhari and Van Wassenhove, 2016), Optimizing fleet size (Eftekhari et al., 2014), More efficient engines, reduced vehicle tare weight, increasing vehicle dimensions and improved vehicle aerodynamic profiling (Wang et al., 2015), Use of drones and helium-filled hybrid cargo airships for delivering humanitarian and medical supplies (Tatham et al., 2017a, Tatham et al., 2017c, Chowdhury et al., 2017, Tatham et al., 2017b), Fuel efficient vehicles and vehicles with dual-fuel engines for LAST-MILE DISTRIBUTION (Alagumalai, 2014, Tacken et al., 2014), Reducing the carbon content of fuel (Wang et al., 2015), Driver training and management (Pedraza Martinez et al., 2011, Huang et al., 2012), Using fleet management software and using local drivers familiar to the area (Huang et al., 2012), Optimized routing and delivery scheduling (Pedraza Martinez et al., 2011, Huang et al., 2012), Merging fuel efficiency policies with sustainable vehicle procurement and maintenance (European Commission), Mutual engagement of the humanitarian organization and country office in last-mile distribution through integrated resources and efforts (Holguín-Veras et al., 2012b)
With other HOs / Country office for RL	Focusing on environmental returns rather than commercial returns (Miernicki et al., 2016), Reuse of aid items (e.g. wheelchairs, beds, or tents) or distribution items (pallets, crates, trolleys, and bins) (Carrasco-Gallego et al., 2012), Transportation planning of packaging waste for incineration or landfilling (Pålsson et al., 2013)

Table 5(d): Packaging and logistics-related product specifications (excluding transportation planning)

Defining purchase specification	Collaborating with supplier to improve the volumetric design of packaging (McKinnon, 2005, Wever, 2011), Minimizing packaging waste and material toxicity and improving recyclability, reuse, returnability, and recovery (Pålsson and Hellström, 2016, Molina-Besch and Pålsson, 2016), Local adaptation of packaging to address regional customers' requirements (Molina-Besch and Pålsson, 2016), Collaboration with suppliers to design environment-friendly packaging considering all levels of packaging together with the product through all SC levels (Svanes et al., 2010), Collaboration with suppliers for the redesign of products for less waste and more environment-friendly, the possibility of refurbishment, reuse or recycle, product simplification while retaining functionality (Bonney and Jaber, 2011), Design and use of returnable packaging instead of disposable packaging (Silva et al., 2013)
Supplier selection	Supplier selection based on the sustainability of packaging (Azadnia et al., 2015)
Contract management	Including environmental laws about packaging and packaging waste in the contract e.g. EU Directive 2004/12/EC and 2015/720, Considering the environmental sustainability of industrial packaging, i.e. the packaging between direct supplier and its suppliers, in the contracts (Verghese and Lewis, 2007)
Ordering, expediting, and evaluation	Packaging postponement (Twede et al., 2000)
With other HOs for outbound	
With other HOs for LMD	
With country office for LMD	
With other HOs / Country office for RL	Local reuse of packaging (e.g. secondary or tertiary packaging of medical equipment, gas cylinders, kegs, containers of chemicals, and glass bottles) (Carrasco-Gallego et al., 2012)

* HO: humanitarian organization, RL: reverse logistics, LMD: last-mile distribution

Table 6: The greening framework

Procurement Duties Supply Chain Areas	Defining purchase specification	Supplier selection	Contract management	Ordering, expediting, and evaluation	With other HOs* for outbound and LMD*	With country offices for LMD	With other HOs & country offices for reverse logistics
Supply chain configuration		Local procurement Selecting suppliers closer to the point of consumption and raw material				Building LDCs closer to beneficiaries rather than country offices Use of local resources for warehouse construction	Considering reverse flow of aid and the location of current recycling facilities for location planning of LDCs
Inventory and warehousing management <i>(excluding warehouse location)</i>		Considering environmental impact of suppliers' inventory for operations for supplier selection Integrated inventory management and supplier selection	Negotiating vendor-managed inventories Leveraging on purchasing power (coercive power) and incentives (non-coercive power) for incorporating sustainability into contracts	Emission reduction by reducing shipment frequency and adjusting inventory level Greener ordering and inventory management policies (e.g. green order lot-sizing, EOQ, and safety stock) Integrated ordering, inventory, and transport management	Haulage sharing with other humanitarian organizations for inventory replenishment Joint procurement and warehousing with other humanitarian organizations Joint warehousing of relief and development aid	Use of integrated electronic logistics management information system by country offices and other humanitarian organizations for inventory management Energy efficient LDC design considering refrigeration, insulation, heating, and humidity control Use of green energies for LDCs, generating green energy from warehouse activities, warehouse waste management, local sourcing of material, and acquiring green warehousing standards	Designing inventory control systems considering returned flow of products Turning recovered inventory into serviceable products at LDCs

						(e.g. BREEAM, LEED, GREENSTAR, CASBEE, and DGNB)	
Transportation and shipment management	<p>Merging fuel efficiency policies with sustainable vehicle procurement</p> <p>Consideration of sustainability criteria in fleet procurement (e.g. engine efficiency, dual-fuel fleet, and aerodynamic profiling)</p>	<p>Selecting suppliers & 3PLs with:</p> <ul style="list-style-type: none"> - higher vertical and horizontal collaboration with other suppliers & 3PLs - stronger ICT resources such as onboard vehicle monitoring systems, intelligent transportation, track-and-trace systems, and computerized vehicle scheduling system - higher capability in return load management <p>Competitive sustainability dialogue procedure with shortlisted suppliers</p> <p>Reviewing the adequacy of</p>	<p>Incorporating environmental logistical legislation and standards in contracts (e.g. ISO 14001)</p> <p>Including requirements about sustainable procurement standard ISO20400 in contracts</p> <p>Including reverse logistics terms such as buyback and return, and revenue sharing, in contracts</p> <p>Incentivizing (through contracts) shift to greener modes or intermodal transport</p>	<p>Collaborating with carrier for modal shift to greener mode or intermodal transport</p> <p>Use of multiple criteria decision making and decision support systems for green supplier evaluation</p> <p>Consolidation from one or more suppliers to close destinations</p> <p>Joint deliveries through spatial or temporal pooling</p> <p>Monitoring and evaluation of sustainability in indirect suppliers</p>	<p>Use of collaborative ICT-based platforms to increase consolidation and integrated fleet management with country offices and other humanitarian organizations</p> <p>Joint use of 3PLs with other humanitarian organizations</p> <p>Joint outsourcing of logistics to 4PLs with other humanitarian organizations</p> <p>Fleet consolidation for collaborative outbound and last-mile distribution with country offices and other humanitarian organizations</p>	<p>Improving the supervision over country offices during last-mile distribution</p> <p>Deploying fleet management software for fleet management and vehicle assignment</p> <p>Optimizing last-mile distribution routing and delivery scheduling</p> <p>Using local drivers familiar to the area of last-mile distribution</p> <p>Driver training and management</p> <p>Designing and implementing vehicle maintenance policies</p> <p>Replacing oversized and overaged vehicles</p> <p>Reducing vehicle tare weight</p> <p>Use of drones and helium-filled hybrid</p>	<p>Focusing on environmental returns rather than commercial returns</p> <p>Reuse of aid items (e.g. wheelchairs, beds, or tents) and logistics items (pallets, crates, trolleys, and bins)</p> <p>Reverse flow transportation planning of product and packaging for recycling, incineration, or landfilling</p> <p>Employing empty running last-mile distribution backhauls vehicles for reverse flow of packaging and products</p>

		sustainable criteria for 3PL selection prior to contractual agreement		Employing empty running backhauls vehicles for reverse flow of packaging and products	Use of internet for identifying mutual backhaul opportunities with other humanitarian organizations	cargo airships for last-mile distribution	
Packaging and logistics-related product specifications (excluding transportation planning)	<p>Collaborating with supplier for:</p> <ul style="list-style-type: none"> - improving the volumetric design of packaging - designing environment-friendly packaging - greener redesign of products considering refurbishment, reuse, recycling, returnability, and recovery - using returnable packaging instead of disposable packaging - product simplification <p>Minimizing packaging waste and material toxicity</p> <p>Local adaptation of packaging to address beneficiaries' needs</p>	Considering sustainability of packaging for supplier selection	<p>Including environmental laws about packaging and packaging waste in contracts (e.g. EU Directive 2004/12/EC and 2015/720)</p> <p>Considering the environmental sustainability of industrial packaging, i.e. the packaging between direct suppliers and indirect suppliers in contracts</p>	Packaging postponement	Product and packaging standardization with other humanitarian organizations	Planning with country offices for collection of packaging waste during last-mile distribution	<p>Local reuse of packaging (e.g. secondary or tertiary packaging of medical equipment, gas cylinders, kegs, containers of chemicals, and glass bottles)</p> <p>Encouraging country offices to collaborate with local businesses for recycling or incineration of packaging and unused products</p>

* HO: humanitarian organization, LMD: last-mile distribution

5.4. Cycle 2 (First Cycle of Implementation)

First, a joint meeting was held to *design* the cycle where it was agreed to aim for an initial implementation of green practices from the framework. Next, the study team prepared a roadmap for the cycle delineating the responsibilities of members, deliverables, and meetings planned over a one-year period and sent it to the management team.

The first step was to understand the status quo of sustainability in Alpha's supply chain. The study team designed questionnaires for responses from Alpha staff in the field and headquarters as well as suppliers. The management team distributed the questionnaires. Within two months, responses from Alpha staff and 12 suppliers were collected and sent back to the study team, showing extant green initiatives across the supply chain. Furthermore, the division head provided the study team with a procurement and logistics dataset of male condoms from 2013 to August 2015 (current time at cycle 2) for further orientation of researchers. The dataset included the details of all purchase orders and shipments including date, item description, weight, quantity, price, supplier/3PL details, destination, mode of transport, and intermediate inventory.

The study team took a month to analyse the dataset and the responses to questionnaires so that potential areas for improving sustainability could be identified. Based on the results, the study team selected appropriate green practices from the greening framework and developed a set of recommendations, which was sent to the management team in the form of a report. After their review, another joint meeting was held to discuss the applicability of the green practices proposed. In the following I present for each supply chain area of intervention, how green practices were put into collective inquiry, what contingency factors were identified, and whether and how the green practices were turned into action steps considering contingency factors.

5.4.1. Supply chain configuration

The configuration of the condom supply chain was investigated both for supplier facilities and local warehouses. Almost all supplier facilities were located in East Asia. Conversely, most beneficiaries were in Africa and Latin America, requiring long-haul transportation. The study team started with the green practice *local procurement* from the greening framework since it could lead to significant reductions in the distances travelled and, consequently, reduce the emissions emanating from logistics. In case local suppliers were not available, building manufacturing plants close to high-demand regions was considered next. However, several barriers were in the way. First, higher costs of production and quality inspection of non-Asian suppliers propelled Alpha to procure most of the demand from Asia. As the supply chain specialist remarked during the joint meeting at the end of the cycle:

“Recently, we made a bid for a Latin American country and we were interested in local sourcing. But the prices of local suppliers were almost double the prices of Indian

suppliers [including transportation] ... Donors assess our performance very much based on price. We need to raise the awareness that environmental sustainability sometimes comes with a cost”.

Second, ecological rubber extent presupposes the natural abundance and higher quality of rubber trees in East Asia, leaving a few countries with appropriate resources in Africa and Latin America (Warren-Thomas et al., 2015). Third, the donors imposed some constraints: most funds had to be spent annually or were tied to a specific purpose, constraining Alpha’s ability to undertake long-term facility planning.

As for the location of warehouses, besides the stocks held by suppliers, Alpha stored condoms only in national inventories. By reviewing the procurement data, the study team realized that East and West Africa are where most procurement is spent. Moreover, due to severe demand fluctuations, Alpha faced delivery delays and increased air transport costs. Building regional warehouses could add a supply chain echelon which to cushion fluctuations and decrease air transport usage. Here again, there were several barriers: limited financial resources, short-term and earmarked funds, import/export barriers, and diversity and customization of products by each country, which acted against establishing regional warehouses. Chapter 6 discusses in detail the environmental analysis of supply chain configuration and the results achieved.

The CMR team continued to brainstorm on the development of original action steps to improve supply chain configuration. For suppliers, speeding up the process of prequalification for several African suppliers and ordering from existing prequalified suppliers closer to destinations (considering available stocks and capacity) were the action steps that were implemented.

In addition to supply chain configuration, coordination among supply chain actors – an area contingent on configuration (Rudberg and Olhager, 2003) – was recognized as having a major role to play in greening. At the end of cycle 2, the CMR team revisited the greening framework and decided to focus on coordination as a distinct supply chain area of intervention in the next cycle.

5.4.2. Inventory and warehousing management

Inventory and warehousing greening in cycle 2 was focused on fostering collaboration among other HSC actors. Building on the green practices of *joint warehousing with other humanitarian organizations* and *joint warehousing of relief and development aid* adopted from the greening framework, the management team strengthened collaboration with another international humanitarian organization which coordinates inter-organizational logistics operations, to facilitate the shared use of specific international inter-organizational humanitarian depots located in several strategic locations around the world. Coexistence of other humanitarian organizations with mutual fields of operation, higher standardization, and lower diversity of relief items with waived customs were facilitating contingency factors for joint inventories.

For development products, Alpha initiated collaboration with a public United States humanitarian organization, another major procurer of condoms, for joint warehousing. Moreover, the management team explored procurement synergies with other humanitarian organizations, leading to the signing of a joint long-term agreement with another international humanitarian organization to source 30 mutual products from two suppliers. Another agreement with a non-profit organization initiated joint procurement of male condoms. Both joint agreements offered a leveraged position to Alpha over suppliers that, in turn, facilitated incorporation of sustainability into supplier practices. However, unlike relief operations, inter-organizational collaboration in development programs came into force only for mutual products.

5.4.3. Transportation and shipment management

During cycle 2, the study team conducted a preliminary carbon footprinting of the supply chain based on the dataset and the data collected from questionnaires. The carbon footprinting analysis identified outbound logistics as the hotspot, suggesting it as the starting point for greening transportation. The study team further scrutinized the dataset and detected individual shipments from Asian suppliers that were dispatched to the same or neighbouring African countries concurrently. The findings were placed in collective inquiry at the CMR team meeting to investigate the causes. The problem was partly due to insufficient intra-department management; for example, the procurement officer in charge of Malawi demand worked in isolation from the officer managing neighbouring Mozambique. Contingency theory asserts that subsystems dealing with highly uncertain environments, such as humanitarian organization's departments, have members oriented to task accomplishment rather than interpersonal relationships with other subsystem members (Lawrence and Lorsch, 1967).

Given that many shipments shared routes either fully or partly, the greening framework was able to assist with these practices: *consolidation from suppliers to close destinations* and *joint deliveries through spatial or temporal pooling*. For shipments with proximate suppliers (origins), consolidation was not a feasible option.

“In our model [of supply chain], we don't really consider this. It's the suppliers who manage the shipments. So, if the orders are issued to two different suppliers, each will have its own contract and own shipper and those shippers may not be the same, even if both suppliers are located in the same country”

stated the contract associate. The department distributes the demand received from country offices among its prequalified suppliers, who were unaware of each other's operations. Therefore, consolidation at origin requires fundamental supply chain redesign to integrate the suppliers' orders and align them for shipment consolidation.

Next, the study team proposed consolidation of shipments with close destinations in regions with high demand (mostly east and west Africa). It was seen as a feasible solution and put into action. However, the results were not satisfactory at the end of cycle 2;

“We have tried several times to ship the goods to a regional warehouse and then distribute to neighbouring countries... It took us months! Because when you enter goods in one country, then you need the support of national authorities to move the cargo somewhere else... That’s almost impossible. It was so difficult that sometimes we even exported it back to Europe and then again to the neighbouring country! It is more complicated than it seems!”

explained the regional procurement manager. One contingency factor was the complex customs regulations of national governments for development products (as previously found for supply chain configuration). Another factor was the low cooperation of national authorities. The problem of host governments imposing restrictions on HSCs through extreme bureaucracy and import/export barriers is supported by Kunz and Gold (2017) and Kunz and Reiner (2016).

Apart from internal consolidation, the study team proposed *joint use of 3PLs with other humanitarian organizations* and *fleet consolidation for collaborative outbound with other humanitarian organizations*. For relief products, Alpha collaborated with two other international humanitarian organizations to share freights for outbound logistics, customs clearance, and last-mile distribution. This action step was shown to be successful with several emergency shipments consolidated and distributed during cycle 2. It also allowed Alpha to benefit from the better access of the other two organizations to certain regions and their freight price agreements. For development items, however, there was no organization hosting a coordination mechanism, and inter-organizational collaboration was sporadic. For example, Alpha had already collaborated with two other major humanitarian organizations to use similar 3PLs for some shipments. Besides the collaboration's temporary nature, the initiative was instituted for pure economic interests and greening was an ancillary benefit. To improve collaboration over development programs, the study team, employing the green practice *use of collaborative platforms to increase the integration of fleet management with other humanitarian organizations*, suggested developing an organized platform to increase coordination among development organizations. For example, a search of procurement bids of several partner development organizations revealed more than 50 notices for Ethiopia, many with similar delivery times and adjacent suppliers. Although the division head was in favour, developing such a platform was beyond the procurement department’s authority, requiring higher-level backing from all development organizations, as stated by the division head;

“The harmonization of development programs stops at contractual level and there is no unified mechanism for integration. Development organizations are not aware of each other’s shipments.”

With last-mile distribution, establishing collaboration is even more challenging due to field specificities such as poor infrastructure and scattered rural areas. According to Burlando et al. (2006, p. 5) *“With the existing operations, it is quite possible that a WHO medical van would visit a village one morning, then a WFP food truck would visit that afternoon”*. Building upon the green practice *Fleet consolidation for joint last-mile distribution with other humanitarian organizations*, Alpha and a logistics leader

humanitarian organization expanded their collaboration into last-mile distribution through a joint pilot operation in the Democratic Republic of the Congo during the second cycle. They mapped out where joint operations and deliveries were possible. The collaboration achieved reduced environmental emissions from last-mile distribution by decreasing the cumulative number of trips by both humanitarian organizations.

5.4.4. Packaging and logistics-related product specifications

Before initiating collaboration, the department engaged in collaborative dialogues with suppliers about greening their operations. A set of Eco requirements for condom manufacturers was defined including acquiring ISO 14001 certification, meeting local regulations on wastewater treatment and air pollution, using recycled material, and eliminating plastic from outer packaging.

The CMR team started from the logistics implications of packaging because the division head, based on her managerial insights, believed opportunities existed for improvement. Since condoms are bulky but light, freight load is well below its maximum weight capacity causing the freight to *cube out before it weighs out* (McKinnon, 2005). Therefore, the study team delved into the volumetric analysis of freight transport because increasing the weight reduces the overall environmental impact of transportation (McKinnon, 2005, Wever, 2011). With three levels of packaging, the study team proposed increasing the number of condoms per secondary packaging to maximize the fill rate during transportation since modifying secondary packaging to fit logistical needs was easier than primary packaging where strict rules and regulations applied (Sohrabpour et al., 2012). A contextual contingency factor in Alpha's last-mile distribution was supporting the increase: in both development and relief last-mile distribution, condoms were often distributed among beneficiaries in the form of strips from the secondary packaging, restricting its function to the point of distribution. Therefore, due to the specificities of the humanitarian context and different perceptions among beneficiaries, delivering secondary packaging was not mandatory, as in commercial supply chains.

After consulting the quality control department, a pilot test was conducted with a supplier to increase the number of condoms per secondary packaging (was 144). A stratification structure separated by cardboard made it possible to load 1000 condoms per secondary packaging (10 squares of 100). The new packaging arrangement created considerable improvement in fill rate and volumetric freight design. There was, however, a drawback; more condoms were contaminated from lube leakage and had to be discarded.

Another action, in line with pooling resources for inventory and transportation, was to expand collaboration with the aforementioned public United States humanitarian organization to standardize and integrate packaging. Here, one factor that impeded the standardization of development products was the diversity and customization of packaging based on country recommendations. Finally, the study team identified *less-than-container-load* shipments by several carriers. After joint discussions, the division

head prohibited less than container loads for port-to-port shipments, excepting intermodal transport due to the risk of theft during modal shift.

5.5. Cycle 3 (Second Cycle of Implementation)

The cyclic approach of collaborative research posits that a fact-finding stage is performed at the beginning of each cycle involving evaluation of previous cycle(s), seeing what was learnt, and proposing corrective actions for the new cycle (Coghlan, 2011). The study team sent a report to the management team evaluating the action steps implemented during cycle 2 and suggesting further green practices based on outcomes. Similar to cycle 2, a joint meeting was held at headquarters to design cycle 3 and discuss implementation of newly suggested green practices. The implementation and scrutiny of results in cycle 3 took 17 months. The followings describe the green practices, contingency factors, and action steps in cycle 3.

5.5.1. Supply chain coordination

One of the sector-specific responsibilities of the procurement department is coordination of logistics with implementing partners at the downstream of supply chain. From the beginning of cycle 2, a palpable impediment was low visibility of the procurement department over operations of country offices. Accordingly, the CMR team revisited the greening framework and focused on supply chain coordination as a distinct area of intervention. The procurement department's reach and visibility ended on transferring products to country offices. The division head explains the situation at cycle 2:

“Alpha mostly ensures delivery to country offices; thereafter, it is up to the country offices to take on the distribution...We don't know much what happens to condoms after delivery to country offices. We have no idea whether they reach beneficiaries, expire in stocks, or burn due to superstitions!”²

This bifurcation was the root of many logistics problems affecting not only last-mile distribution but also amplified over the upstream of the supply chain. The department was unable to make opportune demand forecasts due to low visibility on country stocks;

“We don't have enough information about national stocks much in advance. So, we are afraid to end up with tons of condoms that nobody wants”

² The quotation reflects the situation of Alpha at the start of cycle 2 in 2015 and is no longer valid. As described by the results, by the end of the collaboration, Alpha was able to significantly improve its visibility over the products after delivering to country offices, an effort that is still ongoing. As stated by the division head when collaboration ended:

“The goal of [Alpha] is to be able to fully track product movements until reaching beneficiaries and we are still trying to improve it.”

the regional procurement manager disclosed. Fundraising activities were also adversely affected;

“... it is important to have a clear and right projection to have the appropriate fundraising based on that”

she added. Sudden stock shortages at country level in the absence of headquarters' foresight put pressure on suppliers. Sometimes, a large urgent demand from a country office had to be shared between two or more suppliers leading to several shipments. It was also the main cause of air shipments discharging high emissions.

Based on the theoretical underpinning, the low visibility problem is rooted in the decentralized organizational structure of humanitarian organizations. Contingency theory argues that organizations dealing with heterogeneous or uncertain environments, such as humanitarian organizations, tend to have more boundary units and lean more towards decentralization (Thompson, 2003, Tosi and Slocum, 1984). Therefore, to make a fit, green practices should not only be aligned with the contextual contingency factors but also the visibility of headquarters over field operations (the dashed line in Figure 4) should be improved.

The study team investigated the use of *integrated electronic logistics management information system* and *ICT-based platforms* by country offices and headquarters. The team focused on implementing tracking and tracing technologies such as barcodes throughout the HSC to improve visibility of transportation and inventory management. By the end of cycle 3, major action steps on the use of ICT technologies and barcodes were implemented by headquarters, allowing for the tracking of wrapped pallets until final distribution.

At policy level, country offices were encouraged to exercise greater accountability to headquarters concerning their stocks and last-mile distribution by reporting regularly. Moreover, in line with the green practice *mutual engagement of the humanitarian organization and country office in last-mile distribution*, the management team boosted the active participation of headquarters representatives in country offices.

At the end of the collaborative project, efforts to bridge the visibility gap were still in progress with significant advances made. This quotation from the division head at the end of cycle 3 sums up the transition:

“We can put a checkmark on this [use of technologies for inventory and last-mile distribution]. We have done a lot to increase the visibility of headquarters in country offices over the past years... We have been increasingly involved in last-mile distribution recently due to our fiduciary responsibility.”

Moreover, following efforts to accelerate the prequalification process in cycle 2, two African suppliers became prequalified by the end of cycle 3.

5.5.2. Inventory and warehousing management

Efforts to foster collaboration with other supply chain actors continued into cycle 3, and the increased visibility sharpened the focus on country office inventories. The study team tried to address inventory problems such as frequent small shipments and emergency air deliveries by considering two green practices from the framework: *emission reduction by reducing shipment frequency and adjusting inventory level* and *greener inventory management through order lot sizing and safety stock*. However, some debates about appropriate inventory levels and safety stocks took place. In addition to the risk of excess ordering, the reluctance of national authorities to fund was another barrier acknowledged by the division head:

“More and more donors are saying we have been funding contraceptives now for 50-60 years... They want to see graduation plans and they want to reduce funding so that national governments step up and fund more from their own national budget. That is not happening in many countries; That is the elephant in the room! Many countries are not so interested in their contraceptive agenda. It is so under-funded and neglected and difficult to get the political commitment from governments to fund it.... therefore, to tell them that they should keep even higher safety stocks is very difficult, while they don't have AT ALL enough stocks as it is”.

From a theoretical perspective, low national funding and reluctance by national authorities to support contraceptive planning are contingency factors that thwart green inventory practices being adopted. To address the problem, country offices were encouraged to devise long-term contraceptive plans and update them annually. Such plans included details of projected national programs, campaigns, prediction of emergencies, and the estimated resultant demand. Moreover, in some countries, Alpha worked with more than one implementing partner – for example, country office, ministry of health, and local NGOs – each holding their own stocks separately. The management team tried to promote cooperation and information sharing among its implementing partners in each country so that each other's stocks could be used in case of shortages.

5.5.3. Transportation and shipment management

While the action steps started in cycle 2 were still progressing, reverse logistics were given attention in cycle 3. Alpha relied on an internal document on the safe disposal and management of unused, unwanted contraceptives, World Health Organization (WHO) guidelines for safe disposal of unwanted pharmaceuticals in and after emergencies (WHO, 1999), and national regulations for handling reverse logistics and unused condom disposal.

The CMR team was motivated to restudy reverse logistics on becoming aware of the shortcoming that the guidelines offered little on logistics nor gave consideration to sustainability as a main criterion in selecting disposal methods. Handling the reverse flow of unused condoms was already included in suppliers' contracts for recalled, damaged,

and substandard products. However, for unsolicited donations and expired condoms, no specific reverse logistics planning was in place. The study of Kovács and Spens (2011, p. 37) advocated the problem: “*unsolicited supplies have led to the incineration of many donations and reverse logistics is yet to be researched in the humanitarian context*”. For Alpha, the problem was partly due to the low visibility of headquarters over country office operations.

“In one case in [country’s name], the government told us that they will be meeting the national regulations for the disposal. When we asked for the pictures, it was basically a dug hole, they just put fuel, and burnt the condoms. That was how they were disposing according to the government guidelines!”

stated the project coordinator. The efforts to improve visibility in cycle 3 also contributed to the better management of reverse logistics. Another cause was poor facilities in developing and humanitarian regions for recycling and environment-friendly disposal.

“In [country’s name], there was only one company that met the standards for handling disposal and they just had a very small oven. I remember once they were burning condoms for one week.”

the project coordinator remarked. After further data gathering and analysis, the study team prepared a reverse logistics planning report including a review of suitable disposal methods and their prioritization based on environmental friendliness. The report focused on the primary packaging of condoms, made of polyethylene and aluminium, because the remaining packaging was made from cardboard boxes that could be recycled even with limited facilities. The main challenge was separation of condoms from primary packaging, especially with mass quantities. In a nutshell, the following disposal methods were suggested in the order of environmental friendliness: return to authorized recycling facilities, high-temperature incineration, low-temperature incineration, and landfill. Figure 6 shows the reverse logistics planning of returned unused condoms in the order of environmental friendliness from top to bottom.

Figure 6: Reverse logistics planning of returned unused condoms in the order of environmental friendliness (from top to bottom)

Where recycling facilities were lacking, the plan recommended accumulating products at a collection point before transportation to a recycling facility, preferably using empty backhaul vehicles, as suggested by the greening framework. Where landfill was the only option, the plan suggested using a shredder or compactor to degrade the packaging prior to disposal so that the risk of scavenging – a prevalent contingency factor in developing and humanitarian settings – was mitigated. Close supervision of all transportation and inventory operations was crucial to prevent scavenging and pilferage. The plan was presented for joint discussion and then revised based on managerial insights and past experiences. For example, instructions to country offices were added in response to the management team recommendation that upfront agreements should be established with local facilities possessing high-temperature incinerators, such as cement manufacturers, to access their kilns. After approval, the guidelines were communicated to country offices in the form of a standard operating procedure.

5.5.4. Packaging and logistics-related product specifications

While pilot tests with suppliers and the aforementioned public organization at United States continued in cycle 3, the team focused on improving leaflets and cardboard packaging. Based on the green practice *local adaptation of packaging to address regional customers' needs*, the study team proposed printing leaflets solely in the language of the destination country to reduce leaflet size. The management team withheld the approval because it deprived Alpha of the benefits of economies of scale in purchasing similar products. Brainstorming by the CMR team fashioned the following action steps: printing on both sides of the leaflet, reducing the font size and making the text more succinct, using thinner recycled paper, and standardizing leaflet material and content for all suppliers. Moreover, the cardboard in the outer packaging decreased from three layers to two without diminishing the quality.

5.6. Synthesis of Findings

Table 7 summarizes the findings from the action research. Columns *green practices*, *contingency factors*, and *action steps* correspond to the third, fourth, and fifth research questions of the thesis, respectively. Green practices were either adopted from the greening framework or developed during the implementation cycles. As for contingency factors and their categorization in the theoretical underpinning, few, albeit important, factors fall into organizational categories. *Low visibility of headquarters over country offices' operations* was identified as an influential contingency factor related to organizational structure. Larger humanitarian organizations tend to decentralize their organizational structure to improve responsiveness and performance (Gatignon et al., 2010). In doing so, however, poor alignment among decentralized units, especially between headquarters and implementing partners, can impair traceability and visibility. *Insufficient intra-departmental control* at procurement department level was another contingency factor related to organizational subsystems. On the other hand, most of the contingency factors identified belong to contextual categories vis-à-vis funding, stakeholders, and field of activity. Lastly, the right-hand column presents the action steps through which humanitarian organizations cope with the contingency factors identified.

Table 7: Recommended green practices, identified contingency factors, and implemented action steps

	Green practices <i>Selected from the greening framework or developed based on the outcomes of prior implementation by the study team</i>	Contingency factors <i>Identified as having an impact on the implementation of green practices (the pertaining category from the theoretical underpinning mentioned in parenthesis: ORGANIZATIONAL-related categories presented in capital letters and contextual-related categories in italics)</i>	Action steps <i>Adopted, customized, or developed green practices to cope with or to consider the identified contingency factors that were implemented</i>
Supply chain configuration and coordination	Local procurement	Higher costs and lower quality of suppliers in developing countries and humanitarian setting (<i>stakeholders</i>)	Placing a bid for local sourcing in Latin America (F)* Speeding up the prequalification of local suppliers (S) Ordering from existing prequalified suppliers closer to destination (S)
	Building manufacturing plants or regional warehouses in east and west Africa (SD)**	Short-term funding (<i>funding environment</i>) Earmarked funding (<i>funding environment</i>) Donors' limited awareness of greenness (<i>funding environment</i>) Stricter regulations for import/export of development products (<i>stakeholders</i>) Higher customization and diversity of development products (<i>field of activity</i>)	No action steps during collaboration, but building regional warehouses was considered a solution to be discussed with donors and other stakeholders. Chapter 6 investigates this issue.
	Collaboration with country offices for last-mile distribution	Low visibility of headquarters over country offices' operations (<i>ORGANIZATIONAL STRUCTURE</i>)	Integrating ICT systems at country offices and headquarters (S) Tracking wrapped pallets using barcodes (S) Enhancing the presence and circulation of headquarters' representatives in country offices (S) Improving the reporting of country offices on their inventories and last-mile distribution (S)
Inventory and warehouse	Joint warehousing and procurement with other humanitarian organizations	<i>For relief products:</i> Coexistence of humanitarian organizations in a region (<i>stakeholders</i>) + ***	<i>For relief products:</i> Collaboration with a logistics leader humanitarian organization to facilitate the shared use of depots (S)

		<p>Established inter-organizational coordination mechanisms (<i>stakeholders</i>) +</p> <p>Higher standardization and lower diversity of relief (<i>field of activity</i>) +</p> <p>Waived customs (<i>field of activity</i>) +</p> <p><i>For development products:</i> Inter-organizational collaboration limited to mutual products (<i>stakeholders</i>)</p>	<p><i>For development products:</i> Collaboration with a public United States humanitarian organization for joint warehousing of male condoms (S)</p> <p>Signing long-term agreements with two other humanitarian organizations for procuring more than 30 mutual products (S)</p>
	Improving inventory management to reduce emergency air transport and frequent replenishment shipments	<p>Low national funding (<i>funding environment</i>)</p> <p>Reluctance of national authorities to facilitate contraceptives planning (<i>stakeholders</i>)</p> <p>Low cooperation among national authorities (<i>stakeholders</i>)</p>	<p>Holding more safety stocks at national inventories (F)</p> <p>Devising long-term plans at national level for contraceptives needs and updating it annually (S)</p> <p>Promoting information sharing among national delegations to harmonize national inventories (S)</p>
<i>Transportation and shipment management</i>	Consolidation of shipments for either adjacent suppliers or adjacent destinations	<p><i>For consolidation from suppliers:</i> Insufficient intra-departmental control (<i>ORGANIZATIONAL SUBSYSTEMS</i>)</p> <p>Low integration among suppliers (<i>stakeholders</i>)</p> <p><i>For consolidation at destination:</i> Stricter regulations for import/export of development products (<i>stakeholders</i>)</p> <p>Low cooperation by national authorities (<i>stakeholders</i>)</p>	Consolidation of shipments for two adjacent African countries (F)
	Joint outbound logistics and last-mile distribution with other humanitarian organizations	<p>Coexistence of several humanitarian organizations operating in a region (<i>stakeholders</i>) +</p> <p>Better access of some humanitarian organizations to specific regions (<i>stakeholders</i>) +</p>	<p><i>For relief products:</i> Collaboration with two other humanitarian organizations to share freights for outbound logistics and customs clearance (S)</p> <p>Collaboration with a logistics leader humanitarian organization for last-mile distribution through a joint pilot operation in Democratic Republic of Congo (S)</p>

			<i>For development products:</i> Collaboration with two other humanitarian organizations to share a 3PLs for outbound logistics (S)
	Integrated online platforms for inter-organizational transportation and fleet management for development programs	Inter-organizational collaboration limited to similar products (<i>stakeholders</i>) Poor managerial support at different organizations to implement coordination mechanisms (<i>stakeholders</i>)	No action was taken
	Collaboration with country offices and delegations for RL planning (SD)	Unsolicited donations (<i>funding environment</i>) Scavenging of disposed products in developing countries and humanitarian setting (<i>field of activity</i>) Poor recycling facilities in developing countries and humanitarian setting (<i>field of activity</i>)	Developing a standard operating procedure for country offices to sustainably recycle and dispose of expired products (S)
Packaging and other logistics-related product specifications	Improving the volumetric usage of freights through packaging	Different packaging needs and perceptions of beneficiaries from commercial customers (<i>field of activity</i>) +	Increasing the number of condoms in secondary packaging from 144 to 1000 in a pilot test with a supplier (S) Prohibiting 'less than container loads' for port-to-port shipments (S)
	Inter-organizational collaboration for standardization of packaging (SD)	Different packaging needs and perceptions of beneficiaries from commercial customers (<i>field of activity</i>) + Inter-organizational collaboration limited to similar products (<i>stakeholders</i>)	Collaboration with a public United States humanitarian organization to standardize and integrate packaging (S)
	Improving leaflets and cardboards in packaging (SD)	Benefiting from economies of scale in purchasing from suppliers (<i>stakeholders</i>) Different packaging needs and perceptions of beneficiaries from commercial customers (<i>field of activity</i>) +	Printing leaflets only in the language of the destination country (F) Printing on both sides of the leaflet, reducing font size and making the text more succinct, using recycled and thinner paper, and standardizing the material and content of leaflets for all suppliers (S) Decreasing cardboard material in outer packaging from three to two layers (S)

* S: action step implemented successfully, * F: action step failed or was not implemented, ** SD: self-development, *** +: facilitating contingency factor

CHAPTER 6

Results (ii): Supply Chain Design for Environmentally Sustainable Humanitarian Operations

This chapter attends to research question 2 about the causes of unsustainable operations in HSCs and partly to research question 5 about the considerations at supply chain design level to improve the environmental sustainability of HSCs. It uses a mixed-methods research as described in Chapter 4. The data is collected from the collaborative research project as described in Chapter 5. The application of the mixed-methods can be divided into two parts; The first part conducts a focus group with humanitarian practitioners to address research question 2. The focus group was in fact one of the brainstorming sessions that was held in the premises of Alpha during three years of collaboration with the Alpha. The second part is conceptual in nature and proposes a new supply chain configuration to address research question 5.

6.1. Identifying the Causes of Unsustainable HSC

As a part of the collaborative research project and in line with the research objectives, the CMR team was interested in finding the main causes of unsustainable humanitarian operations. Focus group has been identified as a promising point of entry to the topics of discussion where little prior information is in hand (Liamputtong, 2011). The use of focus group in combination with other methods in social science research leads to generation of more fruitful insights than its use as a self-contained method (Liamputtong, 2011, Morgan, 1996) making it a perfect choice for mixed-method research. As such, focus groups are best to be applied as an initial exploratory phase of a study (Bloor et al., 2001).

The group which participated in the focus group consisted of four participants: a supply chain specialist, a regional procurement manager, and the head of procurement and supply division (the division head), all from Alpha as well as a researcher as the group moderator (the author of the thesis). The focus group was held in the Alpha's headquarters in

structured style (Morgan, 1996) meaning that before the start of the session, the topic of discussion and the questions to be asked were sent to each participant by the moderator via email. The focus group session took about two hours. The practitioners provided their viewpoints about the issues impeding green HSC. The moderator actively engaged in the discussion by providing his knowledge and discoursing the academic aspect of the issue. In addition to direct engagement in the discussions, the moderator encouraged interaction among participants by asking provocative questions and intervening in the discussion when the group was getting sidetracked.

The objective of the focus group was to identify the possible causes of unsustainable HSC. At the beginning, the moderator provided a brief description of environmental sustainability with some examples of unsustainable operations from other humanitarian organizations to ensure that all the participants have sufficient and joint understanding of the topic. Next, the group delved into the topic and articulated their ideas. By the end of the session, a general consensus was reached among the participants about the topic of discussion.

After the session, the moderator transcribed the dialogues. Next, the transcripts were coded to find the causes of unsustainable HSC in the studied organization. Two levels of codes emerged from the analysis. The first higher level corresponded to the overarching causes that impacted on environmental sustainability. The second level were sub-causes of the first level. In the following extract, for example, the participants are discussing about the role of donors in environmental sustainability:

Researcher (moderator): *Do you think that any other stakeholder in the supply chain of [organization's name] has a significant influence on environmental issues?*

Supply Chain Specialist: *I think donors play an important role in [environmental] sustainability. When donors do not ask us for that, it is difficult to put it into agenda with such limited resources and time.*

Division Head: *I absolutely agree with [supply chain specialist's name]. I think we should raise donors' awareness about the importance of that. We see many unsustainable things happening in the field that donors are not aware of... but those things are just taken for granted.*

Supply Chain Specialist: *But you know it is difficult to draw their attention to that. They are more interested in seeing how efficient we perform!*

Researcher (moderator): *I can also support that from academic aspect. We have several studies that show donors influence greatly on performance by for example tying up their donation to specific purposes...*

The extract represents an example of *fully articulated account* (Wilkinson, 1998), i.e. when participants build upon the ideas of each other in a supportive way. The first-level code in this extract was indexed as *donors* as one of the main causes. At next level, the sub-factors identified from the extract were: *donors' awareness about environmental sustainability* and *tying up donations to specific requirements*.

In the same way, the whole focus group discussions were coded to extract first and second level codes. Eventually, five main causes were identified viz. *supply chain configuration*, *material and waste*, *logistics emissions*, *donors*, and *humanitarian specificities*. In order to provide a better illustration of the identified causes a cause-and-effect diagram was used, as described in Chapter 4. Due to the alignment with the purpose of focus group, it was used to visualize and report on the analysis of the focus group discussions. The resulting diagram, shown in Figure 7, was sent to all participants and was approved to contain the key causes of unsustainable HSC.

Figure 7: The cause-and-effect diagram of the causes of unsustainable HSC found through the focus group

6.1.1. Prioritizing the causes

The cause-and-effect diagram is an appropriate tool to identify and visualize the causes of a problem; however, it does not help to determine the causes that affect the problem the most (Irina and Inga, 2015). Prioritization helps to highlight the causes with more room for improvement to start from. The participants were asked to rate the causes based on the potential opportunities for improvement within the organization. A standard five-point scale was used as follows: not important (1), less important (2), so-so (3), important (4), and very important (5). The respondents assigned one of the five points to each cause category. Then, the average of the assigned points to each category was taken to achieve an overall ranking. Table 8 shows the ranking of identified causes based on the participants' points.

Although participants' preferences were elicited individually after the focus group, no major variations were observed. It was because the participants had already discussed and reached a consensus during the focus group session. This was also palpable from the statements of participants about the reason behind their judgements. In the following, some of the quotes, extracted from the focus group, that provide reasons for the rating are reported.

Table 8: Ranking of cause categories based on participants' points

	Practitioner 1	Practitioner 2	Practitioner 3	Researcher	Average
Supply chain configuration	5	4	5	3	4.25
Logistics emissions	3	4	5	3	3.75
Material and waste	3	4	4	2	3.25
Donors	2	3	3	2	2.5
Humanitarian specificities	1	2	1	3	1.75

*“I think we have little influence on **humanitarian specificities** to change them. They are natural characteristics of our working environment. We can never have an accurate prediction of when and where the next crisis is going to happen, no matter what...”*

*“**Donors** are donors. We should adapt with what they want, not the other way around!”*

*“I think improving the environmental sustainability through management of **material and waste** is a great area to start with for typical humanitarian products, but not for our organization. Medical products and even their packaging are highly standardized and we can't easily change them.”*

The quotes above highlight why humanitarian specificities, donors, and materials and waste are ranked as the lowest causes. Prioritizing humanitarian specificities such as uncertainty of demand and timing (the sub-causes) as the area with the least improvement potential is congruent with the findings of Kuo et al. (2017) expressing that while uncertainty is a major influential factor in sustainable supply chains, it is also the most difficult one to address. The next step was selecting one of the most important causes and exploring greening solutions to address it. Since the operations of the organization were expanding to new countries, managers were interested in how to configure the supply chain in way that it is more efficient and environmentally sustainable. Supported by the academic literature, it was agreed that greening solutions for the cause *supply chain configuration* should be explored.

Looking at the identified sub-causes, i.e. *long distance of suppliers from beneficiaries, location of hubs and inventories, and limited number of local hubs*, it was obvious that the distance of suppliers from beneficiaries could not be reduced nor it was not possible to locally procure the items due to the lack of African suppliers and the advantage of Asian suppliers in terms of raw material and price. There were already ongoing discussions among Alpha managers about acquiring hubs in Africa to increase organizational responsiveness. This collaborative research project provided an opportunity to also investigate the optimality of hubs from environmental sustainability perspective.

6.2. Supply Chain Configuration Scenarios Including Regional Hubs

Humanitarian organizations have recognized the advantages decentralized supply chain configuration through building regional hubs. UNHRD and regional hubs deployed by International Federation of Red Cross are real-life benchmarks that were shown to outperform centralized HSC configuration in terms of cost, responsiveness, and effectiveness (Gatignon et al., 2010, Charles et al., 2016). By the same token, Alpha was interested in building hubs in Africa, as the destination of around 90% of its products, while the impact of such hubs on environmental sustainability of the supply chain was the question of researchers and organizational managers.

The term hub in HSC “*describes locations that provide consolidation and deconsolidation functions to allow more efficient shipping*” (Stauffer et al., 2016, p. 194). We use the term to refer to central warehouses which satisfy nearby countries’ demand. Building hubs in high-demand and disaster-prone regions in Africa could protect the organization against demand fluctuation at national level and prevent disturbances to reach to the suppliers’ production by keeping prepositioned stocks, as discussed in Chapter 5. As such, hubs add a cushioning echelon to the HSC between the suppliers at the upstream and the volatile humanitarian demand at the downstream. Since in the current supply chain configuration, the organization relies mostly on supplier-held-stocks, another benefit was apportioning supply chain inventory between supplier stocks and hubs which in turn reduces the service level of *echelon inventory* (hubs) as compared to the single inventory supply chain configuration (Chopra and Meindl, 2013).

Coming to Africa, the researchers were faced with the questions of *how many hubs?* and *where in Africa?* To answer these questions, historic procurement organizational data of the past three years were scrutinized. The analysis showed that within the past three years in Africa, Alpha had not sent any shipment to northern African countries (including Egypt, Libya, Morocco, Tunisia, and Algeria). Also, in the same period, merely 9 out of 358 shipments (2.5%) were sent to southern African countries (8 shipments to South Africa and 1 to Botswana). This meant that almost all shipments were sent either to eastern or western African countries. Therefore, building hubs near seaports in east and west Africa was considered as a viable option. Considering several factors such as availability of seaports, security, closeness to other countries in east or west Africa, and logistics infrastructure, Kenya and Nigeria were selected as candidate locations for the scenarios with hubs in east and west Africa, respectively. Figure 8 visualizes the flow of products for the current supply chain configuration (top) and the supply chain configuration with two hubs in east and west Africa (bottom).

Figure 8

Top: The Current supply chain configuration

Bottom: Conceptual supply chain configuration with Two Hubs in East and West Africa

6.2.1. Scenario development

The researchers considered three supply chain configuration scenarios; First, the current supply chain configuration in which products are sent from the suppliers' stocks in China and India to target countries. Second, two conceptual scenarios with hubs and different inventory replenishment periods as substitutes of the current supply chain configuration. The environmental analysis of conceptual scenarios helps to understand how the

environmental impact of the HSC would have been if regional hubs were added to the current supply chain configuration. In these scenarios, a certain amount of stock is sent by the suppliers to the hubs and kept there as prepositioned inventory which will be later sent to proximate in-demand countries.

Carbon footprinting was chosen as a basis for comparison and decision-making because it is a good estimator of supply chain environmental impact by presenting global warming potential (Montoya-Torres et al., 2015). The system boundary of carbon footprinting, as shown in Figure 9, was set from the supplier stocks to national stocks since adding hubs does not affect the upstream operations nor the last-mile distribution.

Figure 9: Carbon footprinting boundary

Up: Current supply chain configuration

Down: Supply chain configuration with regional hubs

A periodic review inventory management is considered for both conceptual supply chain configurations. Since the organization works only with specific pre-qualified suppliers in India and China, the production and inventory capacity of these suppliers were limited. With the current supply chain configuration, upon the occurrence of an emergency, the impacted country issues a large-size demand which is often difficult to satisfy by suppliers immediately given their production capacity. In such situations, the suppliers have no alternative but to break down the demand and deliver it in several shipments while the urgent shipments are delivered by air. On the other hand, adding hubs with a periodic review system allows suppliers to have a clear estimation of the demand for the upcoming period and allocate their resources duly to meet the demand. Prepositioning inventory in the hubs and replenishing at regular intervals could also absolve the need for the emergency air deliveries.

Based on the consultation with the respondents, country offices could make a projection of their demand within the next two to four months based on historic data, planned

programs and campaigns to be held, and estimation of emergency. For periods longer than four months, the demand projection would be inaccurate and risky due to demand fluctuations and the occurrence of multiple emergencies which might alter the demand drastically. Therefore, the researchers developed two scenarios for the supply chain configuration with hubs: one scenario considers inventory replenishment of hubs every two months and another one every four months. As a result, the following three scenarios were developed:

- **Scenario A:** The current supply chain configuration with direct shipments from suppliers in China and India to target countries in Africa
- **Scenario B:** A conceptual supply chain configuration with two hubs in Kenya and Nigeria with inventory replenishment of every two months
- **Scenario C:** A conceptual supply chain configuration with two hubs in Kenya and Nigeria with inventory replenishment of every four months

Historic data of the past year was used to determine the inventory for the two-months and four-months scenarios. Table 9 and 10 show the demand specifications of east and west African countries for the two-months and four-months scenarios, respectively.

Table 9: Demand specifications of east and west African countries for the two-months scenario

<i>Period</i>	<i>East African Countries' Demand (units)</i>	<i>West African Countries' Demand (units)</i>
January-February	136,334	-
March-April	261,550	128,500
May-June	291,094	460,500
July-August	818,607	268,274
September-October	82,400	77,600
November-December	77,000	61,600
<i>Demand Standard Deviation</i>	<i>279,795.44</i>	<i>170,215.37</i>

Table 10: Demand specifications of east and west African countries for the four-months scenario

<i>Period</i>	<i>East African Countries' Demand (units)</i>	<i>West African Countries' Demand (units)</i>
January-April	397,884	128,500
May-August	1,109,701	728,774
September-December	159,400	139,200
<i>Demand Standard Deviation</i>	<i>494407.06</i>	<i>343521.19</i>

6.2.2. Carbon footprinting of the scenarios

Measuring the carbon footprint of scenarios with hubs and comparing them with the current supply chain configuration can delineate whether the scenarios with hubs offer any significant advantages, apart from the other benefits they offer, in terms of carbon footprinting. For all the scenarios, the Greenhouse Gas Protocol (2018) was used in order

to calculate carbon footprint. The protocol identifies different gases generated by transport activities including CO₂, CH₄, N₂O, HFCs, PFCs, and SF₆. In this study, only the first three gasses were considered to be relevant for carbon footprinting calculations. Greenhouse Gas Protocol's transport tool (2018) was used for the carbon footprinting which considered freight's weight, distance travelled, and vehicle type. The Intergovernmental Panel on Climate Change global warming potential (IPCC, 2014) was used to calculate the CO₂ equivalent. According to that, the coefficient of equivalency for CH₄ and N₂O were 25 and 298, respectively.

For the current supply chain configuration, all the actual shipments of the year before conducting the study (i.e. 2015) from suppliers in India and China to African countries were analyzed, comprising 49 shipments in total. The data about vehicle type for each mode of transport was gathered from the dataset of Alpha. Finally, the carbon footprint of each shipment is calculated using the aforementioned emission factors and considering the vehicle type, distance, and freight load. Several assumptions were made for the carbon footprinting calculations as follows.

- Based on inquiry from the staff of the humanitarian organization, the weight of each unit of product was estimated half a kilogram on average.
- The distances are estimated using Google Map as follows: for air transport, direct line from the nearest airport to the supplier to the capital of the destination country is considered. For ocean transports, the length of sea lanes was estimated using Marine Traffic tool. For road transport, Google Map road directions were used.
- The domestic road transports following the air transports were disregarded since domestic road emissions were negligible compared to the air emissions.

Table 11 shows the shipments and the resulting global warming potential for the current supply chain configuration (scenario A). The analysis of current supply chain configuration shows that 11 out of 49 shipments (22%) of shipments were delivered by air which had the highest carbon equivalent values. In total, the transportations emitted nearly 3,014 metric tons CO₂ equivalent.

Table 11: The shipments and resulting global warming potential for scenario A (the current supply chain configuration)

Date	Supplier	Destination	Quantity (units)	Distance (in km) travelled by...			GWP (metric tons CO ₂ eq.)
				Road	Ocean	Air	
Jan 14	China	Uganda	72,000	1,060	9,800	-	19.501
Jan 24	China	Uganda	64,334	1,060	9,800	-	17.424
Apr 10	India	Malawi	33,300	1,029	5,068	-	6.297
Apr 11	India	Togo	10,000	-	10,705	-	1.778
Apr 12	China	Mozambique	96,600	-	-	8606	258.852
Apr 15	China	Mozambique	103,700	-	-	8606	277.877
Apr 16	China	Nigeria	118,500	-	19,122	-	37.626
Apr 25	China	Madagascar	27,950	-	-	7990	69.535
May 7	India	Tanzania	4,650	-	5,581	-	0.431
May 7	China	Cape Verde	21,600	-	21,662	-	7.769
May 10	India	Tanzania	50	-	6,283	-	0.005
May 13	India	Tanzania	200	-	6,283	-	0.021
May 14	India	Gabon	59,750	-	13,516	-	13.410
May 16	India	Nigeria	68,979	-	14,045	-	16.500
May 19	India	Nigeria	97,917	-	14,045	-	23.417
May 21	India	Nigeria	145,104	-	14,045	-	34.708
May 21	China	Madagascar	62,100	-	-	8213	158.806
May 29	India	Ghana	39,350	-	14,668	-	9.582
Jun 10	China	Swaziland	45,450	-	10,890	-	8.219
Jun 10	China	Sierra Leone	27,800	-	20,680	-	9.546
Jun 17	China	Swaziland	24,000	-	12,204	-	4.864
Jun 25	China	Ethiopia	79,995	1,767	9,542	-	27.093
Jun 28	China	Ethiopia	74,649	1,767	9,542	-	25.278
Jul 10	China	Kenya	151,200	-	-	7950	374.276
Jul 15	China	Kenya	153,300	-	-	7950	379.474
Jul 15	India	Malawi	33,800	1,029	5,068	-	6.392
Jul 21	India	Malawi	34,000	1,209	6,700	-	7.975
Jul 27	India	Malawi	33,700	1,209	6,700	-	7.905
Aug 11	India	Botswana	2,431	1,269	7,549	-	0.619
Aug 11	India	Swaziland	3,126	-	-	7632	7.428
Aug 11	India	Senegal	3,473	-	18,397	-	1.061
Aug 11	India	Nigeria	3,473	-	14,045	-	0.810
Aug 14	India	Nigeria	27,778	-	14,045	-	6.478
Aug 15	India	Congo	42,000	1,937	6,200	-	12.621
Aug 18	India	Congo	39,000	1,937	6,200	-	11.720
Aug 22	India	Congo	63,550	1,937	6,200	-	19.098
Aug 22	China	Uganda	220,000	-	-	8060	552.116
Aug 25	China	Uganda	100,800	-	-	8060	252.970
Aug 27	China	Uganda	82,890	-	-	8060	208.022
Aug 28	China	Uganda	3,360	-	-	8060	8.432
Aug 28	India	Cote D'Ivoire	89,000	-	15,651	-	23.130
Oct 12	China	Congo	60,800	2,041	9,893	-	22.644
Oct 17	China	Congo	21,600	2,041	9,893	-	8.045
Oct 20	China	Congo	43,200	2,041	9,893	-	16.089
Oct 22	China	Congo	34,400	2,041	9,893	-	12.812
Nov 19	India	Congo	45,000	1,937	6,200	-	13.523
Nov 23	India	Congo	32,000	1,937	6,200	-	9.616
Dec 11	China	Cape Verde	21,600	-	21,662	-	7.769
Dec 18	China	Cape Verde	40,000	-	21,662	-	14.338
Total of GWP (metric tons CO₂ eq.)							3,013.902

Coming to supply chain configurations with hubs (scenarios B and C), a safety stock was considered to cushion humanitarian demand fluctuations at hub level and to avoid the risk of stockouts. As already described, since the supply chain also relies on supplier-held-stocks, the service level required for the safety stock at hubs was not high. Chopra and Meindl (2013) propose that in multi-echelon supply chains, carrying inventory in the upstream of the supply chain reduces the inventory level in the next echelon inventories towards the downstream, as in the hubs in our case. Therefore, a 75% service level was assumed for the safety stock of the hubs.

As for the lead time, both suppliers in China and India showed a reliable and almost constant lead time with the average of half a month from the moment the purchase order is issued until the suppliers deliver the products to the country office at the destination. Hence, no lead time variability was considered. The normality of demand was checked based on the Anderson–Darling test (Anderson and Darling, 1952). Accordingly, the demand was assumed to be normally distributed and independent from each period to the next. Finally, safety stock was calculated using the formula 1 considering demand variation (Chopra and Meindl, 2013).

$$SS = Z \times \sqrt{(L + T)} \times \sigma_D \quad (1)$$

Where Z is the coefficient based on normal distribution that guarantees the probability of a stockout is small enough based on a certain service level; L is the lead time; T is the review interval; and σ_D is the standard deviation of the periodic demand (at two- or four-months intervals). At 75% service level, the amount of safety stock for the two-months scenario (scenario B) for the hubs in Kenya and Nigeria were 209,590 and 127,506 units, respectively. For the four-months scenario (scenario C), the safety stock for the hubs in Kenya and Nigeria were calculated as 351,347 and 244,121 units, respectively. The amount of safety stock was added to the demand of the first period. Several assumptions were made for carbon footprinting of scenarios B and C, as follows.

- The port of Shenzhen in China is considered as the origin of all shipments. This assumption is made after investigating the ports mostly used by the suppliers in China and India and finding an average point (in terms of distance) among the ports used by suppliers.
- According to the boundary of carbon footprinting (as shown in Figure 9), the road transportation from the hubs to national stocks has to be included in the analysis. For each travel, an average distance of 800km from hub to the national stock it serves is assumed. Hence, to satisfy all the 49 shipments, 39,200km of road transport each conveying 50,000 units on average is assumed in the carbon footprinting calculations.

Table 12 and 13 show the quantities of products, distances, and the calculated global warming potential for the two-months scenario (scenario B) and four-months scenario (scenario C).

Table 12: The shipments and resulting global warming potential for scenario B (the supply chain configuration with two hubs and two-months inventory replenishment)

<i>Period</i>	<i>East Africa</i>			<i>West Africa</i>		
	Demand (units)	Ocean Distance (km)	GWP (metric tons CO ₂ eq.)	Demand (units)	Ocean Distance (km)	GWP (metric tons CO ₂ eq.)
January-February + <i>safety stock</i>	345,924	6,700	38.485	127,506	15,000	31.757
March-April	261550	6,700	29.1	128500	15,000	14.296
May-June	291094	6,700	32.386	460500	15,000	51.232
July-August	818607	6,700	91.072	268274	15,000	29.847
September-October	82400	6,700	9.176	77600	15,000	8.633
November-December	77000	6,700	8.567	61600	15,000	6.853
Delivery from hubs to national stocks	50,000	19,600 (road)	99.953	50,000	19,600 (road)	99.953
Total			308.739			242.571
Total GWP (metric tons CO₂ eq.): 551.31						

Table 13: The shipments and resulting global warming potential for scenario C (the supply chain configuration with two hubs and four-months inventory replenishment)

<i>Period</i>	<i>East Africa</i>			<i>West Africa</i>		
	Demand (units)	Ocean Distance (km)	GWP (metric tons CO ₂ eq.)	Demand (units)	Ocean Distance (km)	GWP (metric tons CO ₂ eq.)
January-April + <i>safety stock</i>	749,231	6,700	83.356	372,621	15,000	92.811
May-August	1109701	6,700	123.458	728774	15,000	81.08
September- December	159400	6,700	17.734	139200	15,000	15.487
Delivery from hubs to national stocks	50,000	19,600 (road)	99.953	50,000	19,600 (road)	99.953
Total			324.501			289.331
Total of GWP (metric tons CO₂ eq.): 613.832						

6.2.3. Comparison of the scenario results

The carbon footprint measured for both supply chain configurations with hubs (scenarios B and C) is far less than the current supply chain configuration (scenario A). While the shipments in the current supply chain configuration emanate more than 3,000 metric tons of CO₂ equivalent, the global warming potential for the two-months and four-months scenarios (scenarios B and C) were about 552 and 614 metric tons of CO₂ equivalent, respectively, outperforming the current supply chain configuration by roughly, more than five times less. The main reasons for the significant difference are decreasing frequent small-sized long-haul shipments and replacing emergency air shipments with maritime transport to periodically replenish the prepositioned inventory. Between the two scenarios

with hubs, two-months scenario (scenario B) was preferred over four-months scenario (scenario C) due to lower global warming potential as well as lower risk of stockouts.

6.3. Discussion of the Results

This section discusses the findings and further interviews conducted with focus group practitioners about the results. The results of carbon footprinting were sent to focus group members for their review. Next, individual online interviews were conducted to gather their ideas and discuss further the supply chain configurations with hubs since the change of supply chain configuration requires further investigation of challenges and practical considerations. First, the barriers on the way of implementing the new supply chain configuration were discussed. Two major barriers were highlighted by all the respondents: cost and import/export problems. Building permanent hubs in Africa imposes high construction costs and donors might be reluctant to fund it. Import/export issues, also advocated by Kunz and Gold (2017) as a barrier for sustainable HSCs, is cumbersome, especially in Africa due to high bureaucracy. Moving a cargo from one country where the hub is located to another neighbor country might take months. This was a barrier already identified under category of *humanitarian specificities* during the focus group (as shown in Figure 7). The third barrier, mentioned by two of the respondents, is the expiry risk of products. In the current supply chain configuration, the suppliers deliver items directly to where they are needed while shifting to supply chain configurations with hubs (scenarios B and C) requires keeping prepositioned inventory until a demand is received from a country office. In the absence of emergencies or local need, the items might end up becoming obsolete in the hubs.

On the other hand, several incentives motivate the shift from the current supply chain configuration to the new configuration with hubs. The division head mentioned the Economic Community of West African States (ECOWAS) which allows free trade among western African countries. The organization can take advantage of the ECOWAS regulations to address import/export issues in west Africa. As for the building costs, the supply chain specialist suggested that the cost of building hubs can be eliminated if the organization shares the slack capacity of already existing hubs in the region belonging to other humanitarian organizations. He pointed out the possibility of using the depot of UNHRD in Accra, Ghana for this purpose. This highlights the issue of inter-organizational collaboration as a positive factor in HSCs (Balcik et al., 2010). Previous studies in HSC also suggested that joint warehousing and use of hubs for both development and disaster relief operations benefit humanitarian organizations (Jahre et al., 2016). It could also decrease the expiry risk of products by delivery to the beneficiaries of other humanitarian organizations through inter-organizational collaboration.

By and large, deploying hubs could tackle the current problems with suppliers' planning, frequent shipments, and air deliveries. As the division head mentioned:

“Whenever a crisis strikes in Africa, we are challenged with long lead times, bottlenecks in the customs, and limitations in local inventories. Regional hubs can help us deal with these”.

In case local carriers are used from hubs to the national stocks, another advantage of supply chain configuration with hubs is contributing to social sustainability by creating local employment and fostering economic growth.

CHAPTER 7

Results (iii): Mainstreaming Sustainability through Sustainable Procurement in Humanitarian Supply Chains

This chapter addresses research question 6 about the role of purchasing and supply management in mainstreaming environmental sustainability in HSCs. It bridges the gaps identified by the literature review in Chapter 2 about lack of studies on sustainable procurement in HSCs. In line with the theoretical underpinning proposed in Chapter 3, the chapter identifies the humanitarian procurement specificities in form of barriers and enablers and distinguish the most impacting ones.

7.1. Data Collection

The data collection involved two parts. First, in order to identify the main barriers and enablers of sustainable procurement in HSCs, the ideas of a group of humanitarian experts were elicited through questionnaires. Second, when the ideas are gathered and compiled, an analytic hierarchy process (AHP) was used to prioritize the identified enablers. AHP has already been introduced in Chapter 4. For the details of mathematical calculations to conduct AHP and synthesis of individual preferences to conduct a group AHP, readers are directed to Zarei et al. (2019a).

The data was collected during a conference on humanitarian logistics in the United Nations City, Copenhagen, Denmark and the action research project described in Chapter 5. First, the eligibility criteria for the inclusion of respondents were defined. Since the research objective was to identify the real-world barriers and enablers that humanitarian organizations encounter on the way of sustainable procurement, it was decided that the respondent community should be practitioners working in the procurement department of a humanitarian organization with at least five years of experience. Moreover, the pertaining organizations from which the respondents were selected had to have

sustainability in their agenda, reflected either through the annual reports, the organizational website, or any other document which is publicly available.

A project description was developed containing the objective and scope of the study. The respondents, based on their experience, had to express the existing barriers and enablers in the humanitarian context that impact on integrating sustainability into humanitarian procurement. The researchers identified several respondents with the aforementioned eligibilities and approached them with the project description. Before drawing their ideas, a description of sustainability was provided based on the triple bottom line (Elkington, 1998) to ensure that a similar perception of sustainability exists among all the respondents. Out of several eligible people approached during the conference, three practitioners provided their insights and later participated in pairwise comparison for group AHP. The first respondent was the procurement assistant of a large international humanitarian with seven years of work experience as contract manager and procurement assistant. The second respondent was the logistics and fleet manager at a European delegation of a large humanitarian organization with more than 12 years of work experience. Previous to his current position, he worked as the procurement officer in another international humanitarian organization. The third respondent was the procurement and logistics specialist at the country office of an international humanitarian organization in the middle east with around six years of work experience. The diversity of geographical regions and work descriptions of the respondents ensured collection of an inclusive list of barriers and enablers.

7.2. Identification of Barriers and Enablers

After receiving the ideas of the respondents, the barriers and enablers were synthesized. The barriers and enablers were highly alike which showed that the ideas of the respondents were convergent, even though they were from different humanitarian organizations. Similar barriers which were articulated differently were merged. Finally, a total of 20 barriers and 8 enablers were identified. They were categorized under 6 categories based on the similarity and relevance. The list of identified barriers and enablers are presented in Table 14. They will be discussed in more detail in section 7.3.

Table 14: The identified barriers and enablers for sustainable humanitarian procurement

Category	Barriers	Enablers
Local procurement	Higher frequency of issues such as child labor, unfair working times, and sweat shops in developing countries	Reduced transportation emissions through local procurement
	Damaged infrastructure in countries impacted by disasters and crises hampering local procurement	Empowering local communities and local capacity building through local procurement
	Lower quality of locally produced products compared to offshore buying	Better addressing of local communities' needs through local procurement
	Lower production capacity of local suppliers	
	Higher price of local suppliers	
Humanitarian context	Time-pressure and urgency overshadowing on sustainable procurement	
	Unpredictability of demand and location	
	Volatility of humanitarian context requires more packaging (for example for airdrops)	
Intra-Organizational	Limited managerial support and will for integrating sustainability into procurement	Recent introduction of ISO 20400 on sustainable procurement
	Limited knowledge and training among procurement staff for sustainable procurement	
	Higher cost of sustainable procurement	
	Autonomous purchase of local humanitarian offices focusing only on the lowest price	
Inter-organizational and supply chain	Different organizations follow different standards and requirements for their procured items	Cooperative purchasing and pooling procurement resources
		Similarity of many humanitarian items procured by different humanitarian organizations
		Humanitarian organizations benchmark and follow each other's successful practices
		Smaller community of humanitarian organizations compared to commercial counterparts
Funding	Low donors' awareness about sustainability	
	Earmarked funding	
	Funding fluctuation	
Supplier relationship	Short-term supplier relationships due to urgency and intermittence of humanitarian procurement	
	Low purchasing power of humanitarian organizations over suppliers of critical products (such as vaccines)	
	Extended humanitarian supply networks and difficulty in tracking indirect suppliers	
	Corruption in supplier selection and purchasing especially by local offices	

After the barriers and enablers were synthesized and categorized, the final list was sent to the three respondents for verification and conducting AHP. Since the number of identified enablers were relatively small, only prioritization of barriers was considered. The respondents were asked to make pairwise comparisons between the barriers under each category and then between the categories themselves. The basis for pairwise comparisons was the possibility to overcome the barrier in practice. After the responses were received, the comparisons were checked for consistency. All the comparison from three respondents showed a satisfactory consistency level.

Finally, the preferences were aggregated using group AHP. Since the second respondent was a more senior procurement manager with longer experience and he also was in charge of a sustainable procurement project, higher weight was assigned to his preferences (0.5) and the two other respondents' preferences received equal weights (0.25). The weighted preferences of the respondents were aggregated using group AHP. Figure 10 shows the final priorities for each category of barriers (criteria) and the barriers within that category (sub-criteria).

Figure 10: Prioritization of barriers for sustainable procurement in HSCs

7.3. Discussion of the Results

This section discusses the identified barriers and enablers and the prioritization results of group AHP. According to the results, local procurement is the category with the highest number of barriers and enablers (5 barriers and 3 enablers identified). It means that while there are some challenges for local procurement, it is a promising area to start integrating sustainability. The enablers offer several advantages in terms of sustainability for local procurement over overseas procurement. First, local procurement of humanitarian items reduces the need for international freight transport by cutting the distances that items travel and thus, it contributes to environmental sustainability through lowering the emissions emanating from the logistics. Second, buying locally empowers the local community such as local manufacturers and workers by creating jobs and involving the society in value-adding activities. Third, locally produced items better satisfy the needs of local population. For example, previous studies showed that cook stoves which are produced locally for displaced people and refugees are more widely accepted and utilized by beneficiaries due to accounting for local cooking culture (Barbieri et al., 2017).

However, humanitarian organizations need to address several local procurement impediments such as higher costs, social issues, lower quality, and lower production capacity, often associated with local suppliers due to the impact of crisis or weak economic situation in developing countries. The importance of these impediments was so high that local procurement impediments was ranked as the most important category of barriers based on respondents' preferences (see Figure 10). Based on the prioritization, it can be understood that humanitarian organizations procuring locally have to ensure that social issues such as child labor, unfair working hours, and unhealthy working conditions are not present in local suppliers' operations. This can be achieved through frequent supplier audits and evaluation. Moreover, the issues concerning cost, quality, and manufacturing capacity can be addressed through local capacity building and shifting towards longer-term constructive supplier development, rather than short-term intermittent procurement. For example, the relationship with a supplier of blankets or kitchen sets from which items were supplied for emergency situation, can be extended through long frame agreements for post-disaster procurement.

The second important category of barriers concerns the funding environment. Funding and donations are the lifeblood of humanitarian organizations that allow them to survive and sustain their operations. Donor requirements are considered as important mandates in humanitarian context. When donors have limited awareness or require little about sustainable procurement, it is often difficult to take sustainability into account for the humanitarian organizations. In addition, donors usually tie up their funding to special spent purposes which limits humanitarian organizations' flexibility to spend the donations elsewhere. This is known as earmarked funding and has been found to be negatively impacting HSC performance (Besiou et al., 2014). Sustainability typically comes with a cost and when donors do not allow funds to be spent for sustainability or have little knowledge about it, integrating sustainability into procurement is far to achieve.

The third important category is supplier relationship management. Similar to commercial procurement, if the buyer has a higher purchasing power over its suppliers, it would be more feasible to ask for sustainability requirements (Meqdadi et al., 2018). The respondents believed that the most important barrier within this category is the low bargaining power of humanitarian organizations over suppliers of critical products. For some humanitarian products such as vaccines, sometimes humanitarian organization have very few suppliers which reduces the leverage they have over their suppliers and consequently the bargaining power for incorporating sustainability into suppliers' processes. Moreover, humanitarian procurement, in contrast to commercial procurement, is often based on shorter supplier relationships due to the emergency and intermittence inherent in the humanitarian context. Integrating sustainability into procurement processes often requires long-term collaboration with suppliers. As mentioned before, developing long-term supplier frameworks and continuing procurement after the emergency subsides, is a promising way for sustainable procurement in HSCs.

The next important barriers within the category of supplier relationship according to the respondents' preferences is corruption in supplier selection and purchasing, especially in local offices purchases and extended humanitarian supply networks. The corruption in local offices' purchases can be tackled by increasing the visibility of headquarters over local offices' procurement. Some humanitarian organizations leave purchases below a financial threshold to local offices and do not bother to investigate such smaller purchases, increasing the risk of corruption for small purchases. Moreover, the extension of HSCs to several tiers and echelons is an inherent humanitarian characteristic which makes it difficult for headquarters to track down the sustainability of indirect suppliers in the second tier and beyond. Use of non-coercive power such as rewards can contribute to dissemination of sustainability in indirect suppliers (Meqdadi et al., 2018).

The fourth and fifth categories belong to intra- and inter-organizational barriers ranked almost equally. Within an organization, managerial support and awareness is the most important driver of sustainable procurement. This result is supported by the seminal study of Walker and Brammer (2009) in commercial organizations. Next barriers in the intra-organization category include *limited knowledge and training of procurement staff* and *higher costs of sustainable procurement*. Both of these barriers are again associated with managerial commitment and interest in the sustainable procurement. By conducting employee training about sustainable procurement and assigning more financial resources to purchase sustainable products, managers can overcome these barriers on the way of sustainable procurement. Here, absence of pragmatic and clear guidelines to propel organization towards sustainable procurement plays a major role in holding back organizations from putting sustainable procurement into practice. However, the introduction of ISO 20400 on sustainable procurement, listed as an enabler by respondents, can help managers with a practical and implementable procedure. It should be noted that the standard is initially designed for commercial organizations and its implementation in humanitarian procurement requires care and caution to align the guidelines with humanitarian specificities and objective.

At inter-organizational and supply chain level, the respondents believed that there were more enablers than barriers. Humanitarian organizations can pool their resources for joint procurement and achieve sustainable advantages. Joint procurement seems more feasible in humanitarian procurement due to the similarity and standardization of many aid items. Unlike commercial procurement, the aesthetics of humanitarian product packaging is not a major concern for beneficiaries. This reduces the diversity of aid products and leads to higher convergence which facilitates joint procurement among different humanitarian organizations. It also increases the bargaining power over suppliers due to higher procured quantity and economies of scale. Another enabler at inter-organizational and supply chain level is that humanitarian organizations often copy their best practices through benchmarking. A successful sustainable procurement implemented in one humanitarian organization can be benchmarked and adopted by other humanitarian organizations quickly with little modifications due to similarity of operations. The smaller size of humanitarian organizations community, compared to their commercial counterparts, and higher transparency in humanitarian reporting make such benchmarking practices more feasible.

Finally, the respondents ranked humanitarian specificities as the least important category. This is in line with the findings of Chapter 6. The reason behind this is the basis of pairwise comparison: respondents were asked to prioritize the categories based on the possibility to overcome the barriers in practice. Obviously, barriers such as urgency, time-pressure, and unpredictability of demand, while distinguishing HSCs from their commercial counterparts, are inherent in HSCs and cannot be avoided. Therefore, there are less opportunities for modification to align them to with sustainable procurement. With regards to packaging material and higher packaging consumption in humanitarian setting, the use of technology can be helpful. For example, when humanitarian organizations perform airdrops in an afflicted area, they cover the items with extra packaging to prevent it from being torn open when hitting the ground. New technologies on the use of product parachutes for such items is developing, even though they are not always financially justifiable.

Contributions, Limitations, and the Way Forward

This chapter concludes the thesis, puts forward several propositions based on the results, and provides the contributions of the thesis to theory, methodology, and practice. It also states the limitations and future research avenues.

8.1. Conclusions and Propositions

This thesis aimed at improving the environmental sustainability of HSCs as a nascent area of research and practice and paved the path for the development of the field of HSC research to *green HSC*. A thorough review of literature was conducted and main research streams within HSC literature were identified to ascertain the status quo of sustainability in HSC research and attend to the first research question. Next, a theoretical underpinning based on contingency theory was developed as the appropriate lens to look at greening HSCs. Building upon the proposed theoretical underpinning, a collaborative research project between academia and humanitarian practitioners was presented and an action research methodology was implemented in cyclical approach. The action research study employed for this thesis generated relevant findings, as follows.

First, the thesis developed a greening framework as a reference for selecting green practices which synthesized academic knowledge around green practices from the field of commercial supply chain and operations management in a suitable manner for HSCs. Second, the thesis resulted in developing action steps for an HSC and investigated the implementation of the action steps. In addition to producing strong practical insights, the implementation identified the specificities of greening HSCs, in form of contingency factors, and explored how humanitarian organizations can adopt, customize, and develop green practices to cope with the contingency factors identified. These action steps were implemented for different supply chain areas of intervention, as described in Chapter 5. In the following, I put forward several propositions based on the implementation of the action steps. For an elaborated reading about how these propositions were developed, readers are direct to (Zarei et al., 2019c).

***P1:** Improving the visibility of headquarters over field operations through mechanisms such as integrated electronic logistics management information systems, enhanced presence of headquarters staff in delegations, and engagement in last-mile distribution will have a positive impact on the environmental sustainability of HSCs.*

***P2:** Internal integration within the procurement department will have a positive impact on ordering and delivery operations, and, thereby, will improve the environmental sustainability of HSCs.*

***P3:** Local procurement in humanitarian and developing contexts is hampered by lower quality, availability, and price competitiveness of local suppliers. humanitarian organizations can stimulate local procurement through early supplier development and prequalification programs.*

***P4:** Fostering collaboration with other humanitarian organizations active in the humanitarian field, inter-organizational agreements for supplying mutual products, and exploiting established logistics collaboration mechanisms will reduce the emissions emanating from inventory operations, outbound logistics, and last-mile distribution in HSCs.*

***P5:** In development programs, inter-organizational collaboration for sustainability is contingent on sharing mutual products whereas, in relief supply chains, it is contingent on operating in similar geographic regions, regardless of product mutuality.*

***P6:** Humanitarian organizations that rely more on short-term and earmarked funds, or are funded by donors with less sustainability awareness, are less likely to succeed in improving the environmental sustainability of their HSCs.*

***P7:** Lower expectations of beneficiaries in HSCs from packaging help to reduce packaging material and waste, and improve packaging fill rates and volumetric freight design.*

Third, this thesis explored the causes of unsustainable HSC and then identified supply chain configuration, as the most impacting cause in the humanitarian organization under scrutiny. Fourth, it analyzed adding an intermediary echelon of hubs to the current supply chain configuration by developing three scenarios and conducting carbon footprinting for each. The results revealed that a supply chain configuration with hubs and a shorter inventory replenishment policy of two months outperforms the current a supply chain

configuration of direct shipments from suppliers to country offices in terms of carbon footprint.

P8: An HSC configuration with hubs which are replenished periodically outperforms in terms of carbon footprint an HSC configuration involving perpetual inventory replenishment through direct shipments from suppliers to recipient countries with no hub in between.

Finally, the thesis unearthed and ranked the main barriers and enablers on the path of integrating sustainability into humanitarian procurement. Based on the prioritization, issues in local procurement such as price and quality of local supplier as well as issues in funding such as earmarked funds and donors' awareness about sustainability were the direct issues in order to improve the sustainability of humanitarian procurement.

8.2. Theoretical Contributions

Initially, HSC appeared in the academic literature as a *distinct* field of research due to its fundamental differences from other fields (Pedraza-Martinez and Van Wassenhove, 2016). The distinctions of HSC from other fields, referred to as *contingency factors* in this research, are related to many unique characteristics inherent in the field. Since little research is available on incorporating environmental sustainability into HSC, the *distinctions* of HSC context that impact on greening are not known.

As such, the first contribution of this thesis is identifying contingency factors that impact on greening HSCs. These contingency factors can be classified under three types. First, the thesis unearthed original contingency factors not identified by previous research; for example, different packaging needs and perceptions of beneficiaries compared to commercial customers as a facilitating factor, and risk of scavenging as a critical consideration in reverse logistics planning. Second, it identified contingency factors known to impact other HSC areas. Limited visibility of headquarters over delegations, for example, was found to negatively impact fleet management policies (Eftekhar and Van Wassenhove, 2016), overall performance in disaster operations (Gatignon et al., 2010), and decision-making in logistics management (Rodríguez-Espíndola et al., 2018); this thesis identified it as an impeding factor for greening last-mile distribution and reverse logistics. Third, it confirmed the contingency factors which were already identified to impact greening HSCs by previous studies such as low donor awareness of sustainability, poor inter-organizational collaboration (Sarkis et al., 2012), strict import/export regulation, and earmarked funding (Kunz and Gold, 2017).

The second contribution centres on how to *customize* extant green practices or *develop* new ones to cope with the contingency factors identified. In the first case, the study showed how extant green practices to improve the volumetric usage of freight (e.g. McKinnon (2005)) were customized based on the contingency factor *different packaging*

needs of beneficiaries and resulted in an improved packaging design to fit the humanitarian context. The second case is exemplified by the development of reverse logistics standard operating procedures that consider contingency factors such as unsolicited donations, risk of scavenging, and poor recycling facilities in a humanitarian context.

Third, the study elaborates contingency theory in the field of HSC research through horizontal contrasting (Fisher and Aguinis, 2017) with the field of sustainable supply chain management. The theoretical underpinning of this thesis postulates that, similar to commercial organizations, humanitarian organizations can achieve a fit between their context and green practices either by developing/customizing green practices or by influencing their operating environment (or both). The latter, denoted by the *interaction* dashed line in Figure 4 (the proposed theoretical underpinning), emerged in several interventions – for example, raising more flexible or national funds (impact of subsystem on funding environment) or stimulating cooperation among implementing partners (impact of subsystem on stakeholders).

Fourth, the study contributes to the HSC literature by considering environmental sustainability in making supply chain configuration decisions. The review of Habib et al. (2016) concludes that environmental sustainability is a missing aspect in supply chain configuration of HSCs that should be considered for future research. This research is one of the first that has taken environmental sustainability into account and showed that the supply chain configuration with hubs decreases the carbon footprint of the HSC while improving the responsiveness and efficiency. By showing the preference in terms of carbon footprint, our findings are congruent with and advances previous research in the HSC literature where it was shown that hubs contribute to cost-reduction and responsiveness (Stauffer et al., 2016) and proactive prepositioning of imperishable supplies, such as the ones in our study, is the best supply chain configuration strategy (Yao et al., 2018).

Fifth, it identified and prioritized barriers and enablers on the path of sustainable procurement in HSCs. The identification and categorization offered by this study deepens the understanding of sustainable humanitarian procurement for academics and sheds light on the specificities of HSCs and how to deal with them to make humanitarian procurement more sustainable. By and large, the identified barriers and enablers are supported by the literature of as impacting factors on sustainability. The importance of local procurement for sustainability (Van Kempen et al., 2017), the role of training procurement staff about sustainability (Abrahams, 2014), negative impact of earmarked funds on sustainability (Kunz and Gold, 2017), and the impeding role of corruption in humanitarian procurement (Schultz and Søreide, 2008) are some examples of advocacy by extant literature about mainstreaming sustainability in humanitarian procurement.

8.3. Practical Contributions

Using a mode 2 action research method, the research creates *actionable knowledge*; a type of knowledge that advances theory and practice simultaneously. Notwithstanding mode 1 methods with modest practical implications, this research demonstrates the actual implementation of the created knowledge into the field of HSC. By conducting cycles of implementation, it puts the action steps into practice, observes the outcomes, and takes corrective measures. As such, it contributes to practice by highlighting the mechanisms through which humanitarian organizations can green their HSCs, such as improving visibility over delegations by increasing the presence of headquarters staff and employing ICT to track products during last-mile distribution. The research present not only the action steps that were fruitful, but also it reports on the steps that have not worked in order to provide practitioners with the lessons we learnt during conducting the collaborative research.

Second, by proposing a comprehensive greening framework, the research synthesizes the already existing knowledge in other fields in a usable manner for humanitarian organizations. Humanitarian practitioners can benefit from the framework which synthesizes ready-made green practices tailored for HSCs as a point of departure for greening.

Third, humanitarian organizations can benefit from the collaborative process of designing and implementing relevant action steps for their HSCs. Interactive discussions through focus group and follow-up interviews exemplify researcher-humanitarian collaboration as a missing aspect of HSC research.

Fourth, the comparison between supply chain configuration scenarios assisted the organization in making decision. Past research has shown that humanitarian organizations make decisions about the location of their hubs mostly based on individuals' experience and opportunities rather than on decision-support methods (Jahre et al., 2016, Charles et al., 2016). While responsiveness and cost are the common considerations, the environmental impact of hubs has been overlooked in practitioners' decision-making. The conceptual reconfiguration of supply chain by adding hubs and discussing its real-world implementation with practitioners provide visionary advices on the integrating environmental sustainability into supply chain configuration.

Fifth, with sustainability moving to the center of attention for procurement specialists in humanitarian organizations, the main question for the integration of sustainability is simply *where to start from?* The identification and ranking of barriers and enablers for sustainable procurement in humanitarian organizations help humanitarian procurement managers to initiate their efforts for sustainable procurement from tackling the most important barrier categories and the main barriers within each category while benefiting the most from the identified enablers. Since the basis for the prioritization through AHP was the possibility to overcome barriers in practice, it can help procurement managers to assign more resources to the barriers with higher importance which subsequently leads to the biggest improvement while refraining from spending resources on barriers with lower opportunities for improvement.

8.4. Methodological Contributions

Since applying action research methodologies to supply chain management is growing (Näslund et al., 2010), this research contributes to action research in the field of HSC by answering the calls to conduct more empirical research (Pedraza-Martinez and Van Wassenhove, 2016) and addressing the relevance gap in HSC research through academic-practitioner partnerships (Kunz et al., 2017). As such, it makes three specific methodological contributions.

First, while maintaining collaborative relationships is a major challenge in conducting action research (Pasmore et al., 2008a), this research asserts that the challenge is even greater in the HSC context. During the collaborative research project, three members of the management team at Alpha were transferred to other humanitarian organizations. After each change, the team had to orient the replacement to the project. In one case, the position was not even filled:

“Humanitarian organizations constantly change their size in response to real-world situations; For example, due to the problem of refugees, the number of staff at [a partner humanitarian organization in this headquarters] increased from 10 to 100 in recent years.”

remarked the division head. Hence, we identify staff circulation as a common organizational practice in large humanitarian organizations (Van Wassenhove, 2006) and changes in humanitarian organization size as barriers to conducting action in HSC.

Second, while in commercial settings, involving organizational managers and external researchers in a team would provide sufficient grounds for subsequent implementation of action steps, in humanitarian organizations, involving field staff in the development of action steps is recommended. In cycle 3, when local logistics coordinators from two delegations were involved in developing reverse logistics planning, the management team encountered less field resistance and better cooperation for the implementation of the planning.

Third, external researchers collaborating with humanitarian organizations not only provide the knowledge not readily available to practitioners (e.g. the greening framework), co-generate action steps, and co-monitor implementation, but they are also deeply involved in data collection and analysis, which can reveal findings not previously known to humanitarian organizations given the volatile operating environment. For example, the issue of individual shipments going to similar or neighbouring countries highlighted by the research team would not otherwise be discovered by Alpha.

8.5. Research Limitations

Similar to any other piece of research, this work is not devoid of limitations. First, the collaborative research project presented in the thesis was conducted with one humanitarian organization only, which might limit the generalizability of findings. Several efforts were made to increase the generalizability; The greening framework was

prepared based on a deductive literature review approach and can be applied as a point of departure for greening any other humanitarian organization. Moreover, supply chain and procurement staff of several other humanitarian organizations were involved in the research; for example, for the verification of the greening framework or for identifying and prioritizing barriers and enablers of sustainable procurement. As such, some of the findings, particularly the ones pertaining to contraceptives, are specific to the humanitarian organization, while most of the identified contingent factors and the mechanisms to cope with them can be generalized to HSC context.

Second, the supply chain areas of intervention in the proposed greening framework are not exhaustive; some areas such as supplier manufacturing operations or indirect suppliers were beyond the scope of this thesis and therefore excluded. Moreover, although the greening framework placed coordination within the procurement department's responsibilities, it had not initially considered coordination as a distinct supply chain area of intervention. In cycle 3, the team revisited the greening framework and focused on coordination between headquarters and other supply chain actors as a pivotal supply chain area.

Third, in carbon footprinting of the scenarios with hubs, we have not considered, for example, climate-controlled hubs or climate-controlled fleet (e.g. as in cold chain for vaccines), as it was not required for the products of the humanitarian organization investigated in this thesis. If that is the case, other studies should account for such nuances in the carbon footprinting.

Fourth, the proposed supply chain configuration scenarios with hubs are conceptual in nature and may not capture all the issues that might arise in actual implementation. To address this limitation, follow up individual interviews with practitioners were conducted and reported to foresee potential issues that might arise in practice.

Fifth, the identification and ranking of barriers and enablers may not be comprehensive. Eliciting the ideas of different humanitarian experts might return different barriers and enablers from the ones identified in this thesis.

Finally, the length of collaboration was not extended to fully observe the influence of all adopted action steps, many of which were still in progress by the humanitarian organizations at the end of collaborative research project. Pasmore et al. (2008b) suggest three-, five-, and ten-year follow ups to fully validate the impact of action research. The findings are limited to the three years of collaboration and do not include such follow-ups.

8.6. Future Research Directions

Green HSC is still in its infancy and many future research avenues are open. From theoretical perspective, further research is needed to identify the contingency factors in greening other HSCs, explore how humanitarian organizations address them, and

compare the findings with those of this study. Moreover, investigating the green practices specific to each phase of the disaster cycle as well as the specificities of greening humanitarian cold chains and perishable products deepens our understanding of green HSCs.

Methodology-wise, this thesis contends that green HSC epitomizes an appropriate area for conducting action research since academic knowledge and practical know-how are both limited but complementary. More action research studies are needed to address the relevance gap in HSC research.

As for supply chain configuration, future research can study the real application the proposed scenarios with hubs and calculate the actual carbon footprint, as calculated for the current supply chain configuration in this thesis. Moreover, studying the environmental impact of other causes of unsustainable HSC identified by this thesis, such as logistics emissions or material and waste in HSCs are recommended.

Coming to identification and prioritization of barriers and enablers for sustainable procurement in humanitarian organizations, eliciting the ideas of more experts, using other multiple-criteria decision making methods for prioritization, including enablers in the ranking, and studying the interdependence among barriers and among enablers are interesting research directions.

Finally, while social pillar of sustainability is an integral part of HSCs in form of helping beneficiaries, it can further be incorporated into HSCs. In the upstream, humanitarian procurement suffers from social issues such as child labor, unfair wages, and gender inequity in direct and indirect suppliers of humanitarian organizations. In the downstream, there is room for research on providing aid equitably to all beneficiaries (i.e. the crises that receive lower media attention) and investigating issues such as local capacity building and community empowerment after humanitarian crises.

Scientific Outputs of this Ph.D. Thesis

This Ph.D. research has led to successful publication of two top-tier journal publications, one book chapter, and two presentations in international conferences. Each of the publications pertains to one or more research questions. The outputs of this thesis are interconnected to satisfy the overarching research question. In the following a summary of the Ph.D. output is provided.

Paper 1: *To greener pastures: An action research study on the environmental sustainability of humanitarian supply chains* published in *International Journal of Operations & Production Management* (Zarei et al., 2019c)

The paper contains the lion's share of the Ph.D. research and is published in one of the world-class leading journals in operations and supply chain management after five rounds of rigorous review. The journal is Q1 in the following categories: *Decision Sciences*, *Management of Technology & Innovation*, and *Strategy and Management*. It is also ranked in category 4 (the highest) in Chartered Association of Business Schools journal ranking list. The paper aims at firstly *theorizing* about environmentally sustainable HSCs and secondly reporting on an engaged-scholar *implementation* of green practices in a real-world HSC and analyzing the results of implementation. It opens up with a survey of literature on sustainability in HSCs. Next, it develops a theoretical underpinning built upon contingency theory that postulate how green practices should be adopted/customized/developed for HSCs considering organizational and contextual humanitarian contingencies. Coming to the *implementation*, it deploys an action research-based methodology to propose a greening framework and apply it to the supply chain of a humanitarian organization. The paper offers both theoretical and practical contribution in form of *actionable knowledge*. It identifies the main contingent factors that impact on greening arising from the implementation. It then illustrates how action steps were taken to cope with the identified contingent factors and discusses the results of implementation. Finally, the paper puts forward several *actionable propositions* which synthesizes the outcomes of the action research study.

Paper 2: *On the role of regional hubs in the environmental sustainability of humanitarian supply chains* published in *Sustainable Development* (Zarei et al., 2019b)

The paper is the journal *Sustainable Development*. The journal is ranked as Q1 in the category *Development* and Q2 in the category *Renewable Energy, Sustainability and the Environment*. The paper uses a novel mixed-methods methodology to conduct an interdisciplinary research on management and environmental science. First, it identifies the sources of unsustainable practices in HSCs using a focus group. Then, it focuses on the most important category, i.e. supply chain configuration. To this end, it uses carbon footprinting, a methodology in environmental science, to quantify the environmental impact of different scenarios for supply chain configurations: the current supply chain configuration used by the humanitarian organization under scrutiny, and two scenarios with added hubs with different inventory replenishment periods. The paper concludes that adding two hubs in east and west Africa results in significant improvements in carbon footprint of the studied HSC. It then discusses general consideration and managerial implications for implementing the scenarios with added hubs.

Paper 3: *Integrating sustainability into humanitarian procurement: A prioritization of barriers and enablers* published in the book *Sustainable Procurement in Supply Chain Operations* (Zarei et al., 2019a).

The study is published as book chapter in a book about sustainable procurement after being peer-reviewed. The book is published by *Routledge and CRC of Taylor and Francis Group*, one of the leading publishers in management science. The paper delves into the purchasing and supply management as the main function in the upstream of HSC that can institutionalize environmental sustainability along the supply chain up to the downstream. The previous study by paper 1 showed that many of the unsustainable practices in the downstream of HSCs, disposal of products or packaging for example, could have been avoided if appropriate green measures were taken by the procurement department. Therefore, the paper focuses on the purchasing and procurement function and starts with a survey of the literature on humanitarian procurement, the developments and trends, and status quo of sustainability in humanitarian procurement. Next, it gathers the ideas of several humanitarian experts using group analytic hierarchy process to identify, prioritize, and discuss the barriers and enablers on the path of green humanitarian procurement. It discusses the managerial and practical implications about how to overcome the most important barriers of green humanitarian procurement.

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