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The digitalization of the humanitarian supply chain performance management *literature and practice*

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Abstract

Purpose – This study aims to review the current research in the digitalization of the humanitarian supply chain performance management (HSCPM) and complement the insights found in the literature with the support of humanitarian organization (HO) reports. As a result, this study also identifies research gaps and directions for future research.

Design/methodology/approach – The study first used a systematic literature review using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis to collect and review 25 peer-reviewed articles. Second, the study complemented the articles' findings by collecting and analyzing 12 HO reports.

Findings – The study reveals the common understanding and links between HSCPM concepts and digitalization approaches, determining that the digitalization approaches per se used in the literature are indistinct and fragmented. Furthermore, it reveals the gaps between literature and practice that cause the research to develop slowly. Some suggestions are made to aid relevant future research. Both gaps and research directions are presented in Table 5.

Research limitations/implications – This study first contributed to methodology in reviewing the digitalization of HSCPM research from literature and practical perspectives. There is a need to expand the data collection scope, integrate various analyses and foster collaborations with multi-disciplinary researchers and practitioners.

Social implications – This study highlights the gaps and potential pathways for the research community to conduct future research investigations into the digitalization of HSCPM.

Originality/value – To the best of the authors' knowledge, this is one of the first studies to analyze the HSC's current research into the application of digitalization in HSCPM from both academic and practical perspectives. It also provides a replicable methodology for future studies.

Keywords Humanitarian supply chain, Performance management, Digitalization, Systematic literature review

Paper type Literature review

List of abbreviations

AI	= Artificial intelligence;
BC	= Blockchain;
BDAs	= Big data analytics;
CC	= Cloud computing;
CE	= Cost efficiency;
CSC	= Commercial supply chain;
DTs	= Digital technologies;
ETs	= Emergent technologies;
HSC	= Humanitarian supply chain;
HSCPM	= Humanitarian supply chain performance management;
ICT	= Information and communication technology;
IoT	= Internet of Things;
IS	= Information system;
IT	= Information technology; and
LTE	= Lead-time effectiveness;

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1. Introduction

A humanitarian supply chain (HSC) refers to a temporary network that comprises activities similar to those of a commercial supply chain (CSC) (e.g. vendor-managed inventory) (Behl and Dutta, 2019). However, HSCs have characteristics that differ from CSCs. For example, the goal of HSCs is the effectiveness and efficiency of humanitarian operations to supply people in need, while CSCs aim for a competitive advantage (Negi and Negi, 2021). An HSC

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usually collects funding from donors, whereas CSCs obtain funding from sales and shareholders (Behl *et al.*, 2020). HSCs also operate in more complex situations and deal with many challenges, including poor critical infrastructure, the lack of resources, predictable demand and outcomes, and alignment between HSC actors. Thus, it is vital to carefully consider HSC characteristics before developing appropriate strategies (Kovács and Sigala, 2021).

Furthermore, HSC activities involve various actors (e.g. humanitarian organizations [HOs] and donors) in different disaster stages: mitigation, preparedness, response and recovery (Patil *et al.*, 2022). The mitigation stage includes measures to reduce vulnerability to the impact of the disaster. The preparedness stage aims to organize the HSC plans, e.g. allocating relief items. The response stage involves the distribution of relief items, and the recovery stage supports the restoration of damage caused by the disaster (Altay *et al.*, 2018; Trejos *et al.*, 2023).

The volume of HSC activities has rapidly grown to combat world crises, demanding HSC actors to be more accountable and transparent in spending their limited funds efficiently and effectively (Anjomshoae *et al.*, 2022; Iqbal and Ahmad, 2022). HSC actors are required to measure their outcomes, emphasizing lead-time effectiveness (LTE) and cost efficiency (CE) in the HSC field (Paciarotti and Valiakhmetova, 2021). Consequently, HSC actors must implement and improve HSC performance management (HSCPM) to achieve LTE and CE, so that every dollar spent on HSC activities can be shown to assist people effectively (Swaminathan, 2018; Abidi *et al.*, 2020). HSCPM refers to a type of management that coordinates its actors to provide humanitarian assistance in disaster-prone areas (Abidi *et al.*, 2020). HSCPM constitutes different activities, such as selecting performance variables (Frennesson *et al.*, 2021), defining performance metrics (Abidi *et al.*, 2014), setting targets (Haavisto and Goentzel, 2015), as well as measuring (D'Haene *et al.*, 2015) and analyzing actions to capture strategic activities among HSC actors (Moshtari *et al.*, 2021). It is crucial in promoting long-term strategic goals (Anjomshoae *et al.*, 2017), aligning overall objectives (Maghsoudi and Moshtari, 2021) and monitoring HSC performance (Lu *et al.*, 2016).

However, integrating HSCPM between HSC actors is complex and challenging because of chaotic environments, intangible services, unavailable data, immeasurable projects and unknown outcomes. Furthermore, differing goals, systems, standards and disaster stages complicate the HSCPM implementation, resulting in a lack of LTE and CE (Altay *et al.*, 2018). Digitalization is, therefore, important in addressing HSC complexities and challenges, as it enables HSCPM between actors through exchanging information (Dubey *et al.*, 2019). Furthermore, Wagner *et al.* (2020) and Jayadi and Forslund (2023) encouraged HSC actors to advance digitalization when implementing HSCPM at different disaster stages to combat these challenges. Jeble *et al.* (2019) further supported that the emergence of digitalization raised HOs' interest in the application to the HSCPM activities. Even some international HOs have started to invest in the digitalization of HSCPM to improve LTE and CE (UNDRR, 2022; CHA, 2023). In HSCPM, digitalization can be seen as HSC actors (e.g. HOs and donors) switching the tools, systems and technologies when conducting HSCPM activities in different disaster stages from analog (e.g. paper-based records, manual data collection, etc.) to digital information (e.g. electronic data, real-time tracking, etc.) which aims to improve the HSC performance (e.g. LTE and CE) adapted from Dubey *et al.* (2019) and Marić *et al.* (2022).

Digitalization is relevant for its application in the HSCPM concepts for several reasons. The critical elements of digitalization are integration, interconnection and relationships among actors. Thus, the application of digitalization to the HSCPM concepts is suitable where various HSC actors can apply different technologies, e.g. cloud computing (CC), blockchain (BC), big data analytics (BDAs), artificial intelligence (AI), etc. to integrate and conduct joint HSCPM activities, which is in line with Perano *et al.* (2023). Furthermore, digitalization is designed to be agile and customized, so it can be adaptable and face disruption in a dynamic environment (Weerabahu *et al.*, 2021). The characteristics of digitalization are relevant for HSCs that encounter unpredictable and chaotic environments in disaster areas. Swaminathan (2018) pointed out that one way to improve HSCPM lies in how data and information are leveraged between HSC actors, and this can be done by enabling digitalization.

The relevance of HSCPM is amplified by the potential for digitalization, especially for HSC actors who apply it in their organizations. For example, digitalization can help HSC actors improve HSCPM by increasing HOs' accountability to donors and transparency of information sharing, as well as reducing the costs of HSCs (Jayadi and Forslund, 2023). Moreover, to design an effective HSCPM, digitalization can be leveraged to mitigate issues such as goal misalignment, uncertainty and information asymmetries. Consequently, this allows HSC actors to exchange more accurate structured/unstructured data and open/confidential information (Khan *et al.*, 2021). It also can assist HSCPM in effectively managing and tracing resources, financing and information (Jeble *et al.*, 2019; Iqbal and Ahmad, 2022), collecting extensive data, allowing real-time communication at different organizational levels and supporting responsive decision-making (Tortorella *et al.*, 2023). In sum, digitalization has the potential to support HSC actors to improve LTE and CE, e.g. by providing data-driven decisions, real-time communication, as well as tracking and tracing visibility while conducting HSCPM activities. These activities are beyond what the analog systems/technologies can offer, which concurs with Rasool *et al.* (2022) and Shrivastav and Bag (2023).

Despite the potential of adopting digitalization, its application in the HSCPM field has yet to be developed (Abidi *et al.*, 2020). In addition, digitalization is not easy or inexpensive; thus, it requires good planning and execution when added to HSCPM (Rasool *et al.*, 2022). However, the extant studies on digitalization in HSCPM are still fragmented, because they focus on isolated digitalization to support general HSC activities, and not specifically HSCPM performance (Kabra *et al.*, 2023). Thus, there is a need to review the application of digitalization dedicated specifically to HSCPM research, which is in line with Anjomshoae *et al.* (2022). Some literature review studies have primarily focused on investigating broader HSCPM research. They identified an increasing number of studies indicating the advancement of digitalization in HSCPM (Abidi *et al.*, 2020; Anjomshoae *et al.*, 2022; Agarwal *et al.*, 2022); however, there is a shortage of in-depth reviews of digitalization in the existing literature. Likewise, digitalization in the HSC research also identifies the growth of digitalization as a new domain in the research that can improve overall performance, but it is not explicitly connected to HSCPM (Gupta *et al.*, 2019; Marić *et al.*, 2022; Kabra *et al.*, 2023).

Furthermore, there is a lack of literature reviews connected to the HSC context, thus hindering empirical testing in the practical field (Jahre, 2017; Moshtari *et al.*, 2021), who suggested considering HSC actors' perspectives to allow for a stronger foundation grounded in practice to increase the value of implications in the HSC context. Thus, it is beneficial to acknowledge the practical perspectives by combining systematic literature reviews (SLRs) with HO reports (Jahre, 2017).

Given the preceding background gaps, this study aims to review current research in the digitalization of HSCPM. Furthermore, it aims to complement insights found in the literature with the support of HO reports. By addressing these aims, the study can identify the current status of the research, gaps between literature and practice and offer future research agendas in the digitalization of HSCPM. Therefore, the research questions are as follows:

RQ1. What is the current status of research on digitalization of HSCPM?

RQ2. What are the gaps between literature and practice?

RQ3. What are the research directions in the digitalization of HSCPM?

This study uses two methods. First, the study examines peer-reviewed articles on the digitalization of HSCPM by implementing a SLR. Second, the study complements the SLR with findings from HO reports to show gaps in applying the digitalization of HSCPM. The study's contributions include reviewing current research based on articles between 2013 and 2023 and HO reports. It indicates five HSCPM concepts (performance in general, performance metrics, performance measurement, performance management and performance measurement/management frameworks) and nine digitalization approaches (information technology/IT, information and communication technology/ICT, information system/IS, big data analytics/BDAs, