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Sustainable humanitarian supply chains: a systematic literature review and research propositions

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ABSTRACT

The purpose of this systematic review is to synthesise the body of knowledge related to sustainable humanitarian supply chains across disaster relief as well as those of logistics of development aid. The output of this paper is a set of research propositions that will help advance theory building and validation for the management of sustainable humanitarian supply chains. This systematic review identifies and categorises sustainable humanitarian supply chain management (SHSCM) themes, with a particular emphasis on theoretical development based on a categorical analysis of research articles. The thematic analysis reveals that sustainability in humanitarian supply chains encompasses a wide range of aspects, such as supply network configuration, coordination, and partnership, as well as performance measurement. However, theoretical studies typically do not integrate all sustainability dimensions. In particular, social sustainability factors are largely absent from current models of SHSCM, despite their inherent significance in humanitarian contexts. The categorical analysis explains how aspects related to the identified themes impact and pose opportunities for SHSCM. Insights from this systematic review can support humanitarian supply chain sustainability knowledge with policy-driven research directions. These policies can help achieve a greater level of sustainability in humanitarian supply chain management. The originality of this study lies in the development of detailed categories of sustainability studies, in its analytical focus on SHSCM theories, and in the development of research propositions to provide insights to researchers on how to advance theory and conduct impactful research on the topic of SHSCM.

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1. Introduction

The number of people in need of humanitarian assistance and protection was expected to reach 279 million in 2022 (OCHA 2022). The various ongoing conflicts (e.g. in Ukraine or Sudan), the prevalence of virulent diseases (e.g. COVID-19 pandemic), and the adverse impact of climate change (e.g. extreme flooding and droughts in Mozambique) are further complicating factors. These emergencies have placed enormous strain on the humanitarian sector and may be detrimental to the sustainability of humanitarian efforts. From an environmental perspective, due to the massive global volume of humanitarian operations, the sector has already contributed significantly to environmental pollution. For example, the United Nations High Commissioner for Refugees (UNHCR) has the largest fleet of vehicles in the United Nations, producing over 97,000 metric tonnes of CO_2 annually (UNHCR 2022). While this is a significant carbon footprint within the sector, it is much smaller in comparison to the total global contribution of other industrial and service sectors. Despite the comparatively smaller contribution of humanitarian operations, the sector's unique intersection with climate change and humanitarian needs imbues it with an intrinsic and urgent imperative to enhance the environmental sustainability of its operations. As such, the sector has been subjected to heightened scrutiny from donors regarding its carbon footprint, leading to an intensified focus on the sustainability and long-term impacts of humanitarian operations. Humanitarian organisations (HOs) are increasingly being held accountable for their supply chain footprint (European Civil Protection and Humanitarian Aid Operations [ECHO] 2020). Donors and stakeholders have prioritised sustainability agendas and expressed concerns about the rising threats of climate change. For example, ECHO, a major donor of humanitarian assistance, plans to mandate that all of its funded HOs report their carbon footprints by 2023 for funding eligibility (ECHO 2020).

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From a social sustainability perspective, the humanitarian sector is confronted with challenges related to ensuring the inclusivity, equity, and protection of vulnerable populations (Haavisto and Kovács 2014). The displacement of communities due to conflicts and natural disasters can lead to social disruptions, loss of livelihoods, and increased vulnerability to exploitation and violence (Laguna-Salvadó et al. 2019). Additionally, access to basic services, such as healthcare, education, and clean water, remains limited in many crisis-affected regions, exacerbating social inequalities and human suffering (McCoy and Lee 2014). Thus, the social implications of humanitarian supply chains (HSCs) extend beyond logistical efficiency, as they have a profound impact on local communities. Effective HSC practices can lead to improved access to life-saving resources, enhanced community resilience, and strengthened social cohesion, thereby contributing to the overall well-being and sustainability of affected populations (Kunz and Gold 2017; Besiou, Pedraza-Martinez, and Van Wassenhove 2021).

In terms of economic sustainability, the humanitarian sector faces constraints in securing stable funding sources and managing financial resources effectively. HOs often rely on donor funding, which can be unpredictable, impacting the long-term planning and sustainability of humanitarian operations (Burkart, Besiou, and Wakolbinger 2016). Moreover, the cost of delivering aid in remote and conflict-affected areas can be prohibitive, limiting the scale and reach of assistance (Kunz and Gold 2017). Finding innovative financing mechanisms and ensuring cost effectiveness are crucial for enhancing the economic sustainability of humanitarian efforts (Altay et al. 2023; Van Wassenhove 2019). Increasingly, HOs are working towards diversifying funding sources, establishing public-private partnerships, and exploring impact investment opportunities to bolster financial resilience and facilitate a more sustainable flow of resources (Nurmala et al. 2017).

To address the call for more sustainable humanitarian supply chain management (SHSCM), a growing yet limited number of scholars have attempted to incorporate sustainability agendas into their HSC research. However, the question of what constitutes sustainability in HSCs and which aspects lead to sustainable HSCs remains unanswered. The long-term impacts of HSCs and humanitarian assistance are relatively hard to trace and analyse (Salzenstein and Pedersen 2021). This complexity stems from the multifaceted dimensions of sustainability in international humanitarian operations. There is a lack of clarity over which impacts (e.g. environmental or social) should be prioritised in sustainable humanitarian operations, and widely accepted measures of sustainability in HCSs are still missing. Due to this complexity, research on SHSCM has remained challenging.

Despite the complexity of the topic, studies on SHSCM have seen an upward trend in recent years. Among the seminal publications related to SHSCM are those of Haavisto and Kovács (2014) and Kunz and Gold (2017), who advocated for the development of an SHSCM framework. Recently, due to the rapid advancement of technology, more emphasis has been placed on applying Industry 4.0 technologies to achieve more sustainable HSCs (Bag, Gupta, and Wood 2020). In view of the limited literature on SHSCM and because sustainability has become a critical issue in the humanitarian sector, a structural analysis is required to offer a thorough analysis of the field and develop a research agenda for researchers and practitioners to advance theory and research related to SHSCM. To the best of our knowledge, no systematic review with a thematic analysis of the SHSCM literature has been conducted to understand current trends and propose future research opportunities. Our study intends to fill this gap by synthesising the literature on SHSCM and conducting a structured analysis. The following questions are the focus of our investigation:

RQ_1: How has the SHSCM literature evolved over time, and what methods, tools, and concepts have been used to assess sustainability?

RQ_2: What areas in the SHSCM literature have been researched more extensively, and why have these areas gained more prominence?

RQ_3: What are the most important avenues for future research on SHSCM? What research directions have the greatest potential to have a significant impact on the theory and practice of SHSCM?

Answering these questions is critical for a number of reasons. First, it allows for the examination of the body of knowledge related to SHSCM and motivates further research in areas of practical and theoretical relevance. Second, it increases the awareness of humanitarian practitioners to consider the long-term impact of aid and promotes a common understanding of sustainability drivers that combine elements central to the humanitarian sector. Lastly, answering these questions reveals insight into the state of sustainability in HSCs and thus provides an opportunity to address identified shortcomings. The remainder of this paper is structured as follows: Section 2 discusses the significance of sustainability in HSCs. Section 3 outlines the methodology. Section 4 presents the descriptive analysis. Section 5 discusses the themes in SHSCM. Section 6 discusses the key findings and gaps in the literature. Section 7 develops a set of propositions, and Section 8 concludes the paper.

2. Sustainability in humanitarian supply chains

The concept of sustainability in humanitarian settings is not new. The 'do no harm' principle – which dictates that HOs need to avoid any detrimental impact of their operations on society, the economy, and the environment – has been in place for more than three decades. This principle further addresses resilience and ensures affected people communities' capacity to self-manage. However, in recent years, international HOs have been criticised for not expanding their view to encompass the overall supply chain and for not considering the long-term implications of delivering aid.

The negative impacts of HSCs are wide, ranging from global (e.g. CO_2 emissions of transportation) to local (e.g. local plastic pollution or deforestation) outcomes. Their impacts can be direct (e.g. an HO generating pollution) or indirect (e.g. suppliers' poor quality manufacturing) and can materialise in the short or long term (Logistics Cluster 2022). These negative impacts make sustainability in HSCs a particularly challenging but important topic to study. Among the negative impacts that HOs may generate are disruptions to the

local economy, environmental degradation, such as those caused by refugee settlements, and unsafe management practices of waste that include sewage and medical waste, which can lead to public health crises (e.g. cholera epidemics) (EECentre 2019).

In combination with the environmental aspects of HSCs, the social and economic dimensions play an important role in ensuring the effectiveness and sustainability of humanitarian operations. Social sustainability in the context of humanitarian operations entails a comprehensive and unwavering focus on the long-term well-being of affected communities and the equitable distribution of resources among affected communities (McCoy and Lee 2014). Despite this focus, aid distribution can sometimes inadvertently reinforce existing power dynamics and create dependency on external assistance, thereby limiting the voices and agency of affected communities (Anaya-Arenas, Ruiz, and Renaud 2018). Short-term focus and aid may impede the development of sustainable solutions and interfere with localisation processes (Frennesson et al. 2022). Despite the potential benefits of localisation in sustainable HSCs, the challenges of securing stable funding sources and establishing long-term strategic partnerships with local stakeholders continue to be challenging in realising sustainable, locally led humanitarian operations (Matopoulos, Kovács, and Hayes 2014). To address these challenges, HOs strive to prioritise community engagement, equity, empowerment, and the integration of local perspectives in their decision-making processes.

In the economic dimension, the unpredictability and unavailability of donor funding have largely hindered long-term development and limited communities' transition to self-reliance (Aflaki and Pedraza-Martinez 2016). For instance, sudden shifts in donor priorities or economic downturns in donor countries may result in funding cuts or delays in disbursing funds for long-term projects (Burkart, Besiou, and Wakolbinger 2016). As a result, securing stable funding sources poses a significant challenge for international HOs. Additionally, the cost of delivering aid in remote and conflict-affected areas can be prohibitive, limiting the scale and reach of assistance. HOs often face the dilemma of balancing cost effectiveness with the urgent need to reach vulnerable populations. In the volatile and often conflicting humanitarian context, the allocation of aid resources may not always align with the actual economic needs of the affected population, neglecting critical investments in education, health, and protection needed to revitalise local economies (Jahre and Heigh 2008).

These examples illustrate a major trade-off for SHSCM: providing help increases the well-being of people affected by crisis (positive social impact) but often comes at the expense of a negative environmental or economic impact on the communities. To the best of our knowledge, practitioners and researchers need a full understanding of these trade-offs and how best to incorporate them in decision-making.

There have been recent efforts in the humanitarian sector to include sustainable development in humanitarian actions, such as the joint-initiative for packaging waste management, the WREC project, and the training course 'Sustainable Development in Humanitarian Action' developed by the International Federation of Red Cross and Red Crescent Societies in collaboration with the Swedish Red Cross (Logistics Cluster 2023). Another example is the ongoing development of a 'carbon accounting tool' that can be used by more than 150 international humanitarian actors to determine their annual greenhouse gas emissions (EcoAct 2022). In line with the current practices and initiatives of HOs, an increasing number of academic papers related to SHSCM have been published. To understand the current status of the field and motivate researchers and practitioners to concentrate on advancing theory and research related to SHSCM, there is a need for a systematic review of existing SHSCM studies.

3. Review methodology

We developed our SLR following the general principles for conducting a structured literature review, as suggested by Durach, Kembro, and Wieland (2021) and Seuring et al. (2020). Figure 1 illustrates our systematic review process. The following subsections describe the steps of the SLR methodology we conducted to identify seminal work and extract trends in the literature.

3.1. Phase 1 – Identifying gaps and SLR goals

In the first phase, we conducted a pilot review of the SHSCM literature and analysed the main theoretical contributions in the field. We aimed to synthesise the extant literature focusing on sustainability in HSCs using a structured approach. We used the theoretical background from Kunz and Gold (2017) SHSCM framework, which posited that to achieve sustainable performance of HSCs, supply chain design needs to be aligned with HOs' enablers and people affected by crisis long-term requirements, as well as socio-economic and governmental contingency factors. This framework provided the starting point for our inclusion and exclusion criteria, as well as the themes and contextual factors that must be considered in our SLR.

3.2. Phase 2 – Selecting databases and keywords for identifying relevant literature

In the second phase, we identified papers from the Scopus and Web of Science databases. These databases were selected because they encompass a comprehensive range of refereed journals from major publishers. The key selection criterion was peer-reviewed published scientific articles written in English that addressed SHSCM. To identify relevant papers, we used the following combinations of keywords using Boolean operators (AND, OR) to query the title, abstract, and keyword fields:

('Sustainab'*

AND

('Humanitarian Supply Chain' OR 'Humanitarian Relief Supply Chain*' OR 'Humanitarian Logistic*' OR 'Humanitarian Relief Logistic*' OR 'Humanitarian Operation*' OR 'Humanitarian Relief Operation*' OR 'Humanitarian Aid*

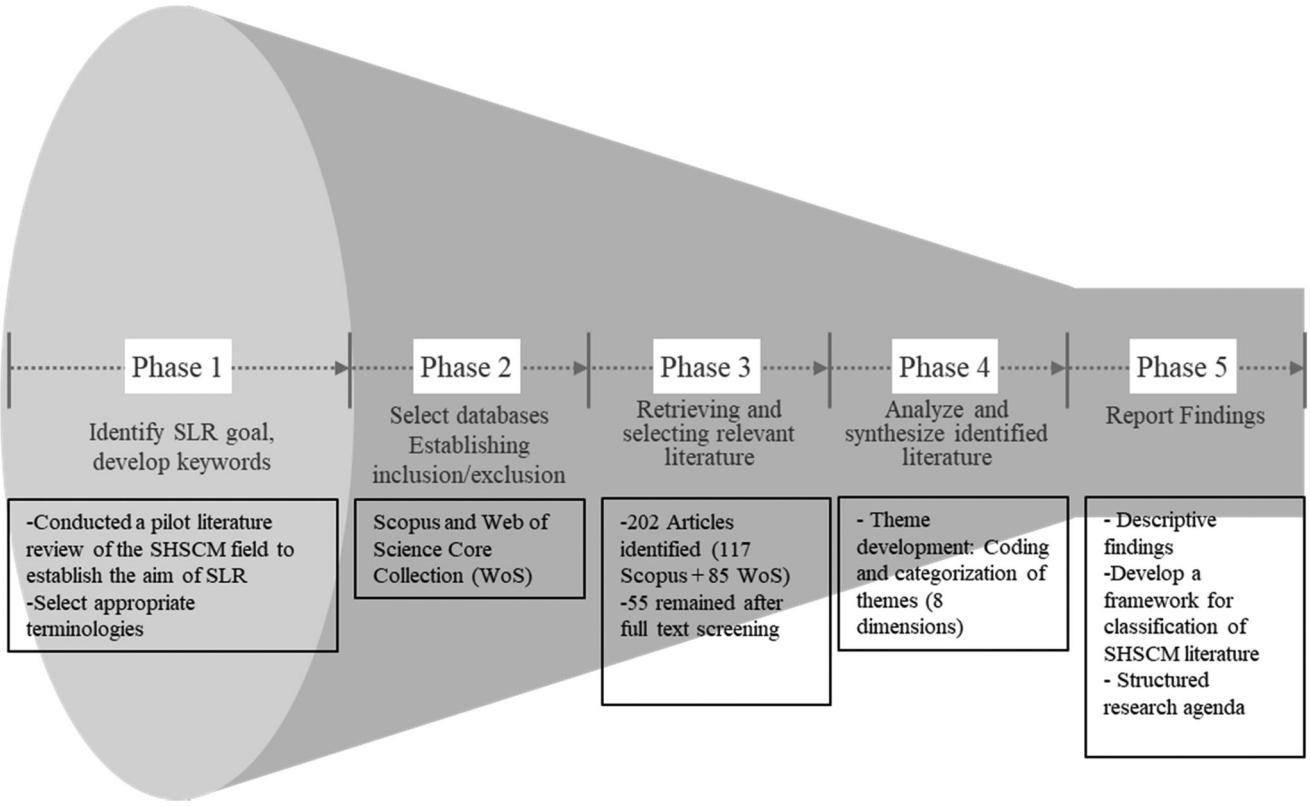


Figure 1. Systematic literature review process.

Logistic' OR 'Humanitarian Relief Chain*' OR 'Disaster Supply Chain*' OR 'Disaster Relief Operation*' OR 'Disaster Logistic*' OR 'Disaster Relief Network*' OR 'Disaster Operation*' OR 'Disaster Relief Logistic*' OR 'Disaster Relief Chain*' OR 'Disaster Operations Management' OR 'Disaster Response Logistic*' OR 'Emergency Relief Logistic*' OR 'Relief Operation*' OR 'Relief Supply Chain*'))*.

Since sustainability includes three performance dimensions (social, environmental, and economic), it is difficult to clearly delineate which topic belongs to sustainability. In particular, one could argue that every study in the field of HSC has a social implication since the objective of humanitarian aid is to help people affected by crisis. Therefore, we decided to focus only on studies that used the word 'sustainability' (and its variations) explicitly and therefore focus only on studies whose authors have identified to be related to sustainability.

For the second part of the keyword list, we included all possible variations in HSC management. We selected this list through an iterative process and refined the keywords until all major papers identified in the pilot review were included. This ensured that our selection of papers was exhaustive.

3.3. Phase 3 – Retrieving and selecting relevant literature

In the third phase, we collected papers using the databases and keywords identified in Phase 2. We then excluded papers based on predefined exclusion criteria. We removed papers that were not published by major publishers (e.g., Elsevier, Emerald Group Publishing, Taylor & Francis, Springer, Wiley, etc.) or that did not address the issue of sustainability in any area of humanitarian operations. We illustrate this systematic sampling process in Figure 2.

After combining the papers from both databases (Scopus and Web of Science), we identified 202 papers. By eliminating duplicate entries, we narrowed the selection down to 123 papers. Next, we conducted a preliminary assessment of the 123 remaining papers and excluded 10 papers based on the journal publisher. After screening the titles and abstracts, we further removed 26 papers that were not related to sustainability and HSCs and were left with 87 papers. Finally, we analysed the full text of the remaining articles and removed 32 papers because they did not have a clear focus on sustainability and HSCs. This final sample consisted of 55 studies published between 2013 and 2022. We did not select 2013 as the start date for our selection of papers; this year simply corresponds to the first published study that satisfies our SLR criteria. Appendix A provides a summary of our sample's final list.

3.4. Phase 4 – Analyse and synthesise identified literature

In the fourth phase, we collated the descriptive findings. This descriptive analysis was intended to describe the literature development trend by frequency analyses of our selected articles according to year, journal publisher, academic institution, and key author. We then categorised the identified papers according to different dimensions. We developed the dimensions and categories of our classification framework through a combination of inductive and deductive reasoning

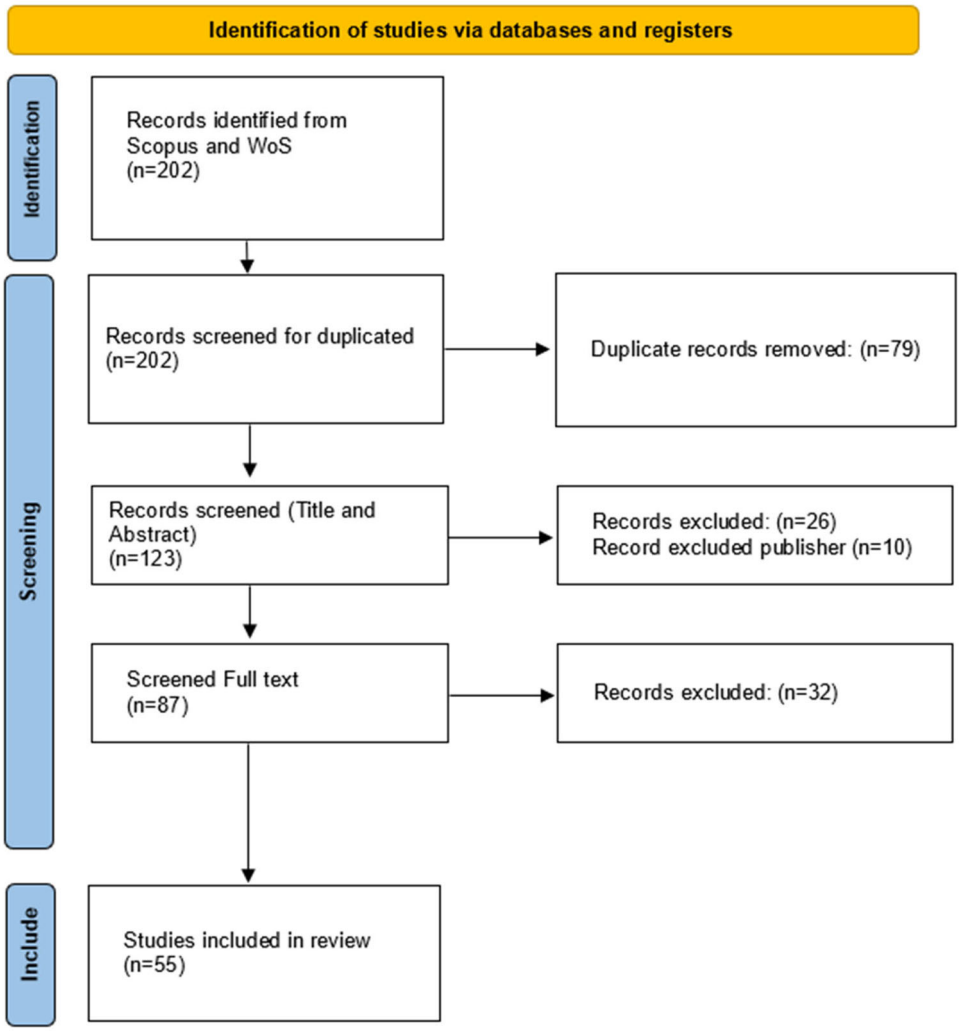


Figure 2. Sampling process.

(Seuring and Müller 2008). Table 1 lists these dimensions and their corresponding categories (all of which are mutually exclusive).

Finally, we followed an inductive process to analyse the primary findings, the topics addressed, the research methods, and the research context of each paper to identify the main sustainability theme of each paper (dimension *viii* in Table 1). Based on this detailed analysis, the key themes of SHSCM were documented for each article. Using a systematic process of discovering patterns and relationships between those categories, we identified a set of SHSCM themes and grouped similar concepts. This allowed us to determine sustainability themes based on an iterative inductive process in which we identified the central theme for each article and grouped those with similar themes until we were left with a list of sustainability themes.

3.5. Phase 5 – Report findings and future research directions

The last stage involved discussing the overall SLR outcomes and research gaps and developing future research directions.

4. Descriptive analysis

4.1. Distribution of reviewed papers over time

The identified papers were 55 articles published between 2013 and 2022, as shown in Figure 3. Sustainability in humanitarian operations was initially explored by researchers such as Green, Weck, and Suarez (2013) and Haavisto and Kovács (2014). More recently, Besiou, Pedraza-Martinez, and Van Wassenhove (2021) and Corbett, Pedraza-Martinez, and Van Wassenhove (2022) have contributed to this field of study. We identified two phases of the development trend in this literature: (a) an early dissemination phase from 2013 to 2018 and (b) a development phase from 2018 to 2022, with a substantial upward trend in the number of publications per year, especially in 2021 (given that this review was conducted during the year 2022, not all papers published in that year have been included).

4.2. Distribution of papers by journal and country

Table 2 lists journals that published more than one SHSCM study. The *Journal of Humanitarian Logistics and Supply Chain Management* published most of the selected articles,

Table 1. Categorical classification.

Dimension	Categories	Approach	Source
i. Disaster type	Sudden-onset Slow-onset Both or not specific	Deductive	Kunz and Reiner (2012)
ii. Context of operation	Disaster relief Development aid Both or not specific	Deductive	Kunz and Reiner (2012)
iii. Disaster management phase	Mitigation and preparedness Response Recovery Several Not specific	Deductive	Kunz and Reiner (2012)
iv. Research design	Empirical Quantitative Qualitative Analytical Conceptual	Deductive	Rebs et al. (2018)
v. Data analysis technique	Empirical/qualitative: Case study | Focus Group Empirical/quantitative: Survey | Database | Experiment | MCDM Analytical: Optimisation | Simulation | Conceptual: Lit. Review | Conceptual reasoning	Deductive	Larson and Halldorsson (2004)
vi. Sustainability dimension	Economic Environmental Social Several Not specific	Deductive	Elkington and Rowlands (1999)
vii. Theories	Contingency, Game theory, Stakeholder theory, etc.	Inductive and Deductive	Touboulic and Walker (2015)
viii. Sustainability themes	Sustainability in disaster relief logistics • *Barriers and enablers* • *Frameworks of SHSCM* • *Performance measurements* • *Collaboration and partnerships* • *Supply network configuration* • *Reverse logistics and circular HSC* • *Innovative solutions and Industry 4.0 applications in SHSCM* Sustainability in humanitarian development-aid logistics • *Performance measurements* • *Collaboration and Partnerships* • *Supply network configuration* • *Reverse logistics and circular HSC* • *Link between humanitarian operations and SDGs*	Inductive and Deductive	Kunz and Gold (2017)

followed by *Production and Operations Management*, *Annals of Operations Research*, and the *Journal of Cleaner Production*. Overall, 58% of the papers in our selection (32 out of 55) were concentrated in the five journals listed in Table 2.

The selected papers were written by authors from 49 academic institutions. Table 3 shows the geographic distribution of these institutions, with the USA, China, and India dominating the list. Interestingly, the number of papers from developed and developing countries is fairly balanced.

Table 4 lists the authors who published more than one paper on SHSCM, showing a wide authorship rather than the concentration of a few authors.

4.3. Distribution of papers per category for each structural dimension

This section addresses RQ_1 and presents the number of papers we classified in each category of our eight structural dimensions (see Table 5). We first present the descriptive statistics related to the classification of papers into various structural dimensions. We discuss the SHSCM themes in Section 5.

5. Themes in sustainable humanitarian supply chains

Figure 4 shows the themes that we inferred inductively from our paper selection. This section presents key thematic concepts and their significance to SHSCM. Although our themes focus on disaster relief and development aid separately, we recognise that these two spheres should be studied together from a sustainability perspective, and that disaster relief should be integrated into broader strategies for long-term development. While disaster relief focuses on providing immediate assistance, development aid focuses on longer-term interventions to address the underlying causes of vulnerability and build communities' resilience.

5.1. Sustainability in disaster relief logistics

5.1.1. Barriers and enablers to SHSCM

Key findings from the literature converge on barriers and enablers faced by HOs as they strive for sustainability, encompassing logistical intricacies, constrained resources, and escalating environmental demands (Abrahams 2014; Bag, Luthra, et al. 2020; Mangla and Luthra 2022). Many studies have focused on

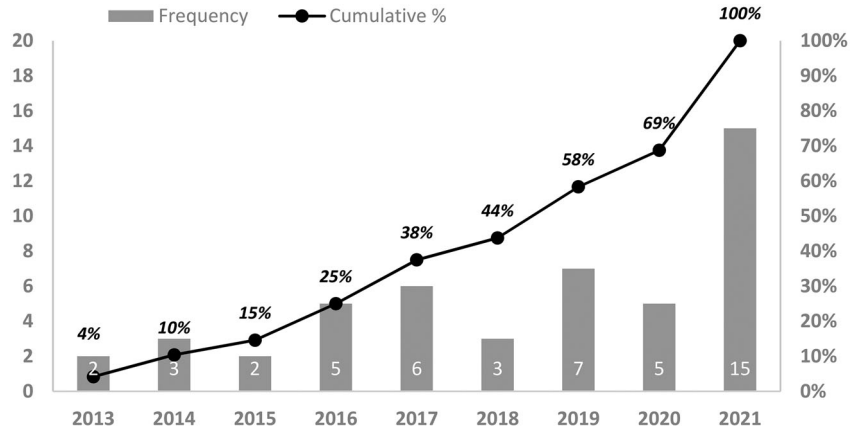


Figure 3. Distribution of reviewed papers over time.

Table 2. Number of papers per journal (included if $n > 1$).

Journal	Number of papers
Journal of Humanitarian Logistics and Supply Chain Management	14
Production and Operations Management	9
Annals of Operations Research	3
Journal of Cleaner Production	3
International Journal of Logistics Research and Applications	2

Table 3. Number of papers published per country (included if $n > 2$).

Country	Number of papers
USA	10
China	6
India	5
Finland	4
Italy	4
UK	3
France	3
Pakistan	3
Iran	3
Germany	3

Table 4. Top contributing authors in SHSCM (included if $n > 1$).

Author	Country	Affiliation	Number of published articles
Haavisto, I	Finland	Hanken School of Economics	2
Cao, C.	China	Chongqing Technology and Business University	2
Zarei, M.H.	Italy	Politecnico di Milano	2
Bag, S.	South Africa	University of Johannesburg	2

examining the barriers and enablers related to the complexities of SHSCM (Patil et al. 2021; Zarei, Carrasco-Gallego, and Ronchi 2019b; Abbas et al. 2022; Lu et al. 2021). For example, Patil et al. (2021) investigated barriers to sustainability in a medical HSC and prioritised key barriers based on their impact. Abbas et al. (2022) identified key barriers to SHSCM and analysed their interdependencies. Zarei, Carrasco-Gallego, and Ronchi (2019b) studied the impact of regional hubs on humanitarian operations' environmental sustainability and identified barriers to sustainable HSCs. Yadav and Barve (2016) developed a hierarchical structure of HSCs' barriers to surmount to achieve sustainability. Tasnim et al. (2022) investigated the barriers influencing sustainable HSCs in Bangladesh, emphasising the significance of sustainable practices in humanitarian operations. Bag, Luthra, et al. (2020) identified enablers of sustainable HSCs and proposed a model for improving responsiveness, highlighting the importance of strategic planning and the collaborative relationship of relief operations.

5.1.2. Frameworks of SHSCM

Research on SHSCM has contributed to the development of theoretical frameworks that govern sustainable practices in HSCs (Kunz and Gold 2017; Meduri and Ahmed 2016). The theoretical foundations and framework development for understanding SHSCM are discussed in five articles. Kunz and Gold (2017) developed a framework of SHSCM that conceptualises sustainable performance in a disaster rehabilitation phase while considering HOs' external contingency factors. Dubey and Gunasekaran (2016) established an SHSCM framework with an emphasis on agility, flexibility, and alignment that ties ecological imbalances with natural disasters and proposes an environmentally conscious supply chain. Haavisto and Kovács (2014) developed a framework for analysing how HOs address different expectations regarding sustainability. Zarei, Carrasco-Gallego, and Ronchi (2019a) relied on contingency theory to develop a framework that synthesised green practices for HSCs. Their framework defines the contingency factors influencing the greening of HSCs and examines how humanitarian service providers can adapt to such factors.

5.1.3. Performance measurement of SHSCM

Studies focusing on performance measurement in SHSCM highlight the necessity of adopting multi-dimensional and adaptive performance indicators that encompass diverse stakeholder perspectives (Haavisto and Goentzel 2015; Laguna-Salvadó et al. 2019). Research on SHSCM performance measurement remains relatively unexplored, with few studies investigating established strategic performance measurement concepts, such as the balanced scorecard in assessing the sustainability and efficiency of humanitarian operations (Agarwal, Kant, and Shankar 2022; Haavisto and Goentzel 2015). Agarwal, Kant, and Shankar (2022) developed a balanced scorecard for the sustainability assessment of humanitarian operations. Laguna-Salvadó et al. (2019) developed a multi-objective master planning decision support system

Table 5. Number of papers per structural dimension.

Dimension	Categories	Number of papers	Frequency
Disaster type	Slow-onset	10	18.2%
	Sudden-onset	29	52.7%
	Both or not specific	16	29.1%
Context of operation	Disaster relief	29	52.7%
	Development aid	16	29.1%
	Both or not specific	10	18.2%
Disaster management phase	Mitigation and preparedness	7	12.7%
	Response	18	32.7%
	Recovery	16	29.1%
	Several	7	12.7%
	Not specific	7	12.7%
Research design	Empirical		
	Quantitative	18	32.7%
	Qualitative	14	25.5%
	Analytical	14	25.5%
	Conceptual	9	16.4%
Research method	Empirical/qualitative		
	Case Study	12	21.8%
	Focus Group	1	1.8%
	Action Research	2	3.6%
	Field Experiment	1	1.8%
	Empirical/quantitative		
	Survey	11	20.0%
	MCDM	5	9.1%
	Analytical		
	Optimisation	13	23.6%
	Simulation	1	1.8%
	Conceptual		
	Literature Review	6	10.9%
	Conceptual reasoning	3	5.5%
Sustainability dimension	Environmental	5	9.1%
	Economic	1	1.8%
	Social	4	7.3%
	Economic + Environmental + Social	16	29.1%
	Environmental + Economic	2	3.6%
	Social + Economic	8	14.5%
	Environmental + Social	3	5.5%
	Not Specific	16	29.1%
Theories	Game theory	3	5.5%
	Contingency theory	2	3.6%
	Grounded theory	1	1.8%
	Diffusion of Innovation theory (DOI)	1	1.8%
	Human capital theory	1	1.8%
	Social entrepreneurship theory	1	1.8%
	Institutional theory	1	1.8%
	Goal-setting theory	1	1.8%
	Multiple theory	1	1.8%
	Not Specific	43	78.2%
Sustainability themes	**Sustainability in disaster relief logistics**		
	• *Barriers and enablers*	10	18.2%
	• *Frameworks of SHSCM*	5	9.1%
	• *Performance measurements*	4	7.3%
	• *Collaboration and partnerships*	5	9.1%
	• *Supply network configuration*	7	12.7%
	• *Reverse logistics and circular HSC*	2	3.6%
	• *Innovative solutions and Industry 4.0 applications in SHSCM*	6	10.9%
	Sustainability in development aid logistics		
	• *Performance measurements*	2	3.6%
	• *Collaboration and Partnerships*	2	3.6%
	• *Supply network configuration*	6	10.9%
	• *Reverse logistics and circular HSC*	3	5.5%
	• *Link between humanitarian operations and SDGs*	3	5.5%

for the performance management of SHSCM. Shafiq and Soratana (2020) established a lean readiness assessment methodology that serves as a tool for HOs' social and economic sustainability. Haavisto and Goentzel conducted an in-depth case study to explore performance measurement in HSCs, emphasising sustainability aspects in humanitarian operations. They identified misalignments between the goals and processes of different groups in humanitarian operations, highlighting the need for long-term sustainable thinking in short-term operations. These misalignments can lead to inefficiencies and duplication of efforts, hindering the overall effectiveness of sustainable relief efforts (Haavisto and Goentzel 2015). This highlights the necessity of establishing common measures for the development of a collaborative performance measurement framework that facilitates the establishment of shared sustainability goals and objectives among the different actors involved in humanitarian operations.

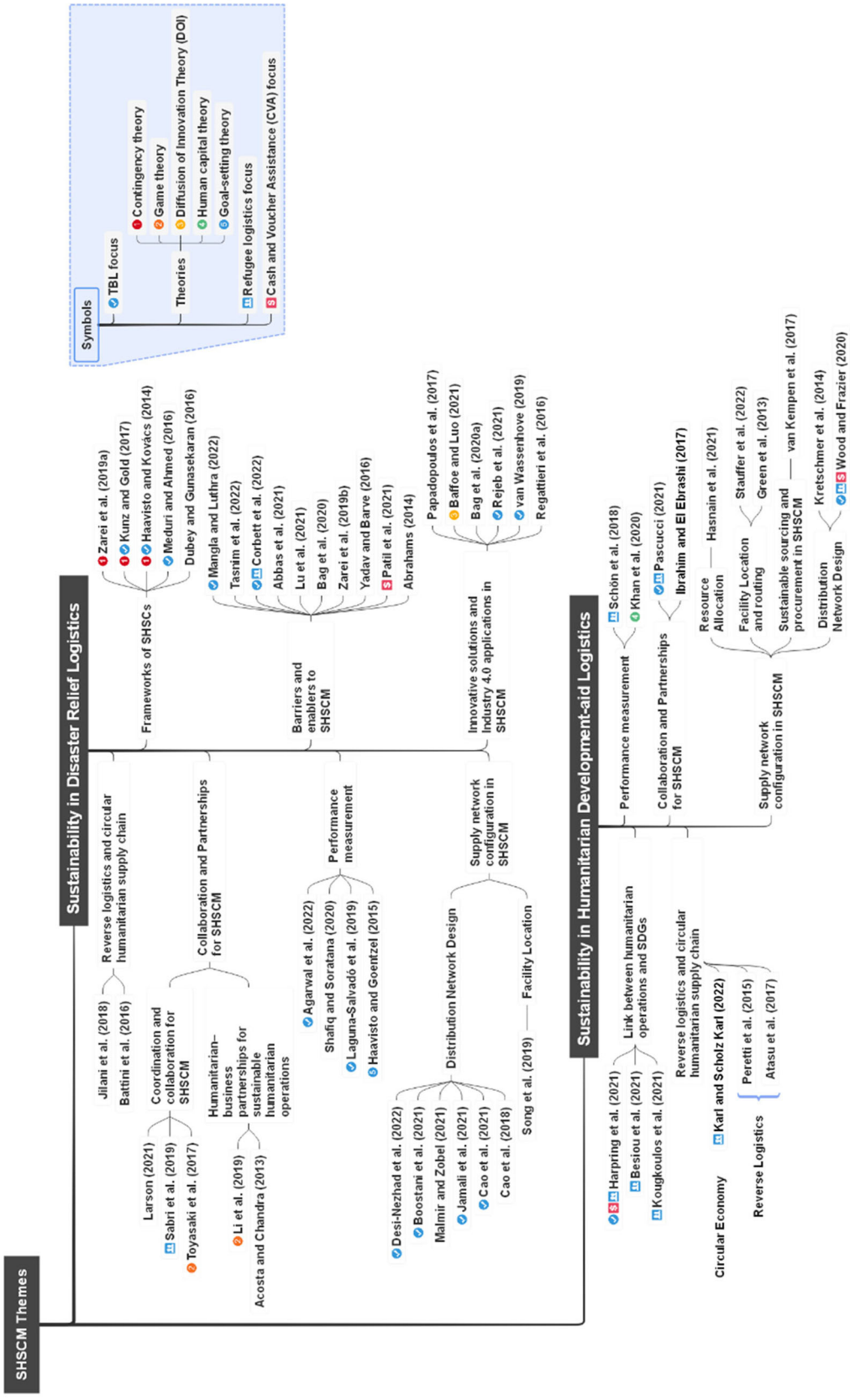


Figure 4. Theoretical themes of SHSCM.

5.1.4. Collaboration and partnerships for SHSCM

This section categorises research themes into two related subcategories: coordination and collaboration of relief operations and partnerships with business organisations.

5.1.4.1. SHSCM coordination and collaboration. The coordination and collaboration of relief operations can reduce the duplication of efforts, thus freeing up resources for other vital operations with less harm to the environment and more sustainable humanitarian operations (Li et al. 2019). An optimal coordination relief network can develop continuous operations, which are an essential feature of sustainability (Li et al. 2019). In our selection, three papers discussed coordination and collaboration in HSCs from a sustainability perspective. Larson (2021) studied the combined effects of security and sustainability in the context of HSC collaboration. His research outlined a brief research agenda addressing future challenges pertaining to the sustainability of HSC collaborative efforts. Sabri, Zarei, and Harland (2019) examined how academics and practitioners may work together to enhance the long-term sustainability of relief packaging in HSCs.

5.1.4.2. SHSCM humanitarian–business partnerships. In the humanitarian sector, partnerships with business organisations and corporate social responsibility initiatives are expected to facilitate knowledge and skill transfer in the supply chain, resulting in more efficient humanitarian operations (Nurmala et al. 2017). Two studies in our SLR analysis focused on SHSCM humanitarian–business partnerships (Acosta and Chandra 2013; Li et al. 2019). Using an evolutionary game approach, Li et al. (2019) examined organisational coordination strategies within SHSCM. They provided insights into how coordination strategies might perform optimally from a sustainability point of view. Their study highlights the significance of coordinated returns and costs, identifies opportunities for normal and extra returns through effective coordination, and emphasises the positive impact of trust in promoting sustainability objectives.

5.1.5. Supply network configuration in SHSCM

This section focuses on two related subcategories: network design and facility location for SHSCM.

5.1.5.1. Network design in SHSCM. Sustainable relief distribution networks have emerged as a critical area of investigation in the literature, emphasising the need to minimise environmental impact and enhance the effectiveness of HSCs (Jamali et al. 2022; Malmir and Zobel 2021). The literature demonstrates a growing recognition of the need to integrate sustainability considerations into relief chain design decisions, ensuring a harmonious balance between meeting urgent humanitarian needs and reducing ecological footprints (Cao et al. 2018). A number of studies in our review have focused on optimising sustainable relief distribution, facility location, resource allocation, and vehicle routeing problems in HSCs (Boostani, Jolai, and Bozorgi-Amiri 2021; Cao et al. 2021). Desi-Nezhad, Sabouhi, and Dehghani Sadrabadi (2022) developed a stochastic programming model for transporting victims from impacted regions to hospitals in the face of repeated interruptions at transportation connections and facilities while accounting for uncertainties and sustainability. Jamali et al. (2022) developed a stochastic multi-objective programming model for integrating sustainability into HSC network design, incorporating economic, social, and environmental considerations. Their results emphasise the need for an optimal balance among all three sustainability aspects, taking into account the specific conditions and severity of the affected area to make informed decisions and enhance the efficiency of relief operations. Malmir and Zobel (2021) developed a mathematical model to minimise the total costs of delivering humanitarian aid for pandemic relief, considering transportation and delivery costs, fleet usage costs, and social equity costs to enable managers to organise the best possible response.

5.1.5.2. Facility location for SHSCM. Facility location decisions in HSCs are essential to ensuring proximity to vulnerable populations, enabling faster response times during emergencies, and reducing transportation costs, resulting in improved operational efficiency and resource utilisation (Balcik and Beamon 2008). Incorporating sustainability considerations in facility location models enables humanitarian decision makers to strike a balance between minimising costs and maximising the positive social and environmental impacts of their operations (Song, Zhou, and Song 2019). However, the location of HSC facilities is a complex problem from a sustainability standpoint. In our review, we found only one study that specifically addressed the facility location problem in the context of sustainable HSCs, highlighting the need for further research and exploration in this important domain. Addressing this gap, Song, Zhou, and Song (2019) studied sustainable shelter site selection under uncertainty using a case study of the Wenchuan earthquake.

5.1.6. Reverse logistics and circular HSC

Reverse logistics is an important part of supply chain management, as it can help reduce waste, improve resource efficiency, and reduce cost (Jilani, Ali, and Khan 2018). In our review, two studies focused on reverse logistics in disaster relief logistics (Battini et al. 2016; Jilani, Ali, and Khan 2018). Battini et al. (2016) developed a mathematical prepositioning model that considers reverse flows to support long-term sustainable HSC management. Jilani, Ali, and Khan (2018) investigated whether the implementation of a reverse supply chain would enhance the sustainability of humanitarian operations by emphasising the reverse flow of recyclable items, information, and finance.

5.1.7. Innovative solutions and Industry 4.0 applications in SHSCM

Advanced digital technologies are widely accepted as enabling factors to integrate green practices across industrial systems and supply chains by improving resource consumption, lowering waste, increasing end-product use, and offering chances for recycling (Baffoe and Luo 2021; Van Wassenhove 2019). Similar to recent supply chain trends, technologies linked to Industry 4.0 have been increasingly

studied to overcome the challenges HSCs face (Marić, Galera-Zarco, and Opazo-Basáez 2022). For example, the adoption of 3D printing technologies has been examined in sustainable HSCs to enhance relief operations and promote environmental sustainability (Corsini, Aranda-Jan, and Moultrie 2019; Corsini and Moultrie 2019). Despite the potential of digital technologies in humanitarian operations, research on the implications of advanced technologies for greening HSC practices has been limited. Papadopoulos et al. (2017) used big data to develop a theoretical framework that explains how resilience in supply chain networks enables sustainability. The applications of drones in humanitarian logistics have been studied by Rejeb et al. (2021), who concluded that drones are a viable, environmentally friendly transportation mode for more adaptable, cost-effective, and long-term humanitarian operations. Regattieri et al. (2016) designed a portable, self-contained solar cooker made from packaging waste of humanitarian supplies that do not require conventional energy sources. Effective packaging waste management fosters long-term sustainability with positive impacts on communities and the environment while supporting the alignment of humanitarian operations with global sustainability objectives and initiatives (Corbett, Pedraza-Martinez, and Van Wassenhove 2022; Regattieri et al. 2016). Despite the important role of packaging waste management in promoting sustainable practices, there remains a scarcity of research addressing this issue within humanitarian operations (Corbett, Pedraza-Martinez, and Van Wassenhove 2022). This highlights the importance of innovative approaches by humanitarian actors to reduce packaging waste.

5.2. Sustainability in humanitarian development aid logistics

Incorporating the sustainability agenda has become important in humanitarian development aid operations. To increase the effectiveness and accountability of HOs, there is a need to address the three pillars of sustainability: economic efficiency, social equality, and environmental preservation. Sixteen articles in our selection addressed different aspects of sustainability in humanitarian development aid operations.

5.2.1. Performance measurement

Performance measurement in development aid logistics focuses on assessing longer-term, sustainable improvements in the lives of people affected by crisis in vulnerable communities (Beamon and Balcik 2008; Schön et al. 2018). The literature emphasises the significance of performance measurement in development aid logistics as a means of evaluating the long-term sustainability and effectiveness of humanitarian interventions in achieving sustainable improvement in vulnerable communities (Schön et al. 2018; Khan et al. 2020). Notably, Schön et al. (2018) developed a performance measurement system focusing on refugee camp self-reliance, which is a fundamental human right enshrined in the United Nations Sustainable Development Goals (SDGs). Khan et al. (2020) explored the role of education in the sustainable development of HSCs and its importance as a central activity for enhancing logistics performance.

5.2.2. Collaboration and partnerships

Collaboration and partnerships in the humanitarian development sector can help build more resilient and sustainable communities by leveraging the resources, expertise, and networks of different actors (Ibrahim and El Ebrashi 2017; Pascucci 2021). In studying humanitarian–business partnerships, Pascucci (2021) explored how to better integrate refugees into markets by improving information and financial flows in refugee settlements rather than relying on the supply of material relief.

5.2.3. Supply network configuration

Supply network configuration in development aid aims to ensure that a supply chain is well-aligned with the long-term objectives of development aid programs (Hasnain et al. 2021; Kretschmer et al. 2014; Moshtari et al. 2021; Stauffer et al. 2022; van Kempen et al. 2017). Wood and Frazier (2019) focused on centralised humanitarian aid. They emphasised that a new decentralised approach might constitute a viable norm for sustainable aid distribution in low-income nations. HSC sourcing and procurement have been extensively studied (Moshtari et al. 2021). For example, Kaur and Singh (2022) have focused on developing sourcing and purchasing strategies for building resilience in HSCs. However, only one paper in our review investigated sustainable sourcing and procurement in HSCs (van Kempen et al. 2017). van Kempen et al. (2017) conducted a life cycle sustainability analysis of sourcing scenarios in a HSC. By incorporating life cycle sustainability analysis into supply network configuration, HOs can foster a more holistic and sustainable approach to development aid that goes beyond immediate relief efforts while addressing the broader challenges faced by communities in the long term (van Kempen et al. 2017). The life cycle sustainability analysis provides a valuable tool that helps evaluate the potential impacts of sourcing decisions on multiple dimensions of sustainability, such as resource consumption, environmental considerations, CO_2 emissions, and social welfare of affected communities (Global Shelter Cluster 2021; van Kempen et al. 2017). Despite being an important topic, the scarcity of research addressing life cycle sustainability analysis in HSCs highlights the need for further exploration and understanding of the potential benefits and implications of this approach. Green, Weck, and Suarez (2013) employed Monte Carlo simulation to evaluate the economic sustainability of sanitation logistics in humanitarian development projects in Senegal.

5.2.4. Reverse logistics and circular HSCs

Reverse logistics can be complex in HSCs due to the challenges of operating in crisis-affected or vulnerable communities, where infrastructure and systems may be damaged or limited (Karl and Scholz Karl 2022). Peretti et al. (2015) investigated the adoption of reverse logistics in a humanitarian setting. Atasu et al. (2017) examined the non-profit medical surplus recovery of unused or donated medical equipment to cater to the needs of marginalised healthcare institutions in developing countries.

