WASTE MANAGEMENT AND REVERSE LOGISTICS IN THE HUMANITARIAN CONTEXT

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Executive summary

The priority of humanitarian aid has always been to help those in need and the do-no-harm mandate has been a guiding force in the operations. Recently due to the impending environmental crises taking place globally, this mandate has been expanded to comprise of the natural environment as well. Humanitarian operations are a very resource intensive exercise requiring transport of goods to challenging locations. In addition to emissions resulting from transportation, these operations often result in significant amounts of waste, the management of which has been neglected in the past. This report therefore focuses on the current state and future pathways of waste management and reverse logistics in the humanitarian context.

The Waste management and measuring, Reverse logistics, Environmentally sustainable procurement and transport, and Circular economy (WREC) project seeks to reduce the adverse environmental consequences of humanitarian logistics through awareness, practical guidance, and real-time environmental expertise. The WREC project focuses on greenhouse gas emissions and waste and looks at the environmental sustainability and impact of humanitarian logistics operations. This report presents the results of a qualitative baseline study which consisted of a state-of-the-art literature review and an empirical interview study. The literature review[1] explored both the academic and grey literature relating to waste management and reverse logistics in the humanitarian context.

Through establishing the current state of research in waste management and reverse logistics, a framework was established. The umbrella theme of environmental sustainability is further divided into six subthemes: climate change, collaboration, localization, performance, barriers, and measures and tools. Waste management and reverse logistics were then specifically analysed through these themes. The empirical material raised procurement, localization, and collaboration as extremely relevant factors in achieving functioning systems within humanitarian operations. Procurement is an operational activity, which can have significant practical implications through streamlined processes and effective partnerships. Through procurement, improvements can be made in e.g. the materials and packaging of the aid items sent, as well as establishing partnerships with environmentally certified suppliers. Collaboration with local partners, including grassroots organizations, local authorities, and private sector is key. Inter-organizational collaboration, for example consolidation of waste management processes and reverse logistics is also a

[1] Tuomala, V., Aminoff, A., & Kovacs, G. (2022). Waste management and reverse logistics in the humanitarian context. In NOFOMA 2022 conference proceedings (2022 Annual NOFOMA Conference, Reykjavik, June 8-10, 2022).

relevant future pivotal point. As most humanitarian operations are highly context specific, having that local knowledge in addition to the high-level strategic policies is essential. This report highlights the interlinkages between these processes and emphasizes the need for a comprehensive approach.

As climate displacement has become one of the main drivers of humanitarian crises, the role of humanitarian organizations both in providing aid, as well as preventing future emergencies that are the unintended result of the impact of humanitarian aid on the environment becomes paramount. This report presents some practical solutions in this regard.

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List of abbreviations

DRC	Danish Refugee Council
EC	European Commission
ECHO	European Civil Protection and Humanitarian Aid Operations
ES	Environmental sustainability
GLC	Global Logistics Cluster
HL	Humanitarian logistics
HNPW	Humanitarian Networks and Partnerships Week
HO	Humanitarian organisation
HSC	Humanitarian supply chain
HSCM	Humanitarian supply chain management
ICRC	International Committee of the Red Cross
IFRC	International Federation of Red Cross and Red Crescent Societies
LogCluster	Logistics Cluster
NFI	Non-food item
NGO	Non-governmental organisation
RL	Reverse logistics
SC	Supply chain
SCM	Supply chain management
SSCM	Sustainable supply chain management
SWM	Solid waste management
UN	United Nations
UNOPS	United Nations Office for Project Services
WASH	Water, sanitation, and hygiene
WFP	World Food Programme
WM	Waste management
WREC	Waste management and measuring, Reverse logistics, Environmentally sustainable procurement and transport, and Circular economy project

1 Introduction

The do-no-harm-mandate has always been the guiding force of humanitarian organisations (HO). Recently, this has been expanded to pertain to the natural world as well, and HOs have become more aware of the environmental impact of their operations. The Waste management and measuring, Reverse logistics, Environmentally sustainable procurement and transport, and Circular economy (WREC) project[2] on "Environmental Sustainability in Humanitarian Logistics" has grown out of this awareness and has brought together numerous HOs coordinated by the Global Logistics Cluster Support Team (GLCST) to tackle questions of waste management, reverse logistics, greenhouse gas emissions and pollution synergically. The WREC project seeks to reduce the adverse environmental consequences of humanitarian logistics through awareness, practical guidance, and real-time environmental expertise. This report summarises the findings of the first qualitative study of the WREC project, which has been carried out by researchers at the Humanitarian Logistics and Supply Chain Research Institute (HUMLOG Institute) at the Hanken School of Economics in the first half of 2022.

This first study focuses on the following two research questions:

1. What is the current state of research and practice on waste management and reverse logistics in the humanitarian context?
2. What are the gaps in waste management and reverse logistics in the humanitarian context?

Thus, this study was structured as follows: First, an initial report was compiled that reviewed and summarised the state of the art of academic literature[3] on the topics of waste management and reverse logistics in the humanitarian context. Then, a qualitative study was conducted with HOs on the same topics. In this paper, the methodology for both studies is presented first, followed by the findings emerging from each study. This final report focuses on the findings and on the outlining future pathways for the WREC project and its next steps.

[2] The WREC Project seeks to reduce the adverse environmental consequences of humanitarian logistics through awareness, practical guidance, and real-time environmental expertise. More information and the project description is available at https://logcluster.org/blog/wrec-project?language=en

[3] Tuomala, V., Aminoff, A., & Kovacs, G. (2022). Waste management and reverse logistics in the humanitarian context. In NOFOMA 2022 conference proceedings (2022 Annual NOFOMA Conference, Reykjavik, June 8-10, 2022).

2 Methodology

2.1 Literature review

A literature review was conducted as a first step in the study. The aim of this review was to establish what has already been addressed in the areas of waste management (WM) and reverse logistics (RL) in the humanitarian context, and where gaps would remain in research and to some extent, in practice.

