

# Humanitarian supply chain management in the digital age: a hybrid review using published literature and social media data

HSCM  
in the digital  
age

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## Abstract

**Purpose** – The purpose of this study is to examine various data sources to identify trends and themes in humanitarian supply chain management (HSCM) in the digital age.

**Design/methodology/approach** – In this study, various data sources such as published literature and social media content from Twitter, LinkedIn, blogs and forums are used to identify trending topics and themes on HSCM using topic modelling.

**Findings** – The study examined 33 published literature and more than 94,000 documents, including tweets and expert opinions, and identified eight themes related to HSCM in the digital age namely “Digital technology enabled global partnerships”, “Digital tech enabled sustainability”, “Digital tech enabled risk reduction for climate changes and uncertainties”, “Digital tech enabled preparedness, response and resilience”, “Digital tech enabled health system enhancement”, “Digital tech enabled food system enhancement”, “Digital tech enabled ethical process and systems” and “Digital tech enabled humanitarian logistics”. The study also proposed a framework of drivers, processes and impacts for each theme and directions for future research.

**Originality/value** – Previous research has predominantly relied on published literature to identify emerging themes and trends on a particular topic. This study is unique because it examines the ability of social media sources such as blogs, websites, forums and published literature to reveal evolving patterns and trends in HSCM in the digital age.

**Keywords** Humanitarian supply chain, Review, Literature, Social media, BERT, Digital age, Industry 4.0

**Paper type** Research paper

## 1. Introduction

Humanitarian supply chain management (HSCM) is the management process that handles the movement of goods and services from source to final destination with the goal of helping people affected by crisis, conflict or natural disasters (Dubey *et al.*, 2018). Recent global disasters include Hurricane Dorian, the COVID-19 pandemic, Cyclone Idai, the Beirut explosion, wildfires in Australia and the United States, floods in India and Pakistan, earthquakes and tsunami in Turkey and Indonesia (Kanwal, 2023). These disasters had severe negative impacts on the planet, human life and the economy, causing extensive destruction and forced displacement. Effective HSCM is essential to ensure the rapid delivery of essentials such as food, water, shelter and medical supplies to those in need (Dubey *et al.*, 2018).

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Inadequate infrastructure and logistics capacity in affected regions and the need to collaborate with numerous stakeholders, including government organizations, international firms and local communities, are just some of the difficulties that HSCM must overcome (Dubey *et al.*, 2019). HSCM uses a range of techniques to address these issues, including needs assessment, purchasing, transportation, storage and distribution. Effective coordination among humanitarian organizations is one of the possible ways to solve HSCM problems (Dubey *et al.*, 2022). In recent decades, digital transformation has evolved tremendously, and HSCM cannot escape this influence (Dash and Dixit, 2022). The various aspects of digital transformation such as artificial intelligence (AI), Internet of Things (IoT) and blockchain have improved HSC systems by producing accountable, transparent and efficient supply chain models (Dash and Dixit, 2022). Due to improved computing power, HSC organizations have over time begun to collect large amounts of data this be used by HSC managers to allocate resources more efficiently, improve emergency response times and distribute aid more accurately (Dubey *et al.*, 2022).

In addition, state-of-the-art delivery models such as drones and autonomous vehicles are now able to reach places that are generally inaccessible or dangerous for traditional delivery techniques (Argumedo-Garca *et al.*, 2021). Digital technologies also improve accountability and transparency within the supply chain by enabling real-time tracking and monitoring of aid. Overall, these developments are revolutionizing the HSC, leading to more effective, transparent and accountable distribution of aid to those in need (Argumedo-Garca *et al.*, 2021; Marić *et al.*, 2022).

Some real-world examples include the response to the recent earthquake in Turkey in 2023, where digital technology played a critical role in coordinating relief efforts and assisting those affected. Social media platforms were used to share important information and location, while a high-pitched whistle app helped attract attention from those trapped. Meta (formerly Facebook) provided a safety check feature, and search and rescue teams established a WhatsApp helpline to spread information about rescue operations and volunteering. The crypto community raised millions of dollars in donations, offering a real-time financial support option when traditional banking operations were impacted. Developers, including youth in the region, created open-source crisis assistance websites and platforms with features such as heat maps for rescue services. Microsoft Turkey also contributed by making its technologies available to aid groups, with satellite imagery used to assess the state of infrastructure and identify the worst-affected areas for effective aid delivery [1].

Compared to other supply chain management disciplines, HSCM has received less attention from researchers and practitioners, but its importance is increasingly recognized. Some of the journals and conferences devoted to HSCM are disseminating recent advances in the field. However, given the unique difficulties and complexities of humanitarian operations, further study and focus is needed. To advance HSCM through empirical research, theoretical frameworks and creative solutions, collaboration among academic institutions, research organizations and humanitarian organizations is essential. As social media is an important venue for opinions and discussions, researchers and industry practitioners prefer sharing their thoughts and concerns regarding HSCM. We did not find any articles that examined both published literature and social media data to understand the progress and issues of HSCM in the digital age.

Due to the emergence of HSCM and its significance for governments and society, numerous review research articles have been published by researchers to understand the recent development, current status, issues, methodologies and potential solutions. Some of these articles include those by Abidi *et al.* (2014), Balcik *et al.* (2016), Habib *et al.* (2016), Seifert *et al.* (2018), Jahre (2017), Behl and Dutta (2019), Agarwal *et al.* (2019), Banomyong *et al.* (2019), Gupta *et al.* (2019), Anjomshoae *et al.* (2022), Polater (2021), Marić *et al.* (2022), de Camargo Fiorini *et al.* (2022), Fosso Wamba (2022) and Sentia *et al.* (2023). All of these review articles have used published literature to delve into the past and recent state of HSCM.

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Hence, the purpose of this study is to identify themes on HSCM in the digital age through data triangulation (published literature and data from social media, including blogs and forums). It provides an overview of the current state of research and practical applications, identifies knowledge gaps and highlights areas for further research. By analyzing social media platforms, researchers can find new trends and solutions that haven't yet been widely implemented or published in the scientific literature (Gupta *et al.*, 2019; Dhamija *et al.*, 2021). They may also gain insightful knowledge about how HSCM is changing. Multiple data sources, including social media content, blogs, forums and published literature, ensure the reliability and validity of the findings (Marić *et al.*, 2022). Hence, we aim to address the following research questions:

- RQ1.* How has digital technology been applied in humanitarian supply chain management, and what are the major themes in this domain?
- RQ2.* What are the issues, opportunities and solutions associated with each theme in HSCM, and what are the future research avenues for researchers?

This research article is divided into two parts. First, we extracted topics and themes from the published literature using the BERT technique. Second, we extracted topics and themes from social media data using the same technique. Then, we combined themes from these two databases and found the final themes. Finally, a framework is proposed for each theme, which is composed of the drivers, processes and impacts.

This study is divided into seven sections. The first section contains an introduction to the topic, while the second section focuses on the methodology. Section 3 deals with the literature review, while Section 4 discusses the proposed framework. Section 5 summarizes the theoretical contribution to the literature and implications for management, while Section 6 draws the conclusion of the study, followed by limitations and future research directions in the last section.

## 2. Methodology

Researchers prefer to use published research articles to explore the topics and themes of a particular subject as these published articles comprehend a wealth of information about the current and past status (Williamson and Johanson, 2017). In addition, these articles are an important resource for researchers conducting a literature review using various techniques such as bibliometric and thematic analysis. This study uses data triangulation (blog, forums, Twitter and published literature in peer-reviewed journals) to examine topics and themes. Data triangulation provides valuable information that includes the researcher's and industry practitioners' perspectives (Wang *et al.*, 2021). In addition, the combined database provides a more thorough analysis and a wealth of information about HSCM. The flow of the study is shown in Figure 1.

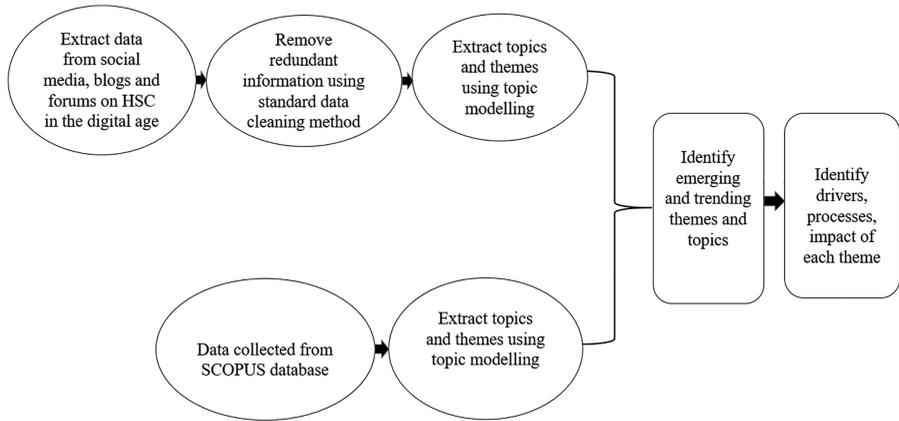
### 2.1 Topic modelling

In this study, we used a popular topic modelling technique called "BERT" (Mustak *et al.*, 2021). BERT is an artificial neural network based machine learning technique for topic modelling. It involves a series of steps before giving a final list of topics from the document such as data cleaning, transformation, removing redundant information and deriving an optimal number of topics (Grootendorst, 2022).

## 3. Literature analysis

### 3.1 Topics and themes derived from scholarly articles in peer-reviewed journals

We have implemented the BERT technique on the articles (Title, Abstract and Keywords) collected on HSCM for topic modelling. We have selected articles on HSCM from SCOPUS



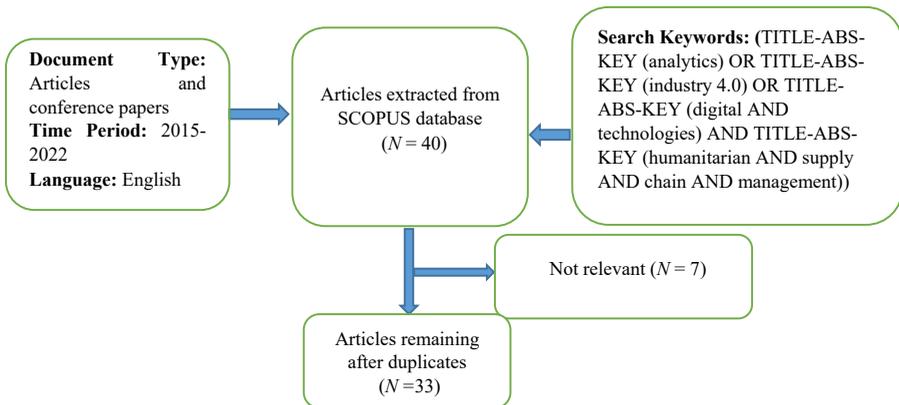
**Figure 1.**  
Flow of the study

**Source(s):** Authors' own work

databases using suitable search keywords (Mohamed Shaffril *et al.*, 2021). The final keywords for selecting published literature on HSCM are shown in Figure 2. We selected articles published during the period 2015–2022 on HSCM, which ensures that they are recent and more advanced literature. Finally, 33 articles were found to be suitable for topic modeling. The article collection process is shown in Figure 2, while the descriptive measures of the articles are listed in Table 1.

*3.1.1 Descriptive analysis of published literature on HSCM in the digital age.* The number of published literature on HSCM in the digital age is very low (see Figure 3), it likely represents that the field is relatively new and has not yet been extensively explored, or the topic is emerging, with limited research conducted thus far.

Figure 4 represents a list of prominent authors who have made the most contributions to HSCM research. It is evident that Professor. Rameshwar Dubey is the leading researcher in this area.



**Figure 2.**  
Process of research articles selection from SCOPUS database

**Source(s):** Authors' own work

In this study, we have selected only the articles listed in the field of business and economics. Since the aim of the study is to understand the recent advances in the field of HSCM from the perspective of management, we are not focused on the mathematical or other part of HSCM. This is one of the main reasons why most of the articles on HSCM selected in this study are listed in the field of business and economics (24.1%), as shown in Figure 5.

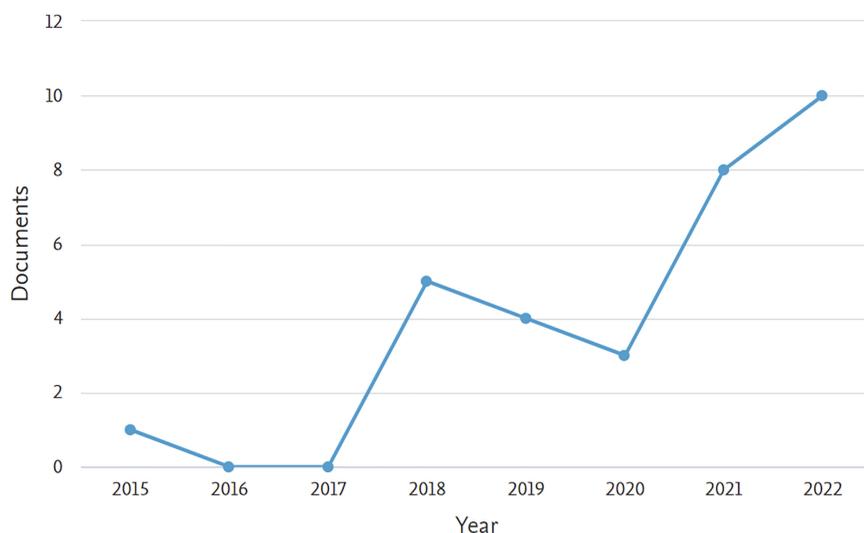
We implemented the BERT method on the articles selected for topic modelling (Hu *et al.*, 2020) on HSCM. We also created a word cloud of the unique words found from the selected articles on HSCM, and shown in Figure 6. The most frequently occurring words in the word cloud indicate the dominant topics within the text.

To identify the current topics and themes, as well as the most important terms and phrases used in the documents (published articles on HSCM), Table 2 lists the frequency of key words and their importance (TF-IDF).

The dominant keywords in the published literature on HSCM in the digital age are preparedness, information, culture and communication (Figure 6 and Table 2). This suggests that digital technology is being used to make the HSC more resilient, efficient, ethical and sustainable. These keywords reflect the growing interest in using digital technologies to address HSCM challenges.

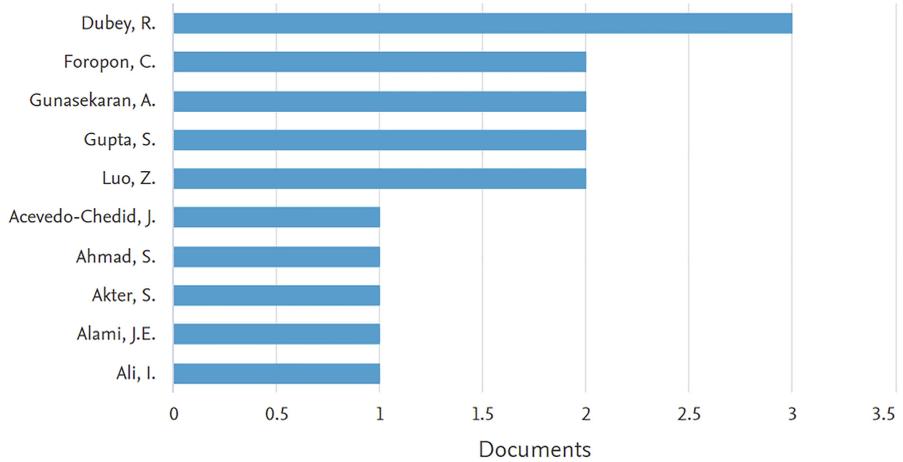
Publication years	2015–2022
Citation years	2015–2022
Papers	33
Citations	4,513
Citations/year	645
Citations/paper	137
Authors/paper	3
h-index	12
G-index	15
<b>Source(s):</b> Authors' own work	

**Table 1.**  
Descriptive measure of  
research articles



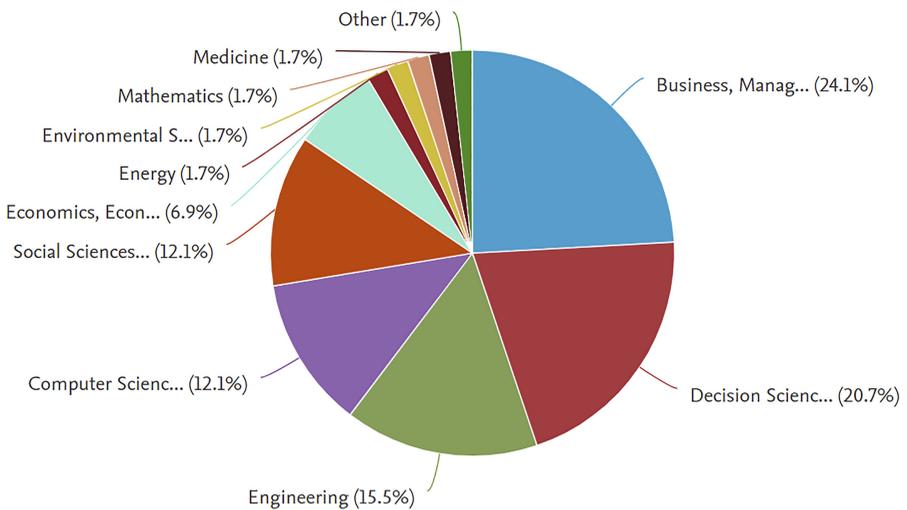
**Source(s):** Scopus academic database

**Figure 3.**  
Documents by year



**Figure 4.**  
Documents by author

**Source(s):** Scopus academic database



**Figure 5.**  
Documents by subject area

**Source(s):** Scopus academic database

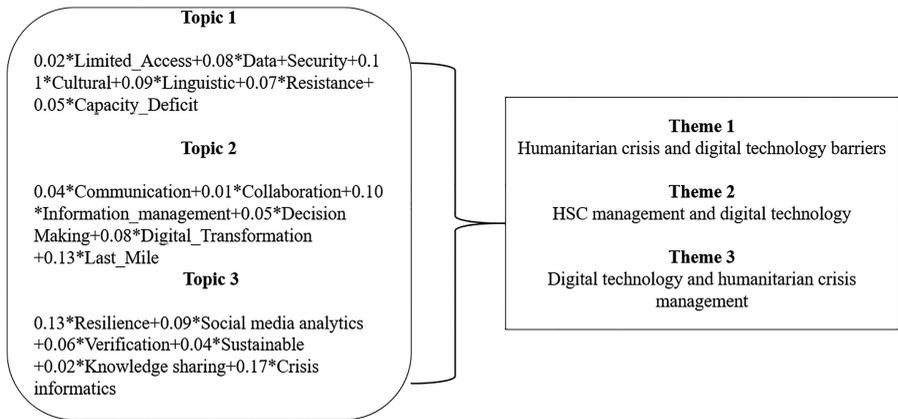
3.1.2 *Topics and themes (published literature).* We derived three optimal topics from the published literature (33 research articles) using the perplexity and coherence score. These topics are shown in Figure 7 below.

Based on the keywords of each topic, a theme is proposed, and these themes are “Humanitarian Crisis and Barriers to Digital Technology Barriers,” “HSCM and Digital Technology,” and “Digital Technology and Humanitarian Crisis Management” (see Figures 7 and 8).

3.2 *Topics and themes (blogs, forums, twitter, LinkedIn)*

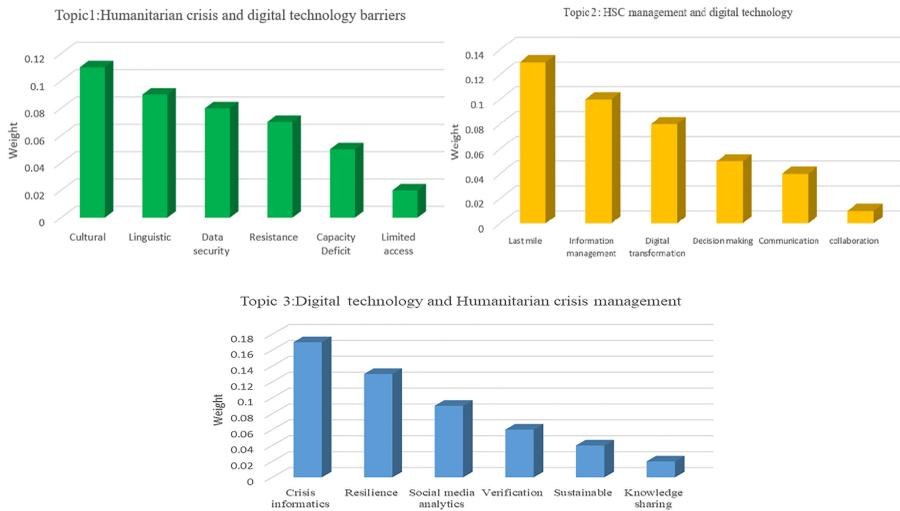
According to Wang et al. (2021), people around the world use various social media platforms to express their opinions and interests regardless of their geographic location. The use of





**Figure 7.** Topics and themes

**Source(s):** Authors' own work



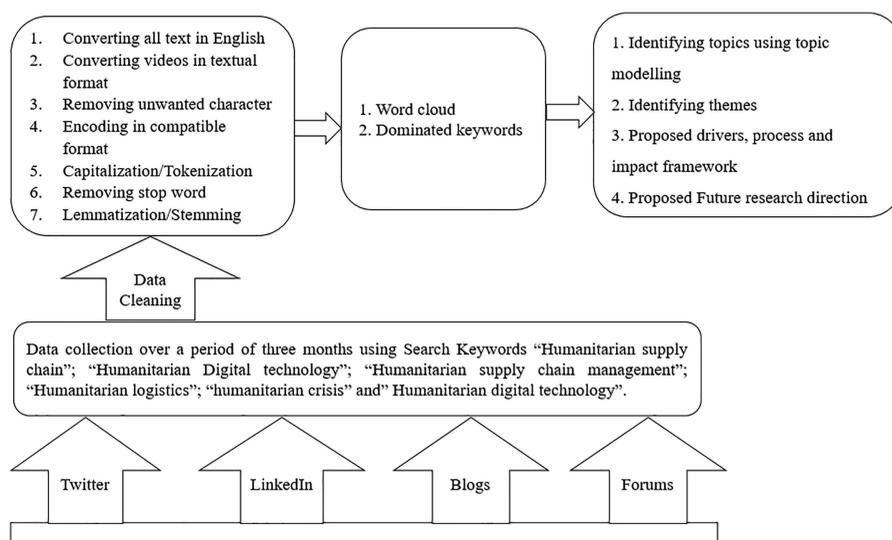
**Figure 8.** Topics and themes derived from figure 7

**Source(s):** Authors' own work

We gathered information from a variety of online sources, including blogs and forums on HSC, LinkedIn and Twitter. Using the keywords shown in Figure 9, we collected data over a six-month period.

**3.2.1 Data from twitter.** Twitter is one of the most popular social media platforms for researchers and industry practitioners. We used keywords (“Humanitarian Supply Chain” OR “Humanitarian Supply Chain Management”) AND (“Digital Era” OR “Digital Age”) to collect tweets from Twitter via API. Since Twitter only provides a limited number of tweets per day (Russell, 2011), we collected data continuously for about six months and analyzed about 92,340 tweets using the Twitter API and the Python package Twipy.

**3.2.2 Data from LinkedIn.** Web Scrapping is a very popular method to extract information from web pages. BeautifulSoup is a very popular Python library for web scraping (Russell,



**Source(s):** Authors' own work

**Figure 9.**  
Process for data  
collection and data  
cleaning

2011; Cortez *et al.*, 2023). We used keywords (“Humanitarian Supply Chain” OR “Humanitarian Supply Chain Management”) AND (“Digital Era” OR “Digital Age”) to collect the posts and discussions about HSCM. Since the information provided by LinkedIn pages is static in nature, we extracted about 761 posts and discussions on HSCM from LinkedIn.

**3.2.3 Data from humanitarian blogs and forums.** Humanitarian blogs and forums are ideal platforms for discussions on HSCM initiatives and issues. “Humanitarian Logistics Association”, “UNICEF Supply Division”, “The Logistics Cluster”, “Harvard Humanitarian Initiative”, “Humanitarian Practice Network”, “Humanitarian Web”, “ReliefWeb”, “United Nations Office for the Coordination of Humanitarian Affairs (OCHA)” and “Humanitarian Innovation Forum” are some of the most popular blogs and forums (Swain and Cao, 2019). We used the keywords (“Humanitarian Supply Chain” OR “Humanitarian Supply Chain Management”) AND (“Digital Era” OR “Digital Age”) to collect posts and discussions from humanitarian blogs and forums (see Table 3).

**3.2.4 Data cleaning.** The data used in this study is collected from a variety of sources, resulting in a mixture of textual information, including redundant information. Our dataset consisted of 93,587 documents, each representing a single instance. To prepare the social media data for analysis, we first converted all data to text using the appropriate Python package. We cleaned the collected data using the Python library “Natural Language Toolkit (NLTK)” (Hardeniya *et al.*, 2016), as shown in Figure 9.

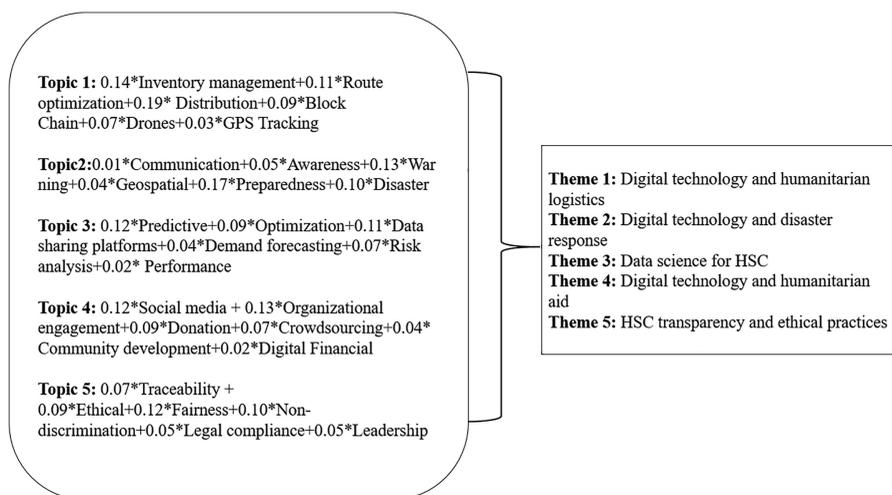
The dominant keywords in social media, blogs and forums on HSCM in the digital age include social media, aid, risk, distribution and ethics (see Figure 10 and Table 4). This shows a trend in discussions and conversations about HSCM on social media. The dominant keywords indicate that people are discussing the role of social media in aid distribution and the associated risks, as well as the ethical considerations involved. In addition, the term “distribution” implies that people are concerned with ensuring that aid reaches those who need it most in an efficient and timely manner.

Forums/Blogs	Description	Webpage	Scrapped number of documents from blogs/forums
Twitter	Social media platform	<a href="https://twitter.com/">https://twitter.com/</a>	92,340
LinkedIn	Social media platform	<a href="https://www.linkedin.com/feed/">https://www.linkedin.com/feed/</a>	761
Humanitarian Logistics Association	This organization maintains a blog that covers a range of topics related to humanitarian logistics, including supply chain management	<a href="https://www.humanitarianlogistics.org/">https://www.humanitarianlogistics.org/</a>	121
UNICEF Supply Division	This is Humanitarian Supply Chain and Logistics Consultation and Expert Sharing Forum	<a href="https://www.unicef.org/supply">https://www.unicef.org/supply</a>	23
The Logistics Cluster	This organization provides logistics support to humanitarian organizations around the world	<a href="https://www.logcluster.org/blog">https://www.logcluster.org/blog</a>	12
Harvard Humanitarian Initiative	This organization focuses on research and education related to humanitarian issues	<a href="https://logcluster.org/blog">https://logcluster.org/blog</a>	43
Humanitarian Practice Network	This organization is part of the Overseas Development Institute and focuses on research related to humanitarian issues	<a href="https://odihpn.org/">https://odihpn.org/</a>	56
Humanitarian Web	This forum provides a space for humanitarian professionals to connect, share information and collaborate	<a href="https://humanitarianweb.org/">https://humanitarianweb.org/</a>	21
ReliefWeb	This website provides a range of resources related to humanitarian crises around the world, including forums for discussion and collaboration among humanitarian professionals	<a href="https://reliefweb.int/">https://reliefweb.int/</a>	19
United Nations Office for the Coordination of Humanitarian Affairs (OCHAs)	OCHA is responsible for coordinating humanitarian responses to crises around the world	<a href="https://community.humanitarianresponse.info">https://community.humanitarianresponse.info</a>	102
Humanitarian Innovation Forum	This forum provides a space for discussion and collaboration around innovative solutions to humanitarian challenges	<a href="https://humanitarianinnovation.org/forum">https://humanitarianinnovation.org/forum</a>	89

**Table 3.**  
Frequency of Tweets,  
posts and discussions  
from social media

**Source(s):** Authors' own work





**Figure 11.**  
Topics and themes

**Source(s):** Authors' own work

uncertainties”, “Digital tech enabled preparedness, response and resilience”, “Digital tech enabled health system enhancement”, “Digital tech enabled food system enhancement”, “Digital tech enabled ethical process and systems” and “Digital tech enabled humanitarian logistics”.

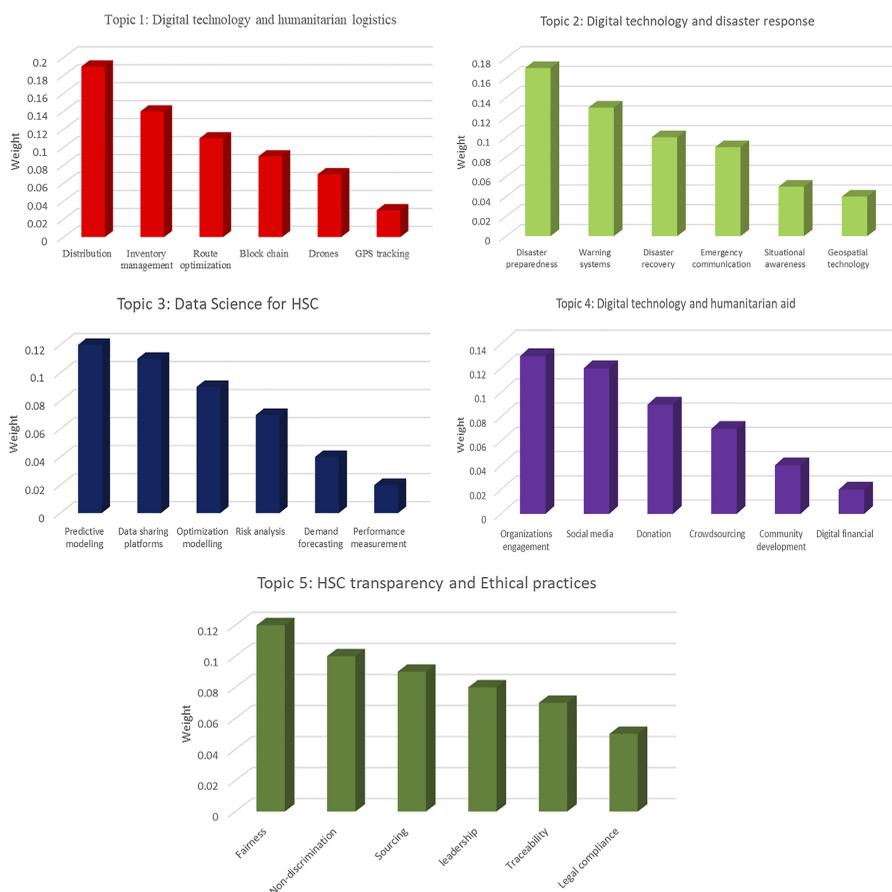
#### 4. Drivers, process and impacts for each theme

This section proposes a framework for each theme which comprises drivers, processes and impacts.

##### 4.1 Theme 1 (Digital technology enabled global partnerships)

The theme “Digital technology-enabled global partnerships” in HSCM refers to the use of digital technology to foster collaboration, coordination and partnerships among parties involved in humanitarian operations around the world. It highlights the need to use digital platforms and technologies to connect organizations, government agencies, NGOs, suppliers and other relevant stakeholders to improve the effectiveness and efficiency of humanitarian supply chains (McLachlin and Larson, 2011). The concept of “Digital technology-enabled global partnerships” is relevant to HSCM for numerous reasons. First, it improves communication and coordination in humanitarian situations. Real-time communication promotes responsiveness. Second, digital technologies improve supply chain visibility and transparency, enabling stakeholders to identify bottlenecks, track aid delivery and ensure accountability for distribution (Dubey et al., 2018). Third, digital platforms facilitate collaboration and cooperation, leading to better resource allocation and new solutions. Overall, theme “Digital technology-enabled global partnerships,” stakeholders may deepen collaboration, improve communication, increase transparency, optimize operations and successfully distribute help on a worldwide scale (Dubey et al., 2018).

4.1.1 Internal drivers for “Digital technology enabled global partnerships”. Global relationships in HSCM facilitated by digital technology can be fostered by a number of

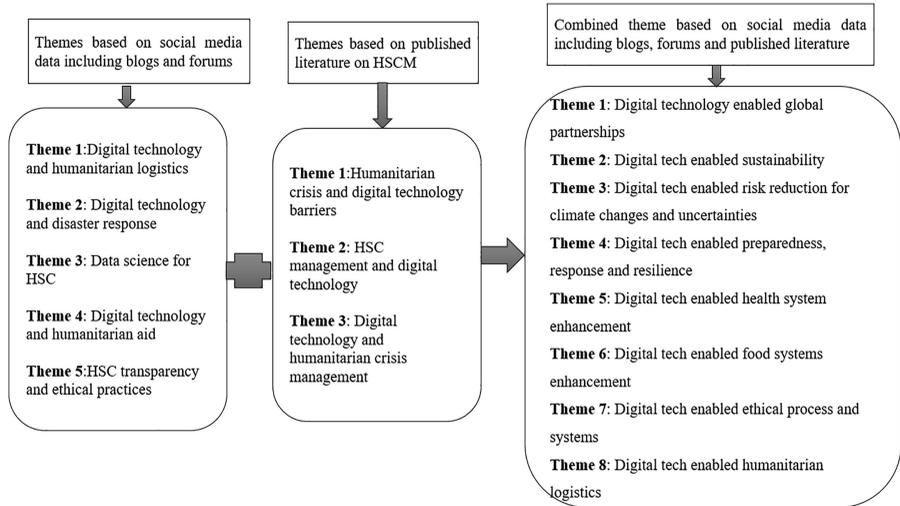


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Figure 12.  
Graphical  
representation of  
Topics and themes

internal factors. These include a common purpose and knowledge of the difficulties facing the industry, as well as access to state-of-the-art digital tools (McLachlin and Larson, 2011). Sharing resources such as data, knowledge and technology can also foster collaboration and minimize duplication of effort. The involvement of beneficiaries, governments and local communities ensures the alignment of HSCM with the needs of the society they serve (Dubey et al., 2018). Together, these factors can help partners collaborate more successfully and improve the effectiveness and efficiency of humanitarian response.

4.1.2 External drivers for "Digital technology enabled global partnerships". Digital technology-enabled global partnerships in HSC are encouraged by external factors such as globalization, technological advances, economic pressures, political pressures and the increasing frequency and severity of humanitarian crises (Meier, 2012). These factors give partners the opportunity to collaborate and pool resources, knowledge and technology, ultimately leading to greater efficiency, openness and accountability. The use of digital technologies improves real-time data sharing and visibility, allowing partners to respond more quickly and successfully to humanitarian emergencies (Dubey et al., 2018). Partners can more successfully collaborate to help those in need by leveraging these external drivers to



**Figure 13.**  
Final emerged themes from two databases

Source(s): Authors' own work

serve the greater good. The drivers (internal and external), process and impact of “Digital Technology-Enabled Global Partnerships” in HSCM are illustrated in Figure 14.

4.1.3 *Processes for a “Digital technology enabled global partnerships”*. Several critical practices must be followed to build digitally enabled global partnerships for HSC. According to Ergun *et al.* (2014), these include conducting a needs assessment to identify barriers and technology requirements, identifying potential partners with complementary skills and expertise, building clear communication and trust, implementing appropriate technology solutions and tools, monitoring and evaluating performance and continuously improving supply chain operations. When partners adhere to these practices, they can more successfully collaborate and help those in need. Successful global partnerships enabled by digital technologies depend on effective collaboration and communication, the use of new technologies and monitoring and evaluation (Dubey *et al.*, 2020).

4.1.4 *Impact of various processes on “Digital technology enabled global partnerships”*. The global connections of digital technology can help the HSCM in many ways. One of the most important benefits is improved efficiency, as it can lead to faster response times, lower costs and more effective aid distribution (Ergun *et al.*, 2014). By enabling partners to track the flow of resources and goods and giving them access to real-time data, digital technology can also



**Figure 14.**  
Drivers, process and impact of “Digital technology enabled global partnerships”

Source(s): Authors' own work

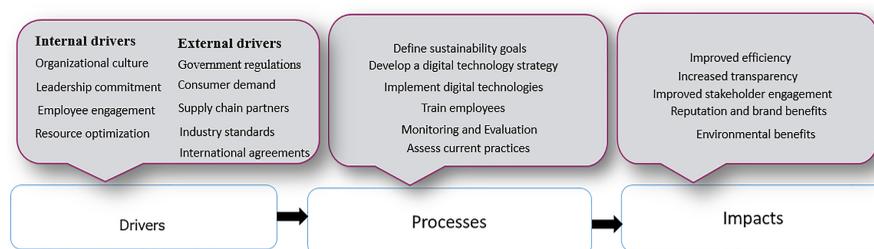
increase transparency. To solve humanitarian problems more effectively, digital technology allows partners to collaborate more closely and pool their resources (Meier, 2012). Another benefit is the improved accountability that comes from more transparent financial and supply chain management. Digital technology can promote better risk management by giving partners early warning of anticipated disruptions so they can take preventive measures to reduce the impact of those disruptions. Scaling up humanitarian activities in times of need can also be facilitated by global alliances enabled by digital technologies, allowing partners to respond more quickly and efficiently to the needs of affected communities (Dubey *et al.*, 2018, 2020).

#### 4.2 Theme 2 (Digital tech-enabled sustainability)

In HSCM, sustainability supported by digital technologies refers to the application of technologies to promote environmentally friendly and sustainable practices at all levels of the supply chain (Dette, 2018). This can include managing waste and recycling, improving transportation and monitoring and reducing carbon emissions using digital tools. In addition, this could include using renewable energy sources such as solar energy to power supply chain processes. Digital technologies can also be used to promote moral behavior and social awareness, such as fair labor practices and ethical sourcing (Modak *et al.*, 2020). By integrating digital technologies into HSC, organizations can reduce their environmental impact, promote sustainable practices and ensure long-term supply chain stability in support of upcoming humanitarian interventions (Zarei *et al.*, 2019). The drivers (internal and external), process and impact of “Digital tech-enabled sustainability” in HSCM are illustrated in Figure 15.

**4.2.1 Internal drivers for “Digital tech-enabled sustainability”.** HSCM can leverage digital technology to improve sustainability through a number of internal factors. An organization can create a culture of sustainability and environmental responsibility to motivate employees to prioritize sustainable practices in their work (Dette, 2018). A leadership commitment to sustainability can also drive the adoption of sustainability practices enabled by digital technologies by setting goals and allocating resources to support sustainable operations. Engaging employees in sustainable practices can help drive the adoption of these practices through training and education on sustainable practices and by encouraging employee participation in sustainability initiatives (Dubey and Gunasekaran, 2016). The use of digital technologies can optimize resource use and reduce waste in the supply chain, which can lead to greater sustainability (Zarei *et al.*, 2019). By leveraging these internal drivers, companies can reduce their environmental impact, promote sustainability and ensure long-term viability in HSCM.

**4.2.2 External drivers for “Digital tech-enabled sustainability”.** In addition to internal drivers, there are several external drivers that can promote sustainability in the humanitarian



Source(s): Authors’ own work

**Figure 15.**  
Drivers, process and  
impact of “Digital tech-  
enabled sustainability”

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supply chain supported by digital technologies (Dubey *et al.*, 2018). Government regulations can set environmental standards and require organizations to adopt sustainable practices, which encourages the adoption of digital technologies to support these practices. Consumer demand for sustainable products and practices can also drive the adoption of digital technology-enabled sustainability in the supply chain and require organizations to reduce their environmental impact (Shrivastav, 2022). Supply chain partners can also require companies to adopt sustainable practices in order to do business with them, which can drive the adoption of digital technologies to support these practices (Bag *et al.*, 2022). Industry standards can set environmental benchmarks and require organizations to adopt sustainable practices, while international agreements such as the Paris Agreement on climate change can set environmental targets and drive the adoption of digital technologies to support these practices (Dubey *et al.*, 2018).

*4.2.3 Processes for a “Digital tech-enabled sustainability”.* Achieving sustainability in the HSC through the use of digital technology requires a systematic approach that includes many procedures. Key procedures include analyzing existing practices, setting sustainability goals, developing a digital technology strategy, putting that plan into practice, training staff and monitoring performance (Soosay and Hyland, 2015). Before identifying areas where digital technologies could be used to improve sustainability, an assessment of current practices in the supply chain is required (Dubey and Gunasekaran, 2016). Then, the sustainability goals for the supply chain should be clearly defined and a plan for using digital technologies to achieve these goals should be established. Once the selected digital technologies are implemented, employees should be trained in their use and educated on the value of sustainability. To ensure progress toward sustainability goals and identify areas for development, the effectiveness of sustainability practices supported by digital technologies should be regularly assessed and reviewed.

*4.2.4 Impact of various processes on “Digital tech-enabled sustainability”.* With potential benefits ranging from the environment to reputation, the impact of sustainability enabled by digital technologies on the humanitarian supply chain can be enormous and far-reaching (Zarei *et al.*, 2019). The use of digital technologies can minimize waste, increase energy efficiency and optimize resource use, resulting in lower greenhouse gas emissions, water conservation and waste reduction (Bag *et al.*, 2020). This has a significant impact on the environment. Another benefit is increased efficiency, as digital technology can simplify supply chain operations while reducing costs and enabling organizations to respond more quickly and effectively to emergencies and disasters (Dubey and Gunasekaran, 2016). Stakeholder engagement can be enhanced through the use of sustainable practices and digital technologies, enabling organizations to demonstrate their commitment to sustainability (Zarei *et al.*, 2019).

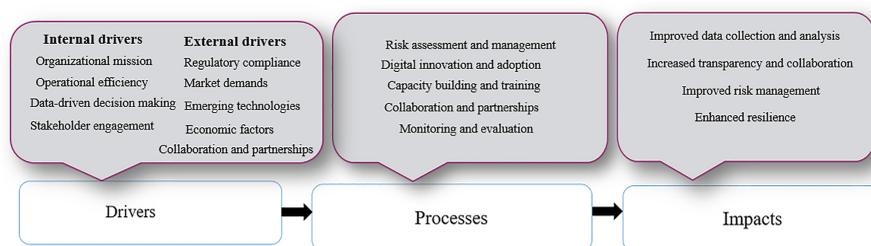
### *4.3 Theme 3 (Digital enabled risk reduction for climate changes and uncertainty)*

The topic “Digital-enabled risk reduction for climate changes and uncertainty” in HSCM represents the use of digital technology to decrease risks related with climate change and uncertainty in humanitarian operations (Jeble *et al.*, 2020). It emphasises the significance of proactively identifying, assessing and mitigating risks associated with climate change consequences and uncertainties. The issue of “Digital-enabled risk reduction for climate changes and uncertainty” is significant in HSCM. It allows for risk identification, the establishment of early warning systems, the building of resilient infrastructure, data-driven decision making and stakeholder cooperation. Embracing this topic improves supply chain resilience and effectiveness in the face of climate effects. The drivers (internal and external), process and impact of “Digital enabled risk reduction for climate changes and uncertainty” in HSCM are illustrated in Figure 16.

4.3.1 *Internal drivers for “Digital enabled risk reduction for climate changes and uncertainty”*. In the face of climate change and unpredictability, the use of digital technologies to manage risk and build resilience in HSC is becoming increasingly important (Jeble *et al.*, 2020). The need for operational efficiency, data-driven decision making, stakeholder engagement, reputational and brand benefits and the organization’s goal of helping people in need are some of these internal drivers (Dubey *et al.*, 2021). Organizations can increase productivity and make better use of resources by adopting digital technologies to optimize their supply chain processes, save costs and make informed decisions based on data analytics. Adopting sustainable practices can also help companies interact with stakeholders, improve their reputation and strengthen their brand image-all while promoting environmental awareness.

4.3.2 *External drivers for “Digital enabled risk reduction for climate changes and uncertainty”*. In addition to internal drivers, external factors also play an important role in the adoption of digital technologies to mitigate risk in the face of climate change and HSC uncertainty. These external factors include regulatory compliance, market demand, emerging technologies, economic factors and collaboration and partnerships. Governments and international organizations may mandate certain standards and regulations for supply chain management, which digital technology can help companies comply with (Patil *et al.*, 2023). Customers and funders increasingly value sustainability and environmental responsibility, and digital technology can help organizations meet these requirements and differentiate themselves from competitors (Patil *et al.*, 2023). The development of new technologies such as blockchain and IoT devices offers new opportunities for managing supply chain risk and increasing resilience, and organizations can adopt them to remain competitive (Dubey *et al.*, 2018; Jeble *et al.*, 2020). Climate change and natural disasters can have significant economic impacts on supply chains (Bag *et al.*, 2023), and digital technologies for risk mitigation can mitigate these impacts and improve financial stability. Digital technologies can also facilitate collaboration and partnerships among supply chain actors to improve risk management and resilience (Patil *et al.*, 2023).

4.3.3 *Processes for “Digital enabled risk reduction for climate changes and uncertainty”*. Organizations need to perform a number of critical activities to achieve digitally-enabled risk mitigation for climate change and unpredictability in HSC. Risk assessment and management is the first phase, which involves identifying potential hazards and vulnerabilities in the HSC and taking action to mitigate them (Kabra *et al.*, 2015). Real-time data and analytics provided by digital technology can help organizations better monitor and manage threats. Another critical step is digital innovation and adoption, that is, finding and adopting new digital technologies (Jeble *et al.*, 2020). Training on data analytics, digital tools and risk management techniques are important components of capacity building and training that help staff and partners effectively use digital technologies to mitigate risk (Dubey *et al.*, 2019).



Source(s): Authors’ own work

**Figure 16.**  
Drivers, process and  
impact of “Digital  
enabled risk reduction  
for climate changes  
and uncertainty”

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Organizations can effectively use digital technologies to reduce risk and increase resilience in the face of climate change and unpredictability in the humanitarian supply chain by adopting these practices.

*4.3.4 Impact of processes of “Digital enabled risk reduction for climate changes and uncertainty”.* Risk mitigation processes are crucial for ensuring the success of humanitarian aid supply chains and climate change adaptation efforts. These processes, when digitally supported, can have a significant impact on reducing uncertainty and improving overall outcomes. One of the main benefits of using digital technologies to support risk mitigation processes is improved data collection and analysis (Dubey *et al.*, 2019). By leveraging these tools, organizations can more accurately and efficiently collect and analyze data, enabling them to make informed decisions about how to mitigate risks. Digital technologies can help organizations collect data from a variety of sources, including sensors, satellites and social media. This data can then be analyzed using advanced algorithms and machine learning techniques to identify patterns and trends, as well as potential risks and opportunities. By using digital technologies to support risk mitigation processes, organizations can also improve their ability to respond to unexpected events (Kabra *et al.*, 2015; Dubey *et al.*, 2019). Real-time data collection and analysis can enable organizations to quickly identify and respond to potential risks, helping to minimize their impact and prevent further disruptions. Overall, digitally supported risk mitigation processes are an essential tool for organizations working in humanitarian aid supply chains and climate change adaptation. By leveraging the power of digital technologies to collect and analyze data, organizations can make informed decisions about how to mitigate risks and improve outcomes.

#### *4.4 Theme 4 (Digital tech-enabled risk preparedness, response and resilience)*

Papadopoulos *et al.* (2017) defines the term “digital tech-enabled risk preparedness, response and resilience of the humanitarian supply chain” as the utilization of digital technologies to enhance the capacity of humanitarian organizations in preparing for and responding to potential risks and uncertainties in their supply chain. The ultimate objective is to establish supply networks that are more robust, resilient to unexpected disruptions and adaptive to changing circumstances. By incorporating digital technologies into their operations, humanitarian organizations can streamline their processes, improve communication and collaboration among stakeholders and gain real-time visibility into the supply chain, enabling them to make informed decisions and respond promptly to any potential disruptions. This approach can result in a more efficient, cost-effective and sustainable supply chain, ultimately benefiting both the organizations and the communities they serve. Humanitarian organizations can use digital technologies to increase their capacity for data collection and analysis, interact more successfully, manage risk and develop greater resilience to unpredictability (Dette, 2018). Ultimately, risk preparedness, response and resilience using digital technologies can be critical to providing vital goods and services to communities in need, even in the face of extreme weather or other disruptive events (Papadopoulos *et al.*, 2017). The drivers (internal and external), process and impact of “Digital tech-enabled risk preparedness, response, and resilience” in HSCM are illustrated in Figure 17.

*4.4.1 Internal drivers for “Digital tech-enabled risk preparedness, response and resilience”.* Several internal factors responsible for achieving risk preparedness, response and resilience of humanitarian supply chains supported by digital technologies. According to Papadopoulos *et al.* (2017), an organization’s strategy can play an important role in improving the risk preparedness, response and resilience of its humanitarian supply chains. To improve overall performance, the organization can prioritize the integration of digital technologies into its supply chain management system. Improved supply chain visibility can track the location and status of transported goods in real time, which can help identify and

mitigate risks. With the help of digital technologies such as artificial intelligence, machine learning and predictive analytics, companies can identify and manage risks in real time. To achieve HSC risk planning, response and resilience supported by digital technologies, proper resource allocation is critical (Dubey *et al.*, 2019).

4.4.2 *External drivers for “Digital tech-enabled risk preparedness, response and resilience”.* Several external factors can impact the development of digital technology-enabled risk preparedness, response and resilience in HSC. Emergencies and natural disasters such as hurricanes, earthquakes and pandemics can disrupt supply chains and put humanitarian organizations at risk (Dette, 2018). However, by providing real-time information and facilitating better decision making, digital technology can help organizations respond more successfully to these events. To increase their risk appetite, responsiveness and resilience, organizations can be pressured by outside regulations to adopt digital technologies. Stakeholders such as donors, partners and beneficiaries may also expect organizations to adopt digital technologies to improve their riskiness, responsiveness and resilience (Papadopoulous *et al.*, 2017). With rapid improvements in digital technologies through the internet of Things (IoT), blockchain and cloud computing, organizations now have the opportunity to improve supply chain visibility, risk management and collaboration (Dubey *et al.*, 2019).

4.4.3 *Processes for “Digital tech-enabled risk preparedness, response and resilience”.* There are several methods that can be applied to achieve risk readiness, responsiveness and resilience in HSC. These tactics involve doing a risk assessment in order to identify potential risks and vulnerabilities in the supply chain and to build a risk management strategy to address them. Predictive analytics, machine learning and artificial intelligence are a few examples of digital technologies that may help businesses detect and manage risks in real time (Bag *et al.*, 2022). Digital technology like RFID, GPS and sensors, which may provide real-time information on the location and status of products in transit, can help supply chains become more transparent (Dubey *et al.*, 2020). Digital technologies such as cloud computing, collaborative platforms and communication tools can help supply chain participants collaborate and communicate effectively. To achieve risk preparedness, response and resilience in HSC, effective resource management is essential. This can be achieved using real-time information on stock levels, transportation routes and demand patterns provided by digital technologies. Organizations can find areas for improvement and adjust their plans by continuously monitoring and evaluating the supply chain using data analytics and performance monitoring tools (Bag *et al.*, 2022).

4.4.4 *Impacts of various processes of “Digital tech-enabled risk preparedness, response and resilience”.* There are many benefits for humanitarian organizations due to digital tech-enabled risk preparedness, response and resilience. To identify potential risks and vulnerabilities in their supply chains and create effective risk management plans to



Source(s): Authors' own work

Figure 17.  
Drivers, process and  
impact of “Digital tech-  
enabled risk  
preparedness,  
response, and  
resilience”

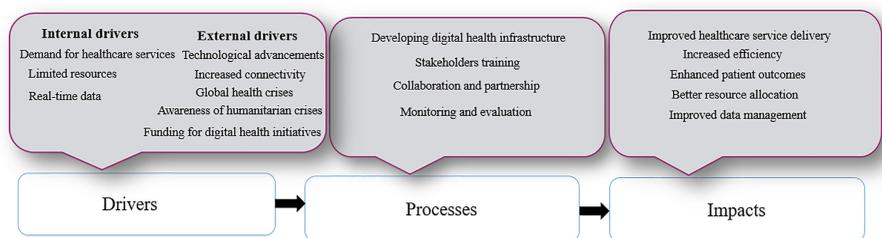
mitigate these risks, organizations can benefit from digital technology (Dubey *et al.*, 2022). Thanks to digital technologies such as RFID, GPS and sensors, the location and status of transported goods can be tracked in real time, which helps organizations manage their supply chains. Digital tools such as cloud computing, collaboration platforms and communication tools can also help supply chain participants collaborate and communicate effectively. Digital technologies can help companies optimize resource allocation and increase overall efficiency by providing real-time information about inventory levels, transportation routes and demand trends (Dubey *et al.*, 2019). Digital technologies can enable better decision making, real-time information and collaboration with supply chain partners, which can help organizations respond quickly and efficiently to disasters. Digital technologies can make it easier for organizations to track and report on their activities, demonstrate their impact and build stakeholder trust by providing greater openness and accountability in supply chains.

4.5 Theme 5 (digital tech-enabled health system enhancement in the HSC)

The use of technology to increase the efficacy, speed and efficiency of humanitarian responses as well as to improve health outcomes for those in need is referred to as the topic “digital tech-enabled health system enhancement in the humanitarian supply chain” (Hossain and Thakur, 2021; Ali and Kannan, 2022). Digital technologies are being utilised to enhance the provision of health services and medical treatment to individuals in crisis or disaster-affected areas, such as electronic health records, mobile health applications and data analytics. This technique tries to solve the challenges that traditional supply chain systems have when delivering health products and services in a timely and correct way, particularly in emergency situations where resources and infrastructure may be limited (Hossain and Thakur, 2021). The drivers (internal and external), process and impact of “digital tech-enabled health system enhancement in the humanitarian supply chain” in HSCM are illustrated in Figure 18.

4.5.1 Internal drivers for “digital tech-enabled health system enhancement in the HSC”. The implementation of digital, technologically advanced health systems in HSC is being fueled by a number of internal factors. As more and more individuals require access to life-saving medical care, the demand for health services in humanitarian contexts is rising. As more individuals have access to the treatment they require, digital technology can assist increase the efficacy and efficiency of the delivery of health services (Hossain and Thakur, 2021). It might be challenging to offer effective health care in environments where humanitarian organizations frequently operate under resource constraints. To guarantee that resources are deployed swiftly and efficiently, digital technology can assist optimize resource allocation and reduce waste (Dubey *et al.*, 2019). Real-time data gathering and analysis are also crucial for efficient decision-making in humanitarian circumstances. Humanitarian organizations may benefit from real-time data collection, analysis and sharing systems that provide them

**Figure 18.** Drivers, process and impact of “Digital tech-enabled health system Enhancement in the HSC”



Source(s): Authors’ own work

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the information they need to make informed decisions. More transparency and accountability in the humanitarian sector are also being demanded by donors and other stakeholders (Iqbal and Ahmad, 2022). The use of digital technology can increase transparency and accountability in the delivery of aid. Supply chain management is essential in humanitarian situations, when the prompt delivery of medical supplies might mean the difference between life and death. Digital technology can assist improve supply chain efficiency by decreasing delays and ensuring that medical goods get to their destination on time (Dubey *et al.*, 2022).

4.5.2 *External drivers for “digital tech-enabled health system enhancement in the HSC”*. The adoption of digital technologies to improve health systems in the HSC is being driven by a number of external causes. One of these factors is the rapid growth of digital technologies, such as mobile, cloud-based and data analytics, which are opening up new opportunities to improve health care in humanitarian settings (Dubey *et al.*, 2019). Medical treatments can now be accessed remotely as the world has become more interconnected and communication between patient and doctor has increased in humanitarian situations. They can be mitigated through the use of digital technologies. In addition, global health crises such as the COVID-19 pandemic have highlighted the need for effective and efficient health systems in these contexts. The frequency and severity of humanitarian crises is increasing, which has raised awareness of the need for effective and efficient health systems in such situations (Zarei, 2022). Last but not least, governments and donors are increasingly funding digital health interventions in humanitarian situations, recognizing the potential of these technologies to improve the quality of health care and service delivery.

4.5.3 *Processes for “Digital tech-enabled health system enhancement in the HSC”*. A number of practices can contribute to “digitally-enabled health system improvement in the humanitarian supply chain” The development of digital health platforms and infrastructures that can facilitate the collection, management and analysis of health data is one of the most important practices (Zarei, 2022). This may include the development of mobile health applications, telemedicine platforms and electronic health records. Another important task is to train health professionals and other stakeholders in the effective use of digital health technologies and platforms. This may include teaching people how to use telehealth platforms, collect and analyze health data and incorporate digital health tools into current health care procedures. To improve the HSC health care system through digital technology, collaboration and partnership building are also essential practices (Zarei, 2022). To develop and deploy digital health solutions that can improve health care in humanitarian circumstances, collaborations can be formed between humanitarian organizations, government organizations and private sector companies. Last but not least, monitoring and evaluation are critical practices that can ensure the effectiveness and sustainability of digital health interventions (Hossain and Thakur, 2021). To identify areas for improvement and measure the impact of digital health interventions on health outcomes in humanitarian settings, this may include routine monitoring and analysis of health data.

4.5.4 *Impacts of “digital tech-enabled health system enhancement in the HSC”*. Improving healthcare in the HSC through digital technology has several benefits. These include better patient outcomes, increased efficiency, better resource allocation and improved data management in the delivery of health services. By enabling remote consultations, improving communication between clinicians and patients and facilitating the collection and analysis of health data, digital health technologies can help improve health service delivery (Hossain and Thakur, 2021). By streamlining workflows, minimizing duplication and improving the accuracy and timeliness of health data, they can also help improve the efficiency of health systems. In addition, they can improve resource allocation by making it possible to identify regions where resources are most needed and to make the best use of resources that already exist. Finally, digital health technologies can improve data management in humanitarian

contexts by enabling the secure and effective collection, storage and sharing of health data (Hossain and Thakur, 2021).

4.6 Theme 6 (“Digital tech enabled enhanced food system”)

The term “digital technology-enabled improved food system” refers to the application of digital technologies to improve the effectiveness, sustainability and efficiency of the food supply chain under humanitarian conditions (Peters et al., 2022). To improve food supply monitoring and tracking, reduce food waste and ensure food quality and safety, this includes the use of digital technologies such as sensors, drones and blockchain (Sahebi et al., 2020). Digital technologies can also be used to increase the transparency and accountability of food aid programs, ensure that food aid reaches its intended recipients and optimize the distribution of food aid to those in need (Dubey et al., 2022; Peters et al., 2022). In general, the use of digital technologies helps ensure that humanitarian food aid reaches those who need it most, while reducing waste and ensuring the sustainability of the food supply chain. The drivers (internal and external), process and impact of “Digital tech-enabled enhanced food system” in HSCM are illustrated in Figure 19.

4.6.1 Internal drivers for “Digital tech-enabled enhanced food system” in the HSC. A number of internal factors promote the adoption of digitally-enabled improved food systems in HSC. First, the traditional food supply chain has come under pressure due to increased humanitarian needs resulting from armed conflict, natural disasters and other emergencies, necessitating the use of new technologies to improve the effectiveness and efficiency of food aid delivery (Peters et al., 2022). Second, digital technologies have the potential to increase the transparency and accountability of humanitarian food assistance programs, especially in the wake of high-profile examples of corruption and mismanagement (Iqbal and Ahmad, 2022). Third, as awareness of the impact of food waste and the need for sustainable food systems grows, so does interest in digital technologies that can help reduce waste and ensure sustainability. Advances in digital technology have also enabled the collection and analysis of data in real-time, increasing transparency and control in the food supply chain.

4.6.2 External drivers for “Digital tech-enabled enhanced food system” in the HSC. In addition, several external reasons motivate HSC to adopt improved food systems supported by digital technologies. First, the changing political and economic environment of the world, including the emergence of new donor nations, multi-stakeholder partnerships, and the changing nature of wars and disasters, has created a need for more creative and flexible ways to distribute food aid. Second, recipients’ increasing use of mobile and digital technologies has created new opportunities for imaginative ways to distribute food aid (Dubey et al., 2019). Recipients can use digital platforms to learn more about food aid programs, provide feedback on aid effectiveness and timeliness, and even receive direct cash transfers through mobile devices. Third, as private sector engagement in humanitarian aid grows in importance, so

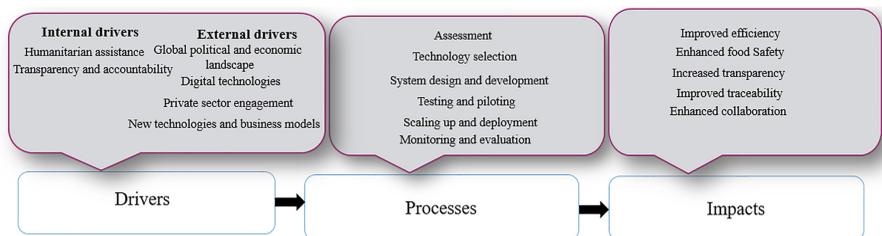


Figure 19. Drivers, process and impact of “Digital tech-enabled enhanced food system”

Source(s): Authors’ own work

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does interest in using digital technologies to improve the effectiveness and efficiency of supply chains. Finally, new technologies and business models such as 3D printing, blockchain, and social entrepreneurship have enabled the decentralized, resource-efficient, and sustainable distribution of food aid (Dubey *et al.*, 2018; Dash and Dixit, 2022).

*4.6.3 Processes for “Digital tech-enabled enhanced food system” in the HSC.* To achieve and build a digital, technology-enabled, better food system in HSC, a number of essential activities are required. These include conducting a needs assessment to identify the unique needs and difficulties of the food supply chain in a humanitarian setting and how digital technologies could help address these challenges (Peters *et al.*, 2022). This includes the adoption of relevant digital technologies, such as IoT, AI, blockchain and mobile apps, that can improve the efficiency, effectiveness and sustainability of the food supply chain. The design and development of a food system supported by digital technologies must include the development of software, hardware and network infrastructure, as well as the integration of multiple technologies and platforms (Dubey *et al.*, 2022). System testing is also necessary to evaluate the performance of the digital food system, detect bugs and improve the system in a real-world scenario, such as a pilot project or field test. Another critical process is scaling up and adoption, which involves rolling out the digital food system on a larger scale, collaborating with other organizations and stakeholders, developing training and capacity-building programs and ensuring the sustainability and scalability of the system (Peters *et al.*, 2022). Monitoring and evaluation is about tracking the performance and impact of the digital food system over time, seeking stakeholder input and making necessary changes and improvements.

*4.6.4 Impacts of “Digital tech-enabled enhanced food system” in the HSC.* The use of digital technologies in the HSC has far-reaching implications for the food system and offers several benefits. A digital, technology-enabled, improved food system in the HSC can increase efficiency by enabling real-time tracking of food from source to final destination, reducing the time and cost of delivering food to affected areas (Peters *et al.*, 2022). Digital technologies can also contribute to food safety by enabling real-time monitoring of temperature, humidity and other environmental conditions that could affect food quality, ensuring that food aid is delivered in the best possible condition (Agarwal *et al.*, 2019). Furthermore, digital technology can improve supply chain transparency by providing stakeholders with real-time access to information about food products, improve traceability by providing accurate and reliable information about the origin and quality of food and improve collaboration among different stakeholders in the food system to ensure that food aid is delivered to those who need it most (Iqbal and Ahmad, 2022). Finally, incorporating digital technologies into the HSC can increase the efficiency, transparency and traceability of the food system, leading to improved food security for vulnerable communities (Agarwal *et al.*, 2019).

#### *4.7 Theme 7 (“Digital tech enabled ethical processes and systems”)*

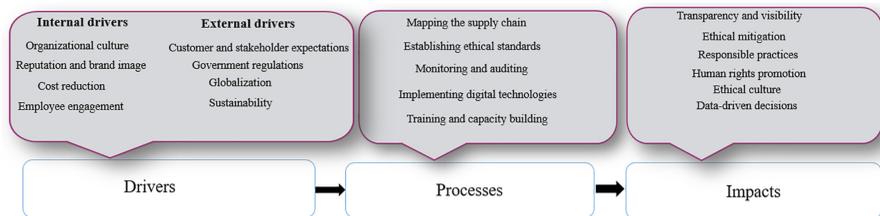
Several digital, technology-enabled ethical practices in systems aim to promote ethical practices in HSC. Transparency and traceability are critical, as digital technologies can track the movement of goods and resources, facilitating the identification of potential ethical issues such as child labor or human trafficking and increasing accountability while reducing the risk of fraud and corruption (Abidi *et al.*, 2014). Digital technology can also be used for responsible sourcing by providing information on suppliers’ social and environmental practices and monitoring social impacts to ensure that supply chain activities do not adversely affect local communities or workers’ rights (Abidi *et al.*, 2014). Finally, digital technologies can contribute to ethical decision making by providing access to relevant data and analytics, and by fostering interaction and collaboration among stakeholders. Aid organizations can strengthen accountability, transparency and responsibility by introducing

these digital technology-enabled ethical practices into HSC, leading to better ethical and sustainable outcomes for all stakeholders (Iqbal and Ahmad, 2022). The drivers (internal and external), process and impact of “Digital tech enabled ethical processes and systems” in HSCM are illustrated in Figure 20.

**4.7.1 Internal drivers for “Digital tech enabled ethical processes and systems” in HSC.** The internal drivers for “digitally-enabled ethical processes in systems” in HSCM are primarily related to the need for aid agencies to meet their ethical and social responsibilities (Abidi et al., 2014). Because humanitarian aid is intended to help those in need, it is important that the delivery of this aid be ethical, transparent and socially responsible. There is a growing awareness among aid organizations that their supply chain activities can affect social, environmental and ethical issues and that they have a responsibility to address these issues (Abidi et al., 2014). In addition, the use of digital technologies in HSC can help organizations increase transparency, traceability, and accountability and support ethical practices (Agarwal et al., 2019). In addition, both donors and recipients are increasingly demanding more ethical and transparent practices from aid organizations. As a result, aid organizations need to integrate digital, technology-enabled ethical practices into their systems to fulfill their obligations, increase stakeholder trust and achieve long-term benefits for all.

**4.7.2 External drivers for “Digital tech enabled ethical processes and systems” in HSC.** The adoption of digital, technology-enabled ethical practices in HSC is becoming increasingly important for a number of external reasons. First, consumers and stakeholders expect openness and accountability in the supply chain, and adopting these ethical practices can help develop beneficial linkages (Abidi et al., 2014). Second, governments around the world are enacting ethical supply chain laws and standards, and adherence to these policies can be a driver for implementation (Agarwal et al., 2019). Third, nongovernmental organizations (NGOs) and the media can expose unethical practices, causing companies’ reputations to suffer and making ethical practices a critical method of risk mitigation (Soosay and Hyland, 2015). Fourth, as a result of globalization, it has become more difficult to monitor and regulate ethical practices, and the use of digital, technology-enabled ethical practices can help improve visibility and control over supply chain activities, especially across many countries and regions. As ethical practices are an essential component of sustainability and are becoming increasingly important to consumers and stakeholders, digital, technology-enabled ethical practices are critical to supporting sustainable practices in the supply chain.

**4.7.3 Processes for “Digital tech enabled ethical processes and systems” in HSC.** Several approaches can help sustain the ethical process during a humanitarian crisis through digital transformation (Abidi et al., 2014). First, each organization should establish a code of conduct and rules that all stakeholders should be informed of in a timely manner so that they can adhere to them; this can be easily tracked using digital technologies. The second process is to map the entire HSC process with the possible ethical concerns related to the system. This will help to accurately define rules and regulations. Another possible process is to train all HSC



**Figure 20.** Drivers, process and impact of “Digital tech enabled ethical processes in systems”

Source(s): Authors’ own work

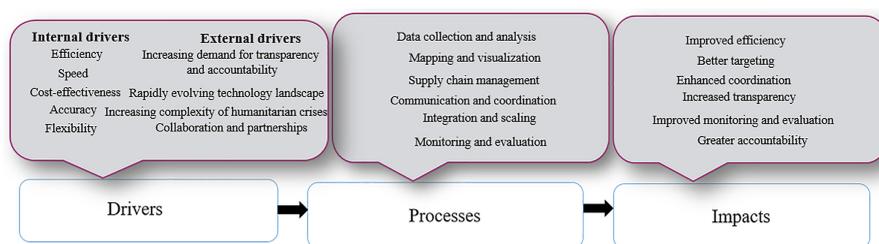
stakeholders on the ethical code of conduct. This will help bring all stakeholders to the table. Also, by using advanced technologies such as blockchain and artificial intelligence, HSC managers can ensure that all parts of the system adhere to recommended ethical practices.

4.7.4 *Impact of various processes on “Digital tech enabled ethical processes and systems” in HSC.* In the HSC, digital, technology-enabled ethical practices can have a variety of impacts and benefits. Transparency and visibility of supply chain activities can help identify potential ethical difficulties and promote responsible practices (Abidi *et al.*, 2014). Improved traceability and accountability in the supply chain can help prevent unethical practices and support sustainable supply networks. Real-time monitoring of supply chain processes can help uncover and resolve ethical issues. This can lead organizations involved in HSC to reduce reputational risk, strengthen trust and stakeholder relationships and support human rights and sustainable supply chains (Abidi *et al.*, 2014). Developing an ethical compliance culture can help promote and reinforce ethical behavior throughout the supply chain. Facilitating better decision making based on data and insights can help identify areas for improvement and promote more effective supply chain management. Digitalizing operations can help minimize waste and improve overall supply chain performance through greater efficiency and cost savings. Promoting innovation in supply chain management can help improve and optimize supply chain operations (Agarwal *et al.*, 2019).

#### 4.8 Theme 8 (“Digital tech enabled humanitarian logistics”) in the HSC

The theme of “digital technology-enabled humanitarian logistics” makes use of digital technologies to handle and coordinate materials, data and activities in relief efforts. It offers a number of benefits to managers and decision makers, including increased productivity through process automation, improved visibility and tracking through real-time monitoring, data-driven decision making through data analytics, seamless coordination and collaboration among stakeholders, effective risk management and resilience through predictive analytics and transparency and accountability through tracking and documentation. Overall, these digital solutions enable more efficient humanitarian response by empowering supply chain managers and decision makers to streamline operations, improve coordination and optimize decision making. The drivers (internal and external), process and impact of “Digital tech enabled humanitarian logistics” in HSCM are illustrated in Figure 21.

4.8.1 *Internal drivers for “Digital tech enabled humanitarian logistics”.* Digital technology supports humanitarian logistics operations through its efficiency, speed, affordability, accuracy and adaptability (Fawcett and Fawcett, 2013). By using digital technology, responders can respond to disasters faster and more effectively, which also reduces waste, increases accuracy and improves flexibility (Dubey *et al.*, 2022). To achieve this goal, processes are automated, real-time monitoring and data analysis are enabled, planning is improved and resources are better distributed (Dubey *et al.*, 2022). Ultimately, humanitarian logistics can be supported by digital technology to save lives and alleviate suffering in emergencies.



Source(s): Authors’ own work

**Figure 21.**  
Drivers, process and impact of “Digital tech enabled humanitarian logistics”

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4.8.2 *External drivers for “Digital tech enabled humanitarian logistics” in the HSC.* According to [Fawcett and Fawcett \(2013\)](#), external drivers for digital, tech-enabled humanitarian logistics in HSC include a rapidly changing technology landscape, increasing complexity of humanitarian crises, greater emphasis on collaboration and partnerships and a growing need for rapid response. These variables impact the demand for digital solutions that can increase the impact, efficiency and effectiveness of humanitarian response by providing real-time data and analytics, enabling better decision making, improving coordination and communication and increasing accountability and transparency ([Kabra et al., 2015](#)).

4.8.3 *Processes for “Digital tech enabled humanitarian logistics” in the HSC.* Digitally-enabled humanitarian logistics refers to the application of technology to optimize and streamline the delivery of aid to those in need during crises or disasters ([Dubey et al., 2020](#)). Key steps in developing digitally assisted humanitarian logistics include data collection and analysis, mapping and visualization, supply chain management, communication and coordination and monitoring and evaluation.

4.8.4 *Impacts of various processes on “Digital tech enabled humanitarian logistics” in the HSC.* The various processes discussed in [subsection 4.8.3](#) help in the use of digital technologies for the HSC. The first benefit is the timely provision of assistance in the event of a crisis. Digital transformation makes the delivery of aid easier and more efficient, while minimizing deployment time and unethical practices. In humanitarian crisis situations, it is common for many people to engage in unethical practices, and this can be avoided through technology-enabled aid delivery. One of the important aspect of digital tech enable tool is Data analysis. Data analysis can benefit organizations in better understanding the needs of the community being impacted, allowing aid efforts to be more effectively targeted. The coordination and communication between relief organizations and other players, like as governmental agencies and local citizens, can also be improved through digital technology. By making it simpler to follow the flow of resources and make sure that money is going to the appropriate people, the adoption of block chain technology and other digital technologies can boost assistance transparency ([Fawcett and Fawcett, 2013](#)).

## 5. Discussion

### 5.1 Theoretical implications

As natural disasters, pandemics and wars continue to pose new problems, the need for robust and ethical HSCM has increased ([Dubey et al., 2020](#)). This study highlights emerging areas of HSCM where digital technology can be used to promote resilience and ethical practices. In this study, eight themes were identified through the use of triangulation of data on HSC in the digital age. The triangulation of database includes 33 published articles and over 90,000 social media data from platforms such as LinkedIn, Twitter, blogs and forums.

[Table 5](#) compares previous literature reviews on HSCM published in the digital era. We identified fifteen review articles including [Abidi et al. \(2014\)](#), [Balcik et al. \(2016\)](#), [Habib et al. \(2016\)](#), [Seifert et al. \(2018\)](#), [Jahre \(2017\)](#), [Behl and Dutta \(2019\)](#), [Agarwal et al. \(2019\)](#), [Banomyong et al. \(2019\)](#), [Gupta et al. \(2019\)](#), [Fosso Wamba \(2022\)](#), [Anjomshoae et al. \(2022\)](#), [Polater \(2021\)](#), [Marić et al. \(2022\)](#), [de Camargo Fiorini et al. \(2022\)](#) and [Sentia et al. \(2023\)](#) published on this topic. These articles differed from the present study in two major ways. First, they did not comprehensively examine the broader issues, benefits and previous work related to HSCM in the digital age. Instead, most articles focused on specific narrow aspects of HSCM. Second, previous studies primarily relied on previously published literature to examine and analyze trending topics and emerging themes. In contrast, this study stands out by taking a triangulation approach that incorporates multiple databases, including both published literature and social media data from platforms such as Twitter, LinkedIn, blogs and forums.

Author(s), year	Research objective	Findings	Comparison with past studies
Sentia <i>et al.</i> (2023)	The goal of this study is to undertake a study of HLSCM articles in order to identify gaps and potential research possibilities	The study identified five themes HLSCM and found that distribution delays, uncertain demand and high operating costs are the main problems of logistics distribution in disaster management	This study is partially similar to our study as some of the theme identified in this study are consistent with our study, e.g., risk in HSC, lean management in HSC, etc. This study relies solely on published literature, while our analysis includes both published literature and social media data. To better understand the consequences, causes, processes and outcomes of management, our study also created a framework for each topic
Anjomshoa <i>et al.</i> (2022)	This paper aims for systematic review of studies on performance measurement in the HSC through a categorical analysis of past published literature	In this work, two main research directions are established: Simulation and Predictive Performance Assessment and Contextual Performance Measurement	This study is limited to peer-reviewed journals that focus on supply chain and operations management literature, and therefore does not include literature from humanitarian organization technical reports, independent evaluations and other academic fields such as organizational studies or accounting literature. Our study used data triangulation (published literature and social media data), while this study used only published literature. In addition, for each topic, we proposed a framework to understand the management implications, drivers, processes and consequences related to each theme
Marić <i>et al.</i> (2022)	The purpose of this article is to conduct a literature review of published articles related to humanitarian supply chain (HSC) and to explore a comprehensive understanding of the current state of digital transformation in HSC operations	The results of the literature review show the primary goals and application areas of DTs and their use in relation to the different HSC phases and support the growing importance of DTs within HSC	This study is similar in some respects to our HSCM study. Although the focus of this study is on understanding the progress of digital transformation in the humanitarian supply chain, our study focuses on understanding the evolution of HSCM in the digital age. This study used only published literature, while our analysis uses both published literature and social media data
de Camargo Fiorini <i>et al.</i> (2022)	The purpose of this study is to examine the current state of research on the human elements of humanitarian supply chains	Key findings show that human resource management impacts how well humanitarian organizations are prepared for and respond to disasters	This study focused on the human component of HSC, whereas ours focused on the in-depth investigation of HSCM. Unlike our analysis, which relied on published literature and social media data, this study used only published literature