5.2.5. The link between humanitarian operations and SDGs

Humanitarian operations and SDGs are inextricably intertwined in that they both address people affected by crisis concerns in vulnerable areas while promoting sustainable communities (Besiou, Pedraza-Martinez, and Van Wassenhove 2021; Harpring et al. 2021). Besiou, Pedraza-Martinez, and Van Wassenhove (2021) discussed how the management of humanitarian operations contributes to achieving SDGs. Harpring et al. (2021) studied the link between SDGs and epidemic preparedness measures, highlighting the importance of cash and voucher assistance (CVA). CVA can contribute to achieving SDGs by providing a flexible and effective means of assistance that aligns with long-term development objectives. CVA has emerged as a viable supplementary operational strategy for the conventional distribution of physical goods in HSCs (Kian et al. 2022). The adoption of CVA in HSCs fosters localisation by channelling resources directly to people affected by crisis and reducing reliance on external aid structures (Harpring et al. 2021). Kougkoulos et al. (2021) developed a method to assess the risk of labour exploitation among migrant workers. Their research contributed to the SDGs, which aim to eradicate forced labour, modern slavery, and human trafficking.

6. Key findings and gaps in the literature

This section addresses RQ_2 and provides an overview of the most significant findings. These results shed light on important aspects pertinent to the testing and development of theory in future SHSCM research, as well as highlight critical gaps in the SHSCM literature. We use these findings to frame our future research directions.

First, the literature shows a rapid increase in published articles since 2018, with topics such as coordination, performance measurement, and innovative solutions gaining more momentum. Second, while SHSCM encompasses a wide range of themes (see Figure 4), we were unable to find research on a particularly important topic: the role of stakeholders in SHSCM. The commercial SCM literature has focused extensively on stakeholder theory (Freeman 2018) in companies and the importance of creating value for all stakeholders (i.e., customers, suppliers, employees, shareholders, and society). However, SHSCM research has yet to consider important questions, such as 'Who are the stakeholders of HOs?' or 'How can HOs ensure they create value for all stakeholders?' In particular, measures of sustainability from a people affected by crisis perspective are poorly understood.

Third, we found that most studies in our selection focused on several dimensions of sustainability (see Figure 5). More than half of the papers (58.2%) investigated all three dimensions of sustainability (or unspecified). The environmental dimension of sustainability was the focus of 9.1% of the studies, followed by the social (7.3%) and economic dimensions (1.8%). The importance of social and economic sustainability factors in humanitarian settings is currently largely absent in the literature, highlighting the need to be more thoroughly integrated into SHSCM models.

Fourth, in line with the findings of prior research (Kunz and Reiner 2012), we observed that the recovery phase of the disaster management cycle is underexplored, especially from the SHSCM standpoint. Table 5 shows a greater concentration of research on the response phase. Studying the recovery phase from a sustainability perspective is particularly important due to the gradual transition of most emergencies into development aid. The recovery phase focuses on cost efficiency, intending to build sustainable capacity in local communities. Research on mitigation and preparedness is important, as these phases significantly impact the sustainability of disaster response.

Fifth, analytical, survey, and case studies are the most utilised data analysis techniques, representing more than half of the research articles. By comparison, only 16% of the studies examined theoretical issues in SHSCM, which suggests that the area as a whole lacks theoretical depth and indicates the need for theoretical studies across all dimensions of sustainability.

Sixth, several authors (Bag, Luthra, et al. 2020; Patil et al. 2021; Abrahams 2014; Abbas et al. 2022) studied barriers and enablers of SHSCM in relief aid, but such studies are very limited in the development aid sector. This is significant, since the majority of emergencies tend to evolve into longer-term development programmes during the recovery phase, which are centred around SDGs.

Seventh, existing research on coordination and collaboration (Toyasaki et al. 2017; Sabri, Zarei, and Harland 2019; Larson 2021) has predominantly focused on disaster relief operations. Coordination and collaboration in the humanitarian development aid sector and its impact on sustainability are less understood.

Eighth, given the significance of multimodal transport in international humanitarian operations, it is surprising that no research has examined the sustainability impact of optimising the combination of different transportation modes.

Ninth, the correlation between HSCs' performance, sources of competitive advantage, and sustainability is less

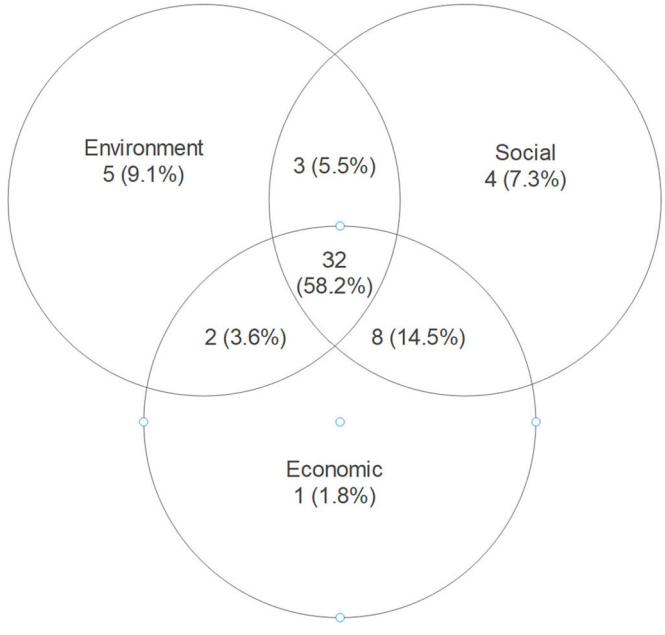


Figure 5. Distribution of papers based on the triple bottom line concept.

Table 6. Summary of SHSCM research propositions.

Areas of emphasis	SHSCM practices	Possible research questions	Possible theoretical approaches	Relevant methodologies

Environmental proactivity	• Advanced emerging sustainable digital technologies
	  • 3D Printing
	  • Social media and crowdsourcing
	• Life cycle assessment
		• How people affected by crisis' views and debates on the sustainability efforts of humanitarian actors may be gleaned from social media?
		• How can 3D printing of HOs' spare parts and support equipment reduce waste, increase efficiency, and improve sustainability and cost savings in the provision of relief items?
		• How to establish sector-wide LCA criteria that can be applied to a wider range of aid organisations?
			• Stakeholder theory	• Social media analytics
				• Data mining-based social network analysis
				• Artificial intelligence
				• Big data analytics
				• Machine learning
				• Analytical modelling
				• Case study

Strategic purchasing and supply	• Cash and Voucher Assistance • Localisation impact on sustainable humanitarian supply chains	• How to trace and environmental impact of CVA programs in HSCs? • How does localisation impact the environmental and social sustainability of humanitarian operations?	• Stakeholder theory • Institutional theories	• Analytical modelling • Conceptual study • Case study
Supply management capabilities	• Leveraging network orchestration and choreography	• How can a clustered approach impact the sustainability of the humanitarian approach?	• Stakeholder theory • Resource orchestration theory	• Analytical modelling • Conceptual study • Case study
Product-based green supply	• Packaging waste management • Sustainable energy generation	• How can humanitarian actors limit the impact of packing waste or transform it into an opportunity to serve people affected by crisis?	• Stakeholder theory	• Analytical modelling • Case study
Green supply process	• Sustainable supplier management in HSCs • Performance measurement of SHSCM	• What are the widely accepted measures of sustainability in HCSs and how HSCs can evaluate their supplier from a sustainability perspective?	• Legitimacy theory • Signalling theory	• Multiple criteria decision analysis • Analytical modelling • Case study

understood in SHSCM literature. This requires identifying and understanding the complex and mediating variables (e.g. coordination and collaboration, ICT, etc.) in HSCs.

Tenth, the most used theories were contingency theory – with three articles by Zarei, Carrasco-Gallego, and Ronchi (2019a), Kunz and Gold (2017), and Haavisto and Kovács (2014) on SHSCM framework development – and game theory, with two articles on coordination and partnerships by Toyasaki et al. (2017) and Li et al. (2019). Performance measurement research uses human capital and goal-setting theories.

7. Future research directions and propositions

Based on our analysis of the literature gaps, we developed a set of research propositions for advancing the SHSCM field and categorised them into five areas of emphasis: environmental proactivity, strategic purchasing and supply, supply management capabilities, product-based green supply, and green supply process. This section addresses the RQ_3 as summarised in Table 6.

7.1. Environmental proactivity: advanced emerging sustainable digital technologies and life cycle assessment

7.1.1. Advanced emerging sustainable digital technologies

The role of advanced digital capabilities in enhancing sustainable supply chain practices has gained rapid momentum in commercial supply chains. Despite this, our study reveals that only a small number of studies have examined advanced digital technologies for SHSCM. We describe a few promising avenues for future research in SHSCM in this area. Despite 3D printing's potential to reduce environmental impacts throughout a product's life cycle, its ramifications in HSCs remain largely unexplored (La Torre et al. 2016). Corsini, Aranda-Jan, and Moultrie (2022) debated whether 3D printing would shorten and simplify the supply chain and argued that to maximise the benefits of 3D printing, a holistic supply chain approach is needed. The proliferation of 3D printers and increased availability of supplies (e.g. filament) can potentially enhance the capacity for local design and manufacturing (Corsini and Moultrie 2019; Corsini, Aranda-Jan, and Moultrie 2019). However, it is crucial to note that

this does not automatically translate into sustainability within HSCs. The sustainability of these initiatives is contingent upon a multitude of factors, including, but not limited to, the utilisation of renewable or recycled materials, the energy efficiency of the manufacturing processes, and the comprehensive lifecycle management of the products (Corsini, Aranda-Jan, and Moultrie 2022). Among the few known examples are 3D printing of vehicle spare parts and other HOs' support equipment. This technology has the potential to reduce supply chain delays, reduce transportation costs, and increase the circularity of supply chains, as the plastic material used by printers can be recycled and reused (Corsini, Aranda-Jan, and Moultrie 2022).