The review was conducted as a state-of-the-art review, which includes grey literature in addition to academic articles. Academic research gets published rather slowly in accordance with requirements of rigor and peer review, which though also results in the academic literature at times lagging behind current practice. Hence it was imperative to include the latest information available from HOs as well as practitioner research. Therefore, the WREC study's literature review included this as "grey literature" in addition to what has been done academically. A first version of this literature review was submitted as the interim report to the WREC steering committee comprised of senior supply chain or environment representatives from the coalition partner organizations, Danish Refugee Council, IFRC, Save the Children, and WFP. Another version was written for a more academic audience and presented and discussed at the Nordic Logistics Conference NOFOMA 2022, where it also won the conference's best paper award.

Detailed descriptive findings and a full list of literature reviewed can be found in the appendix.

2.2 Qualitative study

To fully address both research questions, a qualitative study was conducted next. This study consisted of a combination of workshops and interviews. Both were facilitated by the GLCST, and the WREC project's steering committee. The project was managed through regular meetings between the WREC project manager and the research team, and with some meetings also with the project's steering committee.

A total of 19 interviews were conducted between February and May 2022 (see Figure 1 for the respondent profiles in the sample). Interviewees were selected and interviews facilitated by the project manager from the WREC in response to calls for feedback shared via the GLC's newsletters and recommendations provided by stakeholders during initial interviews. All interviews were transcribed and analysed using the NVivo software. With this software, qualitative data can be effectively analysed through coding and grouping. The interview guide as well as a detailed list of interviewees can be found in the appendix.

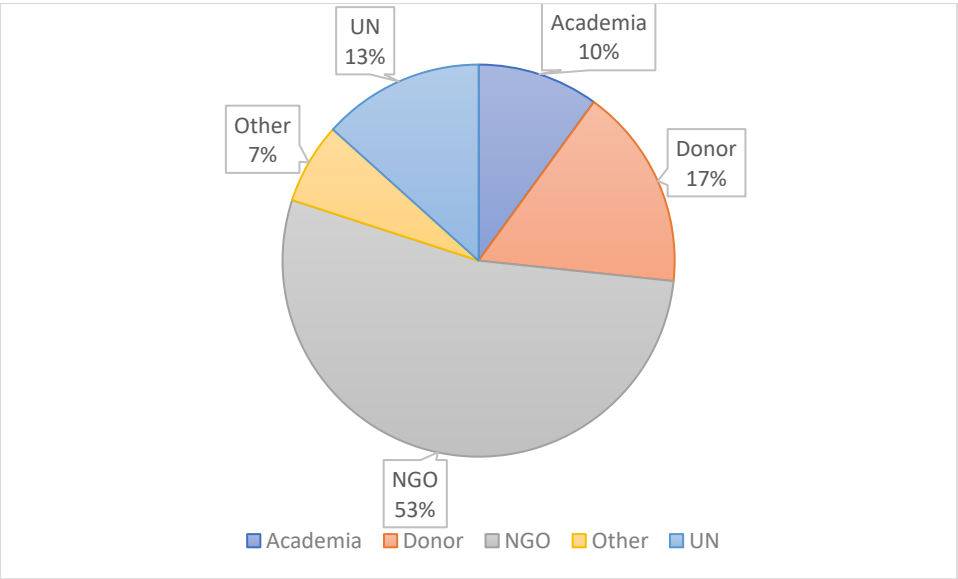

Figure 1 *Respondent profile share in the interviews*

In addition, two workshops were held to validate the findings of the study. The first workshop focused on validating the results of the literature review and was held at the Humanitarian Networks and Partnerships Week (HNPW) with a broader group of HO representatives in May 2022. A total of 31 participants attended this workshop, where they discussed the themes from the literature review in three breakout groups.

The second workshop was held in conjunction with the Global Logistics Cluster (GLC) meeting in June 2022 to validate the results of the interview study. Some of the interviewees and additional representatives of HOs participated in this workshop, totalling 34 participants. The workshop used the Wooclap tool to encourage participants to share their thoughts and those results are also presented here.

3 Findings

While the study was structured in two separate entities (literature review and qualitative study), the findings form a cohesive whole.

3.1 Current state of research and practice

Humanitarian organisations (HOs) have become increasingly more aware of the adverse environmental impacts of their supply chains. However, research in this area is in its early stages and lacks in cohesion. Despite the notable research interest in environmental sustainability (ES) in the context of commercial supply chains, as well as calls from research and practice, there are significant gaps in such research on humanitarian supply chains (HSCs; Zarei et al., 2019).

ES was notably absent in the results of a previous content analysis of annual reports from humanitarian organisations (Haavisto and Kovács, 2014), even though the same analysis discovered important links between various sustainability dimensions and performance measures. The actual efforts and the levels they targeted varied tremendously, however. For example, local sourcing as part of localization would contribute to the appropriateness as well as the effectiveness of aid, while climate change mitigation efforts were more considered in an organization's environmental policy. Fast forward, reverse logistics was the topic of the day at the GLC meeting October 2019, and sustainability, particularly the environmental angle, a shared concern at the GLC's discussions at HNPW 2021. At the same time, by 2020, for the first time, climate and weather events (and not conflicts) were the main factor of displacement (Climate Center, 2021).

In the workshop held for the GLC meeting in June 2022, participants were asked to submit their thoughts in what is currently being prioritised from an environmental perspective in their organizations. Figure 2 represents their answers, with the words mentioned most often becoming larger. *Waste* and *emissions* stand out but also RL-related activities such as *repair/reuse* and *recycling* are mentioned, as well as strategic level actions such as *optimisation* and *management*. These types of exercises indicate that ES activities are becoming a more relevant part of the discussion and that they are present in many sectors and phases of the HSC.

Figure 2 *Word cloud from the validation workshop June 2022*

The literature review explores the current state in the research and practice of HOs in terms of WM and RL. Table 1 presents an overview of the themes covered arising from both academic as well as grey literature. These themes were the starting point for the codes used in the analysis of the empirical data.

Table 1 Overview of current state

Subtheme	Academic	Grey	Examples	Selected references

Environmental sustainability in HSCM	Climate change	x	x	Climate related displacement	Climate Center, 2021
	Collaboration	x	x	Cross-sectoral partnerships	Cricelli *et al.*, 2021 European Commission, 2022
	Localization	x		Local procurement	Pazirandeh and Herlin, 2010
	Performance	x		Lean SCM	Haavisto and Kovács, 2014
	Barriers	x	x	Funding limitations	Sarkis *et al.*, 2012 Brangeon and Crowley, 2020
	Measures and tools		x	REA	EHA Connect, 2018 EHA Connect, 2022
Waste management	Material convergence	x		Unsolicited donations	Holguín-Veras *et al.*, 2014 Suzuki, 2020
	Procurement		x	ICRC guidelines	ICRC, 2022 Pazirandeh and Herlin, 2010
	Solid waste management	x	x	Lack of solid waste plans	WHO/WEDC, 2013 Das et al., 2019
	Waste streams	x	x	Packaging; medical waste	George *et al.*, 2020 Tilley and Kalina, 2020
Reverse logistics	Recycling	x	x	Collect packaging, proper disposal, continuous use of relief items, recycling programs with beneficiaries	George *et al.*, 2020 Stauffer and Kumar, 2021 Peretti *et al.*, 2015 Saidan *et al.*, 2017

A decade ago, Sarkis et al. (2012) were some of the first researchers to explore the ES in the HSC. They listed various barriers to ES that exist within HSCs including a lack of knowledge of ES, the uncertainty of the context, technological and infrastructure challenges, and operational shortcomings. But as Zarei *et al.* (2019) found, most studies regarding ES in HSCs focus on establishing the status quo, rather than practical measures and mechanisms to address the various challenges and barriers. Abrahams (2014), like Sarkis et al. (2012), emphasized the sense of urgency that overrides the capacity to consider environmental

factors. Limitations on the use and duration of funding received from donors can hinder ES efforts still today (Brangeon & Crowley, 2020).

Limitation due to ES efforts on humanitarian projects is starting to change, as donors are also growing aware of the impending ES issues and some donors are proactively setting minimum standards for ES for humanitarian projects. The pressure is building up for addressing environmental challenges together, as also donors such as ECHO have recently embraced greening as one of their core concerns in humanitarian logistics. In fact, the European Commission's (2022) new Humanitarian Logistics Policy[4] and DH ECHO's Minimum Environmental Requirements and Recommendations[5] identify waste management as a key element in greening the HSC.

Timely environmental assessment is crucial, for example, to prevent secondary emergencies that may arise from improper environmental management. In their doctoral thesis, Zarei (2020) reviews some examples of adverse environmental consequences that have directly resulted from humanitarian efforts, such as cholera outbreaks due to substandard water treatment, deforestation due to brick production for HOs, and insecticidal nets releasing toxic chemicals into surrounding waters.

These themes are summarized in a framework (Figure 3) that represents the current state of the research and practice in ES in HSCM and is the main result of the literature review completed as part of the WREC project (Tuomala et al., 2022). The subthemes of climate change, performance, measures and tools, local procurement and action, barriers, and collaboration are overarching themes in ES, and emerge strongly from the reviewed academic and practitioner literature and are applicable to WM and RL as well. This framework is useful for both research and practice and can be used for analysis of any ES issue. For example, in terms of WM, it is imperative to consider the local opportunities and challenges in the context of the humanitarian operation, whether there are institutional barriers, such as funding limitations and how operative performance can be enhanced.

[4] https://ec.europa.eu/echo/files/policies/sectoral/humanitarian_logistics_thematic_policy_document_en.pdf

[5] https://www.dgecho-partners-helpdesk.eu/download/referencedocumentfile/272

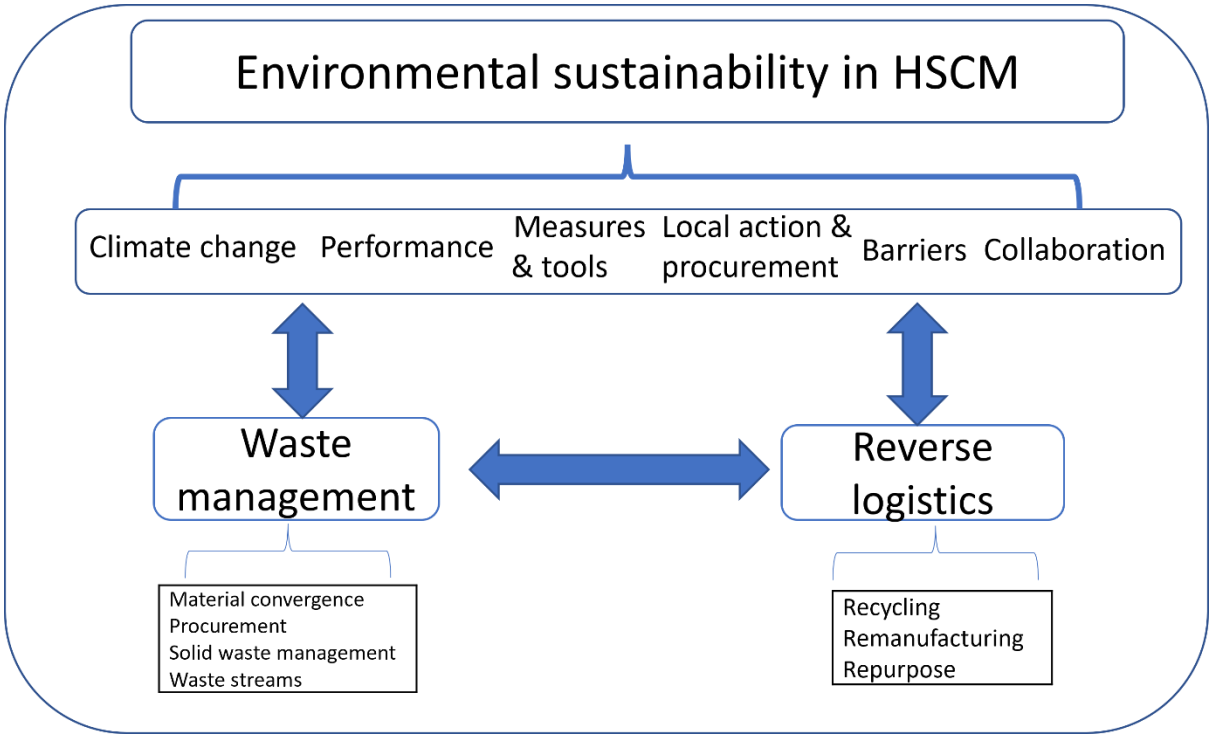

Figure 3 *Framework from literature*

In the following section we zoom into gaps and factors that arose from the interviews.