**Table 5.**  
Comparison of findings  
(*continued*) with previous research

Author(s), year	Research objective	Findings	Comparison with past studies
Fosso Wamba (2022)	The present state of research on the HSC was evaluated in this study using a bibliometric analysis	The main findings are highlighted and discussed, and then some directions for possible future research are suggested	Results are limited to peer-reviewed publications that focus on HSCM and thus do not include technical reports, independent evaluations or other academic topics such as organizational studies or accounting literature. While our used in our study, data from published literature and social media were used in our analysis
Polater (2021)	The primary objective of this research is to review the existing literature on HSCM from the perspective of dynamic capabilities (DCs)	This study concludes that the use of the DCs' perspective in the HSCM literature is still in its infancy	This study is partially similar to our study. This study focused on providing an overview of HSCM from the perspective of dynamic capabilities, while our study focused on understanding the recent developments, advances and problems of HSCM from all possible angles
Behl and Dutta (2019)	This article aims to provide a literature review on HSCM to understand the past and current state of research and issues	This study revealed nine themes that are popular among researchers and provided a roadmap for future research directions	This study is partially similar to our study and found nine themes, of which three themes are consistent with our study and others are different. In addition, our study used data triangulation (published literature and social media data), whereas this study used only published literature
Banomyong et al. (2019)	The two main objectives of this paper are to first identify a good strategy for conducting an in-depth literature review and then to identify the major research topics and clusters in the literature	This study identified key research themes and clusters in humanitarian action and logistical performance	This study is partially similar to our study and derived similar themes to our study. Our study used only published material; our analysis used data from published literature and social media. To understand management implications, causes, processes and consequences, we also provided a framework for each theme
Gupta et al. (2019)	In this study, a thorough analysis of the literature on Big Data and the HSC was done. Scopus was used to obtain data	This paper have shown how Big Data can contribute to a more responsible and efficient HSCM	This study examined only one part of HSCM, Big Data benefits, while our study examined all aspects of HSCM. This study used only published literature, while our analysis used data from published literature and social media
Agarwal et al. (2019)	The objective of this study is to examine and compare existing humanitarian supply chain management (HSCM) frameworks	This study shows that while HSCM frameworks are academically innovative, they lack practical collaboration. It recommends future research on a unified HSCM framework that considers interconnected elements and constructs	This study examined the framework used in HSCM, while our study focuses on understanding the problems and benefits as well as recent developments in HSCM. Our study used only published literature, whereas our analysis uses data from published literature and social media

Table 5.

(continued)

Author(s), year	Research objective	Findings	Comparison with past studies
Seifert <i>et al.</i> (2018)	The purpose of this paper is to review and analyze the literature on humanitarian supply chain management (SCM) in refugee relief from 1989 to 2016	The qualitative analysis of this study concludes that further research on HSCM, as well as technological innovation, is needed to increase data availability, predictive accuracy and efficiency of (local) utility network operations during disasters	This study is partially similar to our study. This study used published literature similar to our study to examine recent advances and current status in HSCM. This study used only published literature, whereas our analysis used data from published literature and social media
Jahre (2017)	The purpose of this study is to link humanitarian logistics (HLs) and supply chain risk management (SCRM)	This study have established a link between HL and SCRM	This study is partially similar to our study. This study focused on one aspect of HSCM and examined the link between humanitarian logistics (HLs) and supply chain risk management (SCRM) to provide an understanding of risk mitigation measures using published literature, whereas our study examined all aspects of HSCM. This study used only published literature, while our analysis used data from published literature and social media
Balcik <i>et al.</i> (2016)	This study provides a review and analysis of studies that address stockpile planning and management in humanitarian assistance	This study proposes strategies and models based on the literature published in the past	This study is completely different from our study. This study focuses only on inventory and related issues, while our paper focuses on all aspects of HSCM. In addition, our study used data triangulation (published literature and social media data), while this study used only published literature
Habib <i>et al.</i> (2016)	The two main objectives of this study are to comprehensively examine recent mathematical models created in the field of humanitarian supply chain (HSC) and to identify and highlight potential research topics that require the attention of researchers	This study reviewed the mathematical frameworks used throughout the HSCM process and proposed new directions for future research	This study differs significantly from our study. While our study focuses on solving HSCM-related problems, this study only examined mathematical models for them. In addition, this study used only published literature, while our analysis combines data from both published literature and social media
Abidi <i>et al.</i> (2014)	The purpose of this study is to measure and understand the current state of performance measurement and management in HSCM. The study also categorizes the performance measurement indicators in the five phases of the supply chain	To address this gap, the authors of this study propose guidelines for performance measurement that include input and output criteria. They also outline a research agenda focused on the development, use and dissemination of performance measurement and management practices in humanitarian supply chains	This study is completely different from our study. This study is about measuring and understanding the current state of performance measurement and management in HSCM, while our study used data triangulation (published literature and social media data), whereas this study used only published literature

Source(s): Authors' own work

Table 5.

This method allowed us to achieve two important goals. First, we used natural language processing (NLP) tools to analyze previous HSCM literature and identify themes and themes. These themes provide useful insights into current research and discussions on the topic, ultimately strengthening our understanding and HSCM processes. Second, unlike previous

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literature reviews that relied primarily on published research, our study incorporated data from social media such as Twitter, LinkedIn, blogs and forums. By including data from social media, we are able to capture the latest difficulties, benefits and viewpoints in the field of HSCM, particularly those from industry professionals and governments. These findings not only draw on existing literature reviews, but also illuminate the framework required for each theme and provide guidance to policymakers and government agencies on how to use the derived themes in their organizations. In addition, this study theoretically strengthens the literature review process by demonstrating a new approach to analyzing past information by incorporating social media data from blogs and forums.

### *5.2 Managerial implications*

This study provides some useful insights for HSC managers, NGOs, society and government working in the field of HSCM. Eight themes were found themes are shown in [Figure 13](#). The first theme is “Digital technology enables global partnership” It focuses on the use of digital technologies and collaborative platforms to improve global coordination and collaboration among different parties involved in HSCM. Managers, policy makers and governments can leverage digital technologies in humanitarian supply chain management for “improved communication and information sharing”, “collaboration and partnerships”, “data analytics and insights,” and “adaptive and agile response.” The second derived theme is “Digital Technology-Enabled Sustainability.” This theme refers to the use of digital technologies and solutions to support sustainable practices and outcomes within the humanitarian supply chain. This theme provides guidance to managers, legislators and governments on how to use digital technologies to reduce environmental impact, improve resource use, ensure ethical sourcing, make data-driven decisions and foster collaboration.

The third theme is “Digital tech-enabled risk reduction for Climate Change and Uncertainty.” This theme focuses on the use of digital technologies to minimize and resolve risks related to climate change and unpredictable situations within the HSC. It helps managers, policymakers and governments better anticipate, mitigate and adapt to climate-related hazards. This will make supply chains more robust, improve responsiveness to climate-related disasters and reduce the impact on affected people and the environment. The fourth derived theme is “Digital tech enabled preparedness, response and resilience”. This HSCM theme refers to the use of digital technologies to improve emergency preparedness, response and resilience within the HSC. This theme shows managers, legislators and governments how to better predict and respond to disasters, ensure timely delivery of relief supplies and improve resilience to future disasters. This in turn leads to more effective and efficient humanitarian responses that save lives and mitigate the impact of natural disasters.

The fifth theme is “Digital tech enabled health system enhancement”. This theme addresses the use of digital technologies to improve and strengthen health systems in humanitarian operations. This theme supports managers, policymakers and governments in improving healthcare delivery, improving access to healthcare services, optimizing supply chain management for medicines and strengthening the overall resilience of the healthcare system in humanitarian situations. “Digital technology enabled food system enhancement” is the sixth theme.” This topic is about the use of digital technologies in humanitarian operations to improve and strengthen the food system. This theme explains how managers, policymakers and governments can improve the food system through the use of supply chain visibility, data analytics and demand forecasting, inventory management and shelf life tracking, traceability and quality assurance, mobile apps and information sharing and collaboration and partnerships. The seventh theme is “Digital tech enabled ethical process and systems.” This topic focuses on supply chain transparency, ethical sourcing, labor rights, stakeholder engagement, compliance monitoring and training. Managers, policymakers and governments can use this to ensure responsible procurement, protection of labor rights,

transparency and the establishment of an ethical and sustainable supply chain in humanitarian operations. The final theme is “Digital tech enabled humanitarian logistics”. This theme focuses on the use of digital technologies to improve the efficiency, effectiveness and coordination of logistics activities in humanitarian operations. In humanitarian operations, this will improve monitoring, route planning, inventory management, collaboration, data analytics and last-mile delivery. Managers, policymakers and governments can use this to increase efficiency, coordination and response times, leading to improved aid delivery and better outcomes for affected communities. Understanding HSCM in general helps managers, policymakers and society increase efficiency, improve responsiveness, allocate resources effectively, promote collaboration, support accountability, address societal needs, mitigate risk, build resilience and improve humanitarian outcomes. This leads to more efficient, effective and long-term humanitarian action that helps people in need.

## 6. Conclusion

This study conducts an extensive literature review to examine previous research on HSCM and identify relevant topics and themes using a triangulation approach. Data from various sources, including peer-reviewed articles and social media platforms such as blogs and forums, were used for the analysis. The database includes 33 peer-reviewed articles and over 90,000 discussions, expert opinions and articles shared by HSCM specialists on various social media platforms. [Figure 7](#) illustrates the final themes derived from the combined dataset.

This study addresses the three research questions raised by the theoretical discussion in the introductory section. The first research question (RQ1) is answered by identifying themes using published literature and data from social media such as Twitter, LinkedIn, blogs and forums.

The second research question (RQ2) is answered by proposing a framework for each theme in [Section 4](#) and identifying avenues for future research in [Section 7](#). One of the key observations is that most of the social media discussions on HSCM revolve around the use of technology to create a more ethical and trustworthy HSC chain, while the published literature mainly focuses on infrastructure, readiness and assistance issues.

## 7. Limitations and future research directions

In this study, topic modeling, a natural language processing (NLP) paradigm, is used to determine the eight topics. The topics, as mentioned earlier, are not independent of each other. Each of the themes discovered in this HSCM research is related to the others in some way. The themes of “improving the health system through digital technologies” and “improving the food system through digital technologies” are linked in the context of humanitarian supply chain management. Both themes are about using digital technologies to improve certain aspects of the health and food supply chain. While “digital tech-enabled health system enhancement” focuses on improving health care and services in humanitarian operations, “digital tech-enabled food system enhancement” is about optimizing the efficiency, safety and sustainability of food-related processes in the supply chain. These themes share common goals, such as using digital platforms for real-time tracking, improving visibility and transparency, using data analytics for informed decision making and fostering collaboration among stakeholders. They aim to improve the overall effectiveness and responsiveness of humanitarian supply chains in delivering vital medical care and food assistance to affected populations. These interrelated topics the potential, threats, difficulties and infrastructure requirements to provide organizations with a comprehensive understanding of how to successfully deploy HSCM in the digital age. The objective of this paper was to examine the

trending topics and emerging themes using a triangulation of databases. In future research, these themes can serve as input or output factors, and further research can be conducted to explore the linear or nonlinear relationship. In addition, empirical validation can be performed.

As the technical culture and environment change at a rapid pace, the field of HSCM is also changing, creating new opportunities and challenges for HSC managers, NGOs and the government. Since this study have used only secondary information, future researchers can collect primary data by conducting surveys for HSC stakeholders to better understand the issues and themes surrounding the humanitarian crisis. Through direct contact with HSC managers, we can gain greater clarity and ensure the accuracy and relevance of the data collected in relation to the research objectives.

### Note

1. <https://www.weforum.org/agenda/2023/02/turkiye-syria-earthquake-ai-emerging-tech-relief-efforts/#:~:text=Technology%20is%20essential%20to%20disaster%20relief%20efforts%2C%20but,longer%20term%20will%20help%20make%20communities%20more%20resilient>

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