Previous studies have shown how social media and crowdsourcing can play important roles in knowledge sharing in HSCs (Poblet, García-Cuesta, and Casanovas 2018). Yan and Pedraza-Martinez (2019) studied social media implications during disaster preparedness, response, and recovery. They suggested that HOs should post more details targeting potential donors and volunteers besides posting information directed to victims. Although there has been some research on social media use in humanitarian operations, no study has addressed the interplay between social media and SHSCM. Social media is a powerful tool for influencing users' behaviour due to its ability to target large audiences, which has important implications for achieving sustainability in HSCs. Future research could investigate how people affected by crisis views regarding the sustainability efforts of humanitarian actors may be obtained from social media, which HOs could use to better understand and enhance their sustainability efforts. Social media analytics can be beneficial in achieving this objective (Rathore, Kar, and Ilavarasan 2017). These findings lead to the following research proposition:

Proposition 1. The adoption of advanced digital technologies, such as 3D printing, social media, and crowdsourcing, increases the potential for HOs to leverage people affected by crisis views on the sustainability efforts of humanitarian actors to better understand and enhance sustainability efforts.

7.1.2. Life cycle assessment

There has been an increasing trend among HOs towards life cycle assessment (LCA) applications in HSCs (van Kempen et al. 2017). The Global Shelter Cluster is currently developing an LCA calculator to quantify the environmental impact of shelters (Global Shelter Cluster 2021). The United Nations Population Fund (UNFPA) has conducted an LCA study of health kits to assess the environmental impacts of different distribution methods via air, sea, and prepositioning (Jurman and t'Serstevens 2022). Despite this increasing industry trend evidenced by the Global Shelter Cluster and UNFPA studies and its importance and practical utility, LCA was addressed by only one study in our review (van Kempen et al. 2017). Due to the complexity of the problem, existing LCA studies are largely limited to a single product with limited applications. There are no industry-wide measures and standards; therefore, each humanitarian actor uses its own metrics, which leads to unclear and contradictory reporting. As a result, due to HOs' limited capacity to accurately measure all emissions, the sector's environmental footprint remains largely unknown. There is a pressing need to establish sector-wide LCA criteria that can be applied to a wider range of HOs. This leads to the following proposition:

Proposition 2. Implementing sector-wide LCA practices provides quantitative evidence to support humanitarian organisations in making decisions that could potentially reduce the overall environmental impact of the humanitarian sector and improve HSCs' sustainability.

7.2. Strategic purchasing and supply: cash and voucher assistance for SHSCM and localisation

7.2.1. Cash and voucher assistance

Recently, CVA has become more common as a method of delivering relief to people affected by crisis (Maghsoudi et al. 2023). CVA reduces logistics costs, supports the development of local markets and economies, and improves aid relevance and quality. Despite this, CVA might still have negative social and environmental consequences comparable to other modalities of relief distribution. According to Maghsoudi et al. (2023), the notion that CVA programmes are designed to remove logistics activities, such as transportation, delivery, and warehousing, is incorrect. Although logistics activities are reduced, and responsibilities are shared with other actors, local producers, suppliers, and retailers still have to deliver goods to the market. However, these impacts are harder to trace for CVA than for traditional relief supply delivery programmes because humanitarian actors do not control how people affected by crisis spend their cash. Despite this, HOs are still responsible for limiting the negative impacts of CVA. There is limited research on the sustainability impact of CVA programmes in HSCs. CVAs have environmental potential that is currently underexploited in terms of more sustainable consumption methods (e.g. vouchers to buy solar cooking stoves), promoting local businesses with more sustainable products, and helping suppliers/traders adopt greener practices, such as less packaging. This leads to the following proposition:

Proposition 3. To ensure the sustainability of HSCs, the underlying financial and social logic of CVA must be evaluated in order to prioritise sustainable consumption methods that are valued by people affected by crisis and key stakeholders.

7.2.2. Localisation impact on SHSCM

Recently, there has been greater emphasis on employing local suppliers and logistics service providers in HSCs (Besiou, Pedraza-Martinez, and Van Wassenhove 2021). For example, Frennesson et al. (2020) examined the localisation of logistics preparedness capacities and offered a framework addressing how HOs should operationalise localisation. Several authors have highlighted that localisation would improve the sustainability of humanitarian operations, recognising that the extent of this improvement is context-dependent (Frennesson et al. 2022).

For instance, while localisation improves social sustainability aspects of humanitarian operations through increased

community engagement, it may result in varying outcomes in different communities due to changes in the local power dynamics (Frennesson et al. 2020). For the economic sustainability, localisation enhances response speed and cost efficiency by reducing supply chain expenses, although exceptions may occur if local suppliers raise prices (Frennesson et al. 2022; Matopoulos, Kovács, and Hayes 2014). Environmentally, local procurement reduces international transport carbon emissions and expatriate flights, yet it is important to factor energy sources and emissions of local suppliers (Frennesson et al. 2022). Nonetheless, despite the increasing trend of localisation, a comprehensive understanding of how localisation impacts the sustainability of humanitarian operations is currently lacking. Localisation efforts require stable funding sources, long-term strategic partnerships, and capacity sharing (Matopoulos, Kovács, and Hayes 2014; Frennesson et al. 2020). Therefore, addressing how funding and partnership models could impact sustainable locally led HSCs is important but still poorly understood in the literature. These findings lead to the following research proposition:

Proposition 4. Localisation efforts result in more sustainable locally led HSCs contingent on stable funding sources, strategic partnerships with international HOs, and capacity-sharing models.

7.3. Supply management capabilities: leveraging network orchestration and choreography

Sustainability in the humanitarian sector goes beyond the scope of a single HO's operation and requires the collaboration and resource sharing of key humanitarian players. Despite an increasing emphasis on and trend towards collaborative approaches in the humanitarian sector, existing sustainability efforts are mainly focused on the horizontal coordination of a network of diverse humanitarian actors (Toyasaki et al. 2017). However, the humanitarian sector has recently moved towards a clustered approach, with key players leading and managing the coordination of its members. For example, the logistics cluster led by the UN World Food Programme acts as the lead agency for a coordinated response to humanitarian emergencies. As a result of humanitarian actors forming a clustered approach, new concepts, such as network orchestration and choreography through a clustering approach in the humanitarian sector, have emerged recently (Grange, Heaslip, and McMullan 2019). However, research on how a clustered approach can impact the sustainability of the humanitarian approach is scant in the literature. There is very limited knowledge about how HOs can achieve sustainability objectives across a network of humanitarian actors. More empirical research is needed to study how network orchestration and choreography concepts contribute to the sustainability of humanitarian operations using a cluster-based approach. The above discussions lead to the following proposition:

Proposition 5. A cluster-based approach that orchestrates and choreographs humanitarian operations makes HSCs more sustainable by eliminating waste due to the duplication of activities.

7.4. Product-based green supply: Packaging waste management and sustainable energy generation

7.4.1. Packaging waste management

Adequate packaging of relief supplies is vital to ensure effective distribution and conservation, but it often leads to an unexpected waste crisis due to the convergence of goods (and their packaging) in vulnerable environments (Corbett, Pedraza-Martinez, and Van Wassenhove 2022). This crisis is especially pronounced in developing countries or communities that lack proper waste management systems (Sabri, Zarei, and Harland 2019). Solid waste is a leading cause of adverse environmental, social, and economic impacts on communities (Salzenstein and Pedersen 2021). Our analysis points to a lack of studies addressing waste management in HSCs. This raises the essential issue of how humanitarian actors might limit the impact of packaging waste or transform it into an opportunity to serve people affected by crisis. More research is needed to develop consistent standards for sustainable packaging across stakeholders and to align procurement criteria accordingly. Further research is required to quantify packaging waste, assess life cycle impact, and explore alternatives to the current packaging of relief commodities. Researchers should explore the right balance of safety, handling, and environmental protection when employing reusable, biodegradable materials or paper-based packaging. This leads to the following proposition:

Proposition 6. Implementing consistent standards for cleaner packaging and aligning procurement criteria in HSCs reduces the environmental impact and supports the sustainability of local communities affected by crises.

7.4.2. Sustainable energy generation

Sustainable energy generation for humanitarian aid operations is another understudied topic. In the humanitarian sector, fuel-powered generators are the main source of electricity in off-grid conditions. Even though generators may be inevitable in many circumstances, organisations should make efforts to look for more sustainable sources of energy that are less harmful to the environment. Some organisations have implemented solar parks in refugee camps, but research on these initiatives is still lacking. More research is needed to provide insight into alternative sustainable power systems, sustainable energy access in refugee settlements, alternative cooking options, and fuel-efficient stoves. This leads to the following proposition:

Proposition 7. The implementation of renewable energy solutions in humanitarian supply chain management improves the sustainability of humanitarian operations.

7.5. Green supply process: sustainable supplier management and performance measurement in HSCs

7.5.1. Sustainable supplier management in HSCs

Sustainable procurement has recently become a central theme in international humanitarian actors' organisational

guidelines. The United Nations Office for Project Services has made sustainability a central tenet of its procurement manual. The International Federation of Red Cross and Red Crescent Societies has also made strides towards a comprehensive set of guidelines on sustainable procurement, in which environmental and social factors are encouraged alongside efficiency and financial considerations. The literature on sustainable procurement is sparse, and theoretical contributions are minimal or nonexistent. Although few studies have addressed sustainable sourcing and procurement in HSCs (van Kempen et al. 2017), none have specifically tackled sustainable supplier management. Environmental and social objectives are mostly neglected in existing supplier management studies, indicating a lack of sustainability criteria for selecting HOs' suppliers. This is especially important since minimising the environmental impact of HSCs requires collaboration with suppliers that monitor the environmental implications of their products and services (Moshtari et al. 2021). According to Médecins Sans Frontières, 70% of its supply chain emissions are related to its supplier operations (Salzenstein and Pedersen 2021). These findings lead to the following research proposition:

Proposition 8. Selecting qualified suppliers that rigorously monitor the environmental implications of their products and services by developing ethical, environmental, and social measures reduces the environmental impact of HSCs.

7.5.2. Performance measurement of SHSCM

There has been limited research on sustainability performance measures related to the social and environmental impacts of HSCs. SHSCM requires the collective efforts of HOs and information sharing. Thus, establishing common measures in a collaborative performance measurement framework is important. Given that HSCs are highly dependent on stakeholder funding, it is surprising to see a lack of sustainability performance measurement from theoretical lenses, such as stakeholder theory. Nonetheless, to move the field forward, we need to revisit the theoretical foundations of performance measurement, which lie in organisational and management control theories. There is a need to ground solid theoretical foundations in the field to rationalise the various phenomena associated with collaborative performance measurement in SHSCM. Legitimacy theory and signalling theory are particularly relevant theoretical lenses for measuring sustainability (Mura et al. 2018). These gaps prompt the following final proposition:

Proposition 9. Establishing a collaborative performance measurement framework improves sustainable humanitarian operations by coordinating information sharing.

8. Conclusion

This paper provides a systematic review of the research related to SHSCM. To the best of our knowledge, this is the first systematic literature review to address sustainability in HSCs. This is noteworthy given the significant increase in academic research published on this topic since 2018, as well as the mounting pressure from donors and other stakeholders towards making humanitarian operations more sustainable. Our study examined 55 research papers, all of which were classified under the two categories of sustainable disaster relief and sustainable development logistics. We categorised the papers according to eight structural dimensions, seven of which were derived deductively from existing research. The last dimension (the main theme of the paper) was developed inductively based on the content of the papers in the selection.

Our review contributes to the practice of SHSCM by supporting HOs' sustainability transitions and providing them with an overview of best practices related to sustainability in HSCs. On a societal level, our study offers a better understanding of the current breadth and projected landscape of sustainability issues in humanitarian contexts. This helps donors, the public, and policymakers understand the current state of sustainability and plan effective resolutions and more informed funding allocation decisions. Our review contributes to theory by providing a set of policy-driven research directions for various aspects of achieving a greater level of sustainability in HSCs. This research offers a comprehensive state of research on sustainable HSCs, identifies a number of shortcomings in the literature, and develops nine research propositions that will guide researchers in pursuing important questions related to sustainability in HSCs.

This study is not without limitations. Despite rigorous selection criteria, it is possible that some relevant works have not been identified within the systematic scope of this review. Although we developed the classification framework through an iterative process in which we identified relevant categories and assigned studies to each of them, these categorisations remain interpretive. Statistical methods could provide additional insights into clustering the selected studies. Bibliometric analyses can provide an opportunity for a more structured analysis of the existing literature.

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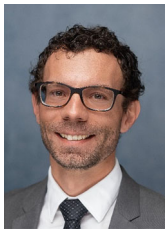
Award from the *Journal of Humanitarian Logistics and Supply Chain Management*.



Professor Ruth Banomyong is currently the Chairman of the Advisory Board to the Thai Minister of Commerce and a former Dean at the Faculty of Commerce and Accountancy (a.k.a Thammasat Business School), Thammasat University in Thailand. He was the winner of the James Cooper Cup in 2001 for the best PhD dissertation in logistics from the Chartered Institute of Logistics and Transport (CILT) in the United Kingdom. In 2016, Supply Chain Asia (Singapore) awarded the prize of supply chain educator of the year. In 2021, the Industrial Engineering and Operations Management (IEOM) Society awarded him with the Distinguished Educator Award in 2021 while the National Research Council of Thailand (NCRT) awarded him with the National Outstanding Researcher Award in the field of Economics for 2022. Ruth's main research interests are in the field of multimodal transport, international logistics, trade facilitation, logistics development policy, supply chain performance and humanitarian supply chains. He has published over 100 papers and reports in scientific journals and has co-authored more than 10 books.



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Appendix A. List of sustainability studies included in the SLR

Author	Disaster type			Context of operation			Disaster management phase					Research approach			Data analysis technique				Sustainability dimension			
	Sudden-onset	Slow-onset	Both or not specific	Disaster relief	Development aid	Both or not specific	Mitigation and Preparedness	Response	Recovery	Several	Not specific	Empirical	Analytical	Conceptual	Empirical/qualitative	Empirical/quantitative	Analytical	Conceptual	Economic	Environmental	Social	Not specific
Green *et al.* (2013)		✓			✓				✓				✓				✓		✓			
Acosta and Chandra (2013)	✓			✓				✓						✓				✓				✓
Kretschmer *et al.* (2014)		✓			✓		✓					✓			✓				✓		✓	
Haavisto and Kovács (2014)			✓			✓				✓				✓				✓	✓	✓	✓	
Abrahams (2014)	✓			✓					✓			✓			✓					✓		
Peretti *et al.* (2015)			✓		✓		✓					✓			✓				✓	✓		
Haavisto and Goentzel (2015)			✓			✓					✓				✓							✓
Yadav and Barve (2016)	✓			✓				✓				✓				✓						✓
Regattieri *et al.* (2016)			✓			✓				✓		✓			✓					✓		
Meduri and Ahmed (2016)	✓			✓						✓				✓				✓				✓
Dubey and Gunasekaran (2016)	✓			✓						✓		✓				✓						✓
Battini *et al.* (2016)	✓			✓					✓				✓				✓		✓	✓		
van Kempen *et al.* (2017)		✓			✓				✓			✓			✓				✓	✓	✓	
Toyasaki *et al.* (2017)	✓			✓				✓					✓				✓					✓
Papadopoulos *et al.* (2017)	✓			✓					✓			✓				✓			✓		✓	
Kunz and Gold (2017)			✓			✓			✓			✓			✓				✓	✓	✓	
Ibrahim and El Ebrashi (2017)	✓				✓				✓			✓			✓				✓		✓	
Atasu *et al.* (2017)		✓			✓				✓				✓				✓			✓	✓	
Schön *et al.* (2018)			✓		✓				✓			✓			✓				✓		✓	
Jilani *et al.* (2018)	✓			✓				✓				✓				✓						✓
Cao *et al.* (2018)	✓			✓				✓					✓				✓				✓	
Zarei *et al.* (2019a)			✓			✓					✓	✓			✓					✓		
Zarei *et al.* (2019b)			✓			✓					✓	✓				✓				✓		
van Wassenhove (2019)			✓			✓					✓			✓				✓				✓
Song *et al.* (2019)	✓			✓			✓					✓				✓				✓	✓	
Sabri *et al.* (2019)	✓			✓				✓				✓			✓					✓		
Li *et al.* (2019)	✓			✓				✓					✓				✓					✓
Laguna-Salvadó *et al.* (2019)	✓			✓				✓					✓				✓					✓
Wood and Frazier (2020)		✓			✓					✓				✓				✓	✓	✓	✓	
Shafiq and Soratana (2020)	✓			✓				✓				✓				✓			✓		✓	

Author	Disaster type			Context of operation			Disaster management phase					Research approach			Data analysis technique				Sustainability dimension			
	Sudden-onset	Slow-onset	Both or not specific	Disaster relief	Development aid	Both or not specific	Mitigation and Preparedness	Response	Recovery	Several	Not specific	Empirical	Analytical	Conceptual	Empirical/qualitative	Empirical/quantitative	Analytical	Conceptual	Economic	Environmental	Social	Not specific
Khan *et al.* (2020)			✓		✓						✓	✓				✓					✓	
Bag *et al.* (2020b)	✓			✓				✓				✓				✓						✓
Bag *et al.* (2020a)	✓			✓			✓					✓				✓			✓		✓	
Rejeb *et al.* (2021)	✓			✓			✓							✓				✓	✓	✓	✓	
Patil *et al.* (2021)	✓			✓				✓				✓				✓						✓
Pascucci (2021)		✓			✓			✓				✓			✓				✓	✓	✓	
Malmir and Zobel (2021)	✓			✓				✓					✓				✓		✓		✓	
Lu *et al.* (2021)	✓			✓				✓				✓				✓						✓
Larson (2021)			✓			✓					✓			✓				✓		✓	✓	
Kougkoulos *et al.* (2021)			✓		✓						✓	✓				✓					✓	
Jamali *et al.* (2021)	✓			✓				✓					✓				✓		✓	✓	✓	
Hasnain *et al.* (2021)		✓			✓				✓				✓				✓				✓	
Harpring *et al.* (2021)		✓			✓				✓			✓			✓				✓	✓	✓	
Cao *et al.* (2021)	✓			✓					✓				✓				✓		✓	✓	✓	
Boostani *et al.* (2021)	✓			✓			✓						✓				✓		✓	✓	✓	
Besiou *et al.* (2021)			✓		✓					✓				✓				✓				✓
Baffoe and Luo (2021)	✓			✓				✓				✓				✓						✓
Abbas *et al.* (2021)	✓			✓					✓			✓				✓						✓
Tasnim *et al.* (2022)	✓			✓				✓				✓			✓							✓
Stauffer *et al.* (2022)			✓		✓				✓				✓				✓		✓		✓	
Mangla and Luthra (2022)	✓			✓				✓				✓				✓			✓	✓	✓	
Karl and Scholz Karl (2022)		✓			✓				✓					✓				✓				✓
Desi-Nezhad *et al.* (2022)	✓			✓				✓					✓				✓		✓	✓	✓	
Corbett *et al.* (2022)			✓			✓				✓		✓			✓				✓	✓	✓	
Agarwal *et al.* (2022)			✓			✓		✓				✓				✓			✓	✓	✓	