3.2 Gaps

3.2.1 Procurement

In terms of waste management, procurement is a process that has significant influence. The technical specification of items in terms of materials is one factor that dictates the way they are disposed of, their re-usability, and/or recyclability. The interviews indicate that procurement processes are highly de-centralised across organizations and involve a myriad of stakeholders from local staff to strategic-level managers. As well, HOs work in a highly volatile environment, where predicting needs is difficult. Either supplies are pre-positioned in warehouses in strategic locations globally, or context-specific items are procured immediately once the disaster has struck (Moshtari et al., 2021). This can lead to instances where there might be items sitting in warehouses for years, only to be discarded as they have reached the end of their lifespan.

Procurement is an internal function, and thereby under the control of humanitarian organizations – unlike delivery in the last mile that can occur through, and engage, a myriad of implementing partners. It does not however occur in a vacuum, as the items are procured from suppliers, normally in the private sector. In the commercial sector it is common for companies to engage in environmental audits for their suppliers, but very little evidence of

this exists within HOs. On the other hand, technical specifications and product design have started to garner attention, as this impacts the life cycle of the product. This can come with significant trade-offs regarding durability and quality of the product, as well as cost related questions.

Sustainable procurement has been a reoccurring theme of the UNOPS supplements to their annual procurement report, where already in 2010 there was a theme on the role of humanitarian procurement in creating and shaping markets (Pazirandeh and Herlin, 2010). On a more operational level, as of now, the ICRC and the IFRC (2021) for example has comprehensive guidelines on sustainable procurement in their joint product catalogue, where environmental and social factors are encouraged in addition to efficiency and financial perspectives.

Table 2 *Procurement factors highlighted in interviews*

	Gaps	Exemplifying quotes
Processes	• Decentralised supply chain • Supplier screening • Life-cycle assessment for items • Engagement with environmental audits	*"I think procurement's the stage where we can have the greatest influence."* *"we are highly decentralised, and I think we're still trying to get order into the madness of how we're buying things"* *"we're not always great as an organisation at predicting what we need"*
Trade-offs	• Technical and environmental aspects versus cost • Priorities	*"if tomorrow, we have eco design tarpaulin that will cost 10 times more, we will not be able to go for it"* *"we will tip that a bit more to say quality, we're really looking at the environmental angle, and durability is very important."*

3.2.2 Collaboration

WREC is a timely project, especially so since it brings many organizations together. In their analysis of inter-organizational collaboration in reverse logistics, Cricelli et al. (2021) suggest that regulatory pressures from institutions, such as governments, bring about mimetic,

coercive, and normative processes that organizations functioning in similar contexts start adhering to. Through mimetic processes organizations start to imitate one another's practices, while coercive processes result from formal or informal outside pressures such as legislation or societal expectations. Normative pressures stem from professional networks and education. These different types of pressures can initiate collaboration either horizontally, i.e. among supply chain peers on the same level, or vertically, meaning along the supply chain (Cricelli et al., 2021). Also, humanitarian organizations face numerous stakeholders who exert pressure on them to green their operations, but not all these pressures extend to them the same way as to commercial organizations. For example, concepts such as extended producer responsibility are legally binding in certain countries and regions (only). Yet humanitarian operations can take place in diverse regions where this type of legislation may not exist. SSCM research in these types of contexts is scarce in the commercial stream due to complexity and uncertainty of the economies (Silvestre, 2015).

The empirical study highlights collaboration between the private sector, as well as intra- and inter organizational collaboration. Benefits of working with private sector include their technical expertise on certain practices, such as recycling or environmental policies. However, as the private sector's aims are more on the commercial side, it is imperative to find where the interests match and benefit both parties. WM is often overseen by local governments and other public sector entities, as well as being dependent on infrastructure such as roads, landfills, and recycling centres. The collaboration between HOs and local public and private sector can prove challenging, as the contexts vary enormously and there is never a one-size-fits all solution. Therefore, collaboration with teams on the ground, local branches of the HOs as well as local NGOs is the key. Large HOs as well as donor organizations wield a certain amount of influence and have access to resources which could be used to significantly improve local WM processes. Grassroot WM activities in many contexts where humanitarian operations take place are significant but lack resources and opportunities to scale up. There is also stigma related to working with waste, which may hinder upscaling of these activities.

Most disaster aid contexts involve a diverse range of HOs and sectors within HOs, all of whom create waste. However, the responsibility of WM is not shared. For example, the WASH sector along with logistics and SCM are the ones that bear the brunt of organizing the WM practices, even though, as one interviewee put it, "*creating waste is truly transversal*".

Table 3 Collaboration factors highlighted in interviews

	Gaps	Exemplifying quotes
Private sector	• Different, sometimes contradicting interests • Insufficient local infrastructure • Support of small local initiatives and organizations	*"obviously [partner's] perspective is a commercial one: if I can't make money from it, I'm not interested"* *"taking the waste from humanitarian context to a local waste management plant, but also, upgrade this plant, to find more sustainable, greener solutions, that will actually work, not only for the humanitarian side, but also, for the local communities, nearest urban centres"* *" we've got to find the space where the commercial interests hit the well-meaning interests"*
Intra- and inter-organizational	• All sectors create waste, responsibility should be shared • Consolidation of WM within an operation	*"[waste management] is not really addressed by health projects, water projects or shelter projects, even though it impacts all of those, right, it's truly transversal"* *"if there are a bunch of organisations working in the same area, let's consolidate the waste, so then it's a bigger bang for their buck."*

3.2.3 Local action and procurement

Local action and procurement is often seen as the solution to environmental issues relating from e.g. procurement. However, working with local suppliers does not guarantee more sustainable practices, as impacts from transport are not necessarily the biggest contributors to adverse environmental impacts. The entire life cycle of the material and products need to be analysed in its entirety to properly understand the effects these products may be having. As environmental audits are not yet standard practice in the humanitarian context, and even less in some of the more challenging Global South contexts operations often take place in, it

is very difficult to guarantee environmental specifications, especially with the tight schedules that humanitarian operations function under.

However, having strong local connection is imperative within humanitarian operations. The interviews stated that those working directly with beneficiaries have the biggest impact and as the contexts vary enormously, the local knowledge needs to feed into the management and strategic level decisions. Having those WM plans and being aware of the contextual challenges is paramount, and these are often missing within HO operations. Due to lack of infrastructure and standardised processes, waste can be disposed in ways that are further harming the environment and/or people. Non-existent safety protocols for getting rid of hazardous and medical waste are very common, as are improper incineration practices. Waste is being burnt in pits in the ground or dumped in landfills regardless of their recycling or repurpose value, because processes simply do not exist to deal with them.

Table 4 *Local action and procurement factors highlighted in interviews*

	Gaps	Exemplifying quotes
Localized processes	• Local suppliers can lack environmental credentials • Improving and integrating local WM with HO WM • Local grassroots initiatives	*"our local suppliers… they're going to buy whatever they get and the cheapest they can get"* *"The ones that deal directly with waste in the field, with the beneficiaries, are the ones that have the biggest impact"*
Infrastructure	• WM systems have trouble coping even without a disaster situation • Aid operations lack SWM plans	*"so much food assistance and other assistance, but no capacity to manage it at all"* *"most of the places we work in don't have, we can't say there's no public waste management systems, but usually, they're poor or limited capacity and all the rest of it"*
Education and awareness	• Strategic high-level plans need to be disseminated throughout the organization • WM management policies in different contexts	*"So, again, it's also educating our programme task staff and our programme teams to think of these solutions"* *"There's a guy standing there in flip flops with no gloves, no safety*

		goggles, pouring it into the soil. So, we need to do that due diligence"

3.2.4 Interlinkages

The themes of procurement, collaboration, and local action and procurement are strongly interlinked, as is visualised in Figure 4. The factors in the middle, such as streamlined processes and education were brought up in the empirical interviews in conjunction with all the themes. Streamlining processes in procurement requires collaboration both within the organization and with other stakeholders. As well, it is vital to make informed comparisons between local supply chains and importing materials from outside. There are of course always trade-offs involved, as procuring locally could potentially reduce packaging, as they do not need to be transported as extensively, but there are no guarantees of the rest of the life cycle and supply chain of the locally procured products, unless an audit has been performed or they have a certificate of ES. The decision makers involved in sourcing of humanitarian materials must remain vigilant in purchasing to avoid low quality, short lifespan products which are likely to contribute to an increase in waste (despite reduced packaging). Establishing partnerships with different stakeholders to improve e.g. education, the technical knowledge of HO staff, and local infrastructure in the field of ES is imperative as well.

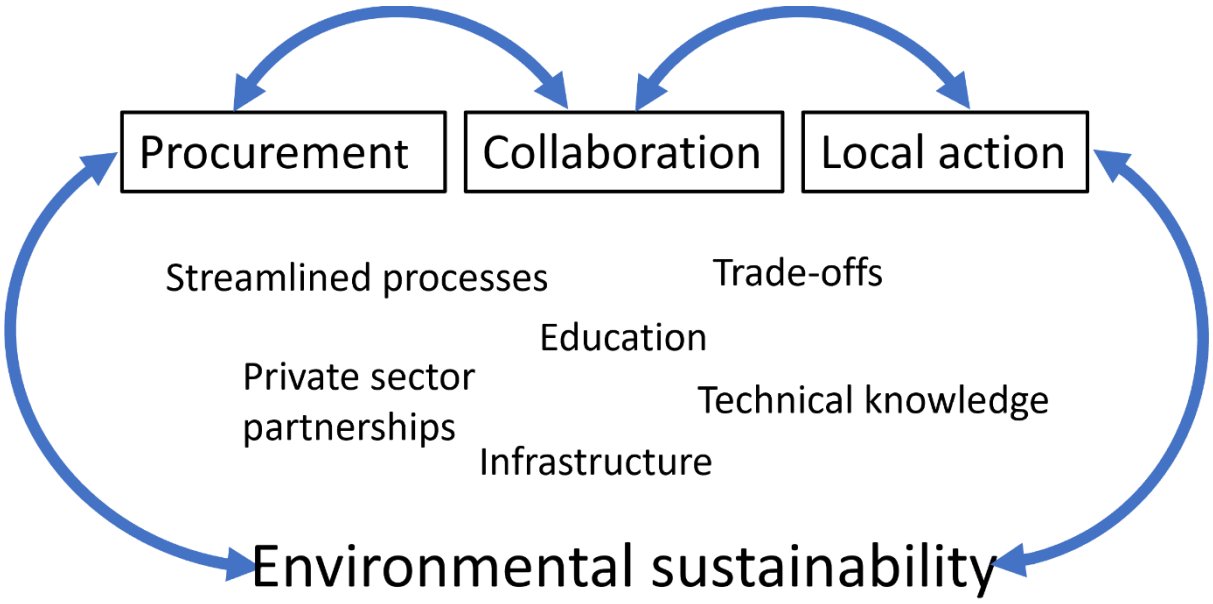

Figure 4 Interlinkages between themes

The second workshop (held during the Global Logistics Meeting (GLM) in June 2022) took up the questions of procurement, collaboration, and localisation further, in order not only to identify gaps but also discuss and share ideas for tangible improvements in these areas. Figure 5 summarises the results of this workshop. Participants were asked how these three processes can be improved, and the interlinkages again were apparent. Communication and collaboration among HOs and local stakeholders were highlighted, along with working closely with procuring partners for innovative and environmentally sustainable products. Full life cycle analyses (LCA) of SCs are suggested, where possible, to avoid outsourcing of impacts, which was raised many times during the interview processes as an issue with local procurement. Many of these issues are solvable with sufficient resources and lessons learned from commercial SCM. However, compared to the commercial sector, sufficient human, financial and other resources for full LCAs can be challenging to obtain in a humanitarian context.

Figure 5 Improvement ideas for processes

3.3 Waste streams and their management

There are limited ways to prevent waste from occurring in the humanitarian context. Product design and questioning which products, as well as quantities and qualities thereof, to deliver and from where, has important implications not only for waste management but also greenhouse gas emissions. Packaging is questioned for many operations, but packaging also serves the function of protecting items during their delivery, and/or can be utilised itself on site. Overall, while there are ways to reduce waste in the humanitarian context, there is no way to eliminate it altogether. Thus, it is key to consider waste management practices. In commercial logistics, WM is concerned with end-of life/end-of-use products, and the number of stakeholders in supply chains is manageable and somewhat controlled. In a humanitarian context however, the donors of goods and those in charge of distributing them can reach tens of thousands (individuals, different types of organizations, NGOs etc.) (Holguín-Veras et al., 2014). Donors can thus be not only financial but also material suppliers, regardless of whether this is part of any procurement activity or not.

In terms of the phases of disaster relief, donations that arrive after the occurrence of a disaster are seen as part of post-disaster HL (Suzuki, 2020). They can extend to any kinds of materials, including shelter, hygiene kits, food, water, or even medicine. Post-disaster HL is special in that it is characterized by a lack of information, while it may involve thousands of decision makers, at the same time as logistical activities are impossible to plan for as material flows are uncertain and infrastructure potentially impaired (Holguín-Veras et al., 2012). Because of the heterogenous group of stakeholders involved, the influx of solicited but also unsolicited items (materials and supplies) being sent as response to a disaster can be overwhelming, and this is referred to as material convergence. A lot of the supplies sent are life sustaining and critical, but there are useless items as well, which can cripple the already overwhelmed SC at the disaster site (Holguín-Veras et al., 2014). Material convergence studies approach the problem through an elimination of flows that are not high priority, but these items still contribute to the levels of waste in the HSC (Suzuki, 2020).

There is however a severe lack of attention and therefore funding of solid waste management (SWM). Waste such as plastic, paper, and organic waste, if not properly disposed of, leak toxins into and pollute the environment (Das et al., 2019). For many local authorities, waste management can be the biggest budget item (Kaza et al., 2018). This is particularly relevant in the Global South, where most humanitarian operations take place, and disasters further exacerbate the challenges of waste management (Tilley and Kalina, 2020). In an overarching study of humanitarian organizations, George et al. (2020) concluded that most organizations

or their field partners do not have solid waste management plans in their operations, even though awareness regarding the issue exists.

Different waste streams warrant different types of solutions. Focusing on specific waste streams is important for understanding (a) where the waste occurs and thereby, which stakeholders need to be involved in managing that waste stream, and (b) which materials are included in the waste and thereby, which waste management processes need to be followed.

There is significant focus on packaging and plastics, the "low hanging fruit", but which also have extremely relevant impacts on ES. Because humanitarian operations largely take part in places with lacking WM infrastructure managing plastic waste is a challenge. The volatile nature of the context is also an issue. With longer running operations, such as long-standing refugee camps for example, it is possible to achieve somewhat functioning WM practices as there is time to establish those. However, this requires significant collaboration with local stakeholders. These relationships can be difficult to establish due to for example the short terms contracts that HO employees often have, particularly with field work. Plastic and packaging are often grouped together in the same category, even though not all plastic is packaging and vice versa. Many NFIs given to beneficiaries, such as tarpaulins or jerry cans are made of plastic, but these have a much longer life cycle than packaging. However, the volumes of these types of items are considerable, whereby they will end up in landfills. There are numerous initiatives in process to make these items more durable and/or made of more sustainable materials, but often these initiatives suffer from lack of resources.

The continuous emphasis on packaging and plastic was validated through the interviews as well as the workshop, where 81% of attendees viewed packaging and/or plastic as the biggest problem in terms of waste streams. Medical waste also received attention within the interviews, particularly in the wake of the Covid-19 pandemic. Medical waste needs specific ways of disposal, such as proper incineration methods and infrastructure for its disposal, which can be challenging to have on site. For biological waste, for example maternal waste such as placentas, a burial method is used whereby the waste is dug into the ground and degraded naturally. Glass syringes etc are also buried in a condemned waste area, rather than sterilised to be used again due to lack of equipment, where access is extremely restricted, so people do not accidentally stumble upon a landfill of used syringes This type of incineration is used for masks, gloves, and other facilitating items as well. Once the medical equipment has been incinerated, the ashes are also buried and covered in concrete.

From other facilitating items used in humanitarian operations, e-waste items received multiple mentions, as their life cycle is not long and infrastructure to repair them can be difficult to obtain in the contexts of humanitarian operations. In many countries there are

also custom restrictions related to technology, that prevent e-waste from being shipped out to be properly disposed of, including the Basel Convention, if that infrastructure is unavailable in that context, leaving humanitarian managers without sustainable solutions for managing the waste. Similarly, fleet management waste such as used oil (for gensets and vehicles), lead acid batteries, and used tyres takes considerable effort and time to dispose of in ecological ways in many humanitarian contexts, leaving practitioners with limited resources and sustainable solutions for these hazardous by-products of humanitarian operations. In Figure 6, the different waste streams are visualised in terms of their emphasis in the interviews and workshops. The "low hanging fruit" of packaging and plastic are still seen as the biggest problems, even though this garners the most attention in ES efforts in the humanitarian sphere.

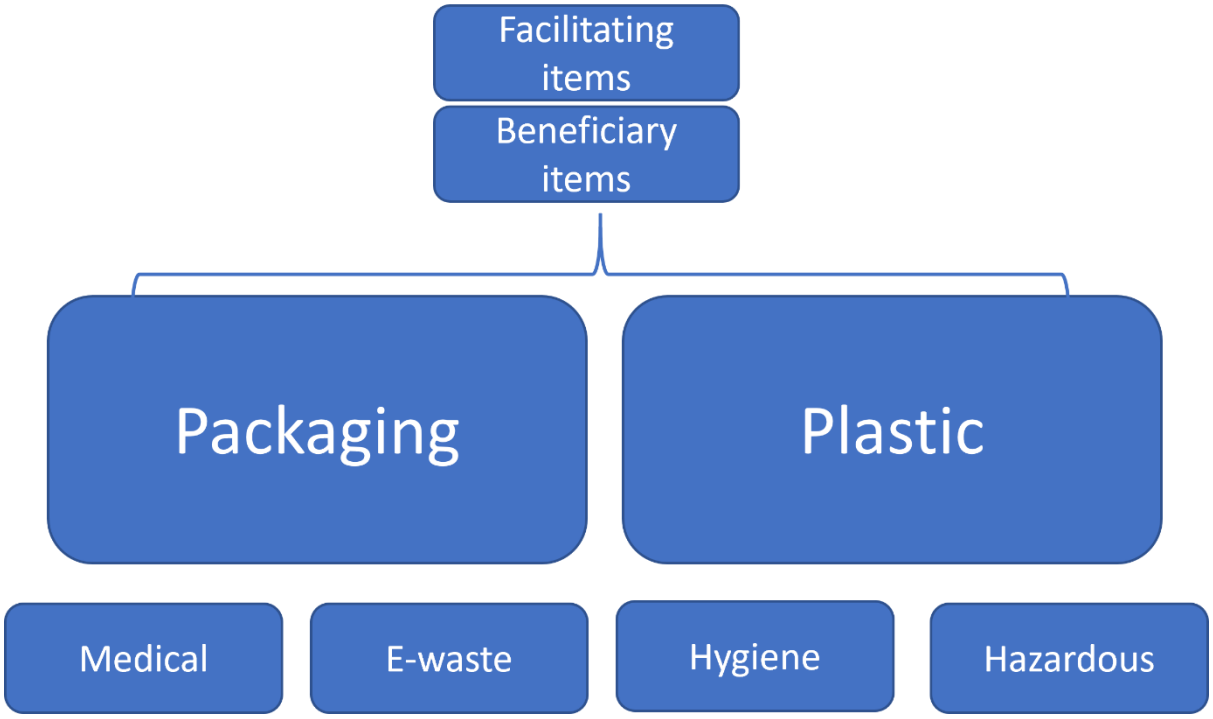

Figure 6 Categorising waste streams in humanitarian logistics

SWM in many Global South context is arranged through grassroots actions, and in many places for example informal settlements have better recycling and WM processes than many wealthier neighbourhoods. Initiatives related to waste pickers as a form of employment have been established in some cities. While important and valuable work, they still suffer from stigma related to for example substance abuse, as well as the significant health and safety risks related to waste picking. Again, education and awareness on WM is required, not just in HOs but also in many Global South cities. Waste pickers and other WM professionals need

proper infrastructure and environments to work in, and collaboration and local partnerships are key in this as well. Greener technology solutions for landfills and waste incineration already exist and are in use other places, so there are options and HOs and funding organizations are often in positions to further the dissemination of these types of solutions, not just for HOs to use but also for local communities and cities.

3.4 Reverse logistics

Rogers and Tibben- Lembke (2001) define reverse logistics (RL) as the cost-effective and efficient handling of products and materials from the point of consumption with the purpose of recapturing or recreating value or proper disposal thereof. RL arguably starts when a product is collected from the end user (Govindan et al., 2014). There are several avenues to be taken within the RL process. The products must be assessed, even disassembled if appropriate, after which their convertibility into usable products or raw materials is established (Prajapati et al., 2019). Products may be repaired or refurbished and reused. *Recycling* refers to reprocessing or incorporating the raw materials into new products or energy through incineration for example (Grant et al., 2017). The last option is disposal into landfills, if the product or its components are deemed insufficient (Prajapati et al., 2019).

In commercial SCs, reverse logistics practices have resulted in economic savings as well as environmental benefits (Prajapati et al., 2019). There is reason to assume the same would be true for HSCs, as they largely take their cues from commercial SCs (Peretti et al., 2015). As established, it is difficult to predict the amount of resources and items that are needed in an emergency, and deploying vast amounts of inventory 'just in case' is extremely costly and can be detrimental to the organizations reputation if the unused items are not returned, improperly disposed of, or re-donated or resold through other charities (Stauffer & Kumar, 2021).

Humanitarian operations often take place in remote contexts that have no WM systems in place, and are located far from e.g. urban centres that provide such infrastructure. This issue is well represented in HL in terms of transporting goods to the locations but transporting them out as waste has received considerably less attention. Issues related to this have been emphasized during the interviews. First, the feasibility of transporting vast amounts of waste over long distances and unreliable infrastructure to the nearest available WM facility has been questioned. Considering for example plastic waste: transport costs alone would be prohibitively expensive, and while volumes of light weight plastic can be significant, the commercial viability is likely insufficient, especially if not properly sorted by e.g. colour and type. Second, once goods have been transported to the operation site, trucks often return empty, resulting from a lack of logistical coordination. With proper inter- and intra-organizational coordination, those empty trucks could be used to transport waste to WM

facilities. This would however require somebody to take responsibility for this, as well as additional equipment such as balers for crushing the waste into transportable units. Loose waste is unmanageable and a safety hazard.

In addition to transportation, RL focuses heavily on recycling and repurposing of items. RL in general has not received much attention in humanitarian contexts, where material at the end-of-use phase has been largely regarded as waste, rather than valuable material than can be repurposed with appropriate handling. On the other hand, contexts such as refugee camps have very high rates of recycling and repurposing. This is not due to a strategic level decision or programme but rather a result of the dire circumstances in these contexts. However, the dynamics developed as coping mechanisms are extremely valuable in terms of RL and WM practices and should be explored. As well, more stringent WM practices, such as regular waste collecting and/or incentives to bring back certain types of waste, may decrease the existing grassroots RL dynamics, therefore increasing the volumes of waste generated. Grassroots and local action is in a key position to improve both RL and WM in humanitarian contexts. Key partnerships between local NGOs and stakeholders in e.g. recycling and WM are an imperative step in the process to maximise the value and use of the aid materials, as well as minimise the impact on the environment. Table 5 summarises the biggest gaps and factors to consider in RL within the humanitarian context.

Table 5 Factors in reverse logistics in HOs

	Gaps	Exemplifying quotes
Transport of waste	• Delivery trucks going back empty • Transport costs prohibitively high • Impacts on communities if left in-situ	*"I mean driving you know enormous amounts of waste, heavy plastic waste up and down, what is the feasibility or not of that and how does that look."*
Grassroots initiatives	• Support for grassroots initiatives, waste picker, and micro entrepreneurs • Value in materials and their uses beyond initial purposes	*"If we can think more about these materials as valuable things, rather than waste being managed, we continue to try to push this a little bit"*

		"there's a lady doing eco-bricks for example with plastic bags, there's already a company focusing on cork, there's another company already in place that's very heavy that focuses on glass"
Coordination	• Lack of coordination and responsibility among different HOs	*"So if we're going to make reverse logistics a priority here, then it has to be coordinated and it has to be organised and someone has to take responsibility for that"*
Collaboration	• A circular approach • Encourage and enable ES throughout the SC	*"a cradle to cradle approach, to make us more responsible, but also the suppliers, the manufacturers, the whole chain, so everyone will be thinking about this, because now, nobody thinks about this."*
Recycling	• Lack of local recycling infrastructure • Increased opportunities for recycling	*"cardboard cartons, HTP, polypropylene, these are all things that I think we need to be looking at those as an opportunity. We've had recent examples in Kenya, in Ethiopia, in Uganda, of actually receiving income from recycling"*

Repurpose	• Do not want to discourage repurposing • Learn from refugee setting repurposing activities	*"people in refugee settings are generally much more conscientious about reusing and repurposing stuff."* *"in the camps people tend to reuse and reuse and reuse and then repurpose and then reuse again."*

3.5 Other issues

There are numerous issues which impact the ES of humanitarian organizations, but one that has been emphasised is the influence of individual employees. Several interviewees spoke of having "*a guy who was already very sustainably aware*", which was said to be a key instigator. However, as the turnaround of HO employees is quite large, i.e., short-term contracts are common and people often don't spend very long in one location, those projects tend to get cut off as the instigators leave. While it is imperative to have individual employees spearheading projects, there needs to be strategic and managerial support to maintain them.

The role of funding organizations and donors in providing guidance and parameters for ES processes has also been brought up on numerous occasions. Different donors however have different processes and varying interests. This can cause gaps between the understanding of donors' goals and the goals of the HOs, as well as different perceptions over the overall achievements of an operation. While many donors now include ES requirements in their frameworks, HOs and NGOs may have difficulties in meeting them without additional resources.

4 Future pathways

This WREC study has highlighted several remaining gaps for waste management and reverse logistics in the humanitarian context. Those gaps raise a number of important questions.

On a strategic level, the question is how humanitarian organisations, and their operations, contribute to climate change. This question cannot be overstated in importance. A changing climate and its impact on the frequency, intensity and occurrence patterns of hydro-meteorological hazards has severe consequences for humanity, and by extension, for the humanitarian sector. Apart from the direct impact of such hazards, they also have indirect ones. As the Climate Center highlighted in 2021, 2020 was the first time when climate and

weather events were the main reason for displacement. Environmental sustainability considerations overall, and greening humanitarian operations in specific are important measures to mitigate HO's impact on climate change.

The importance of different partnerships between stakeholders have also been deemed of strategic and practical importance. Processes to improve ES within humanitarian operations include for example procurement, where there is already considerable effort. In the future more effort needs to be geared towards engaging all partners and stakeholders along the supply chains to consider ES in their processes and having that transparency. While local procurement can improve ES to some degree with for example shorter transport times and less packaging, unless the life cycle of the sourced materials is known fully, there is no guarantee of ES.

Partnerships with local stakeholders such as WM companies are also imperative to establishing adequate processes in this regard. As more HOs and NGOs establish transparent partnerships with e.g. private sector, this could be an instigator for other organizations to follow suit. As well, these types of partnerships could be a step to improve WM systems in Global South contexts, where humanitarian operations take place. WM programmes could be integrated into livelihoods efforts through collaboration with local partners, but with careful consideration of local markets and the viability in terms of livelihoods. Using waste to manufacture for example building materials has had success in some contexts but creating additional single use plastic products keeps the waste in circulation and wastes energy and resources (as well as produces carbon emissions) with negative effects.

The role of donor organizations and the frameworks they set for ES is an important future consideration. As many ES processes require additional resources to be able to be established, the role of the donors is significant. The interests of the HO and the donor organization need to meet, meaning the HO needs to also include the ES interests in their funding applications. Donors can also require certain parameters to be included in applications for funding to be granted.

This qualitative study provides an initial overview of the ES efforts currently discussed within HSCM. With subsequent quantitative research, the themes in this review can be conceptualized into practical actions. Issues such as which products and services within HOs have the largest environmental impacts in terms of greenhouse gas emissions and waste creation are integral steps in forming a roadmap to reducing those impacts.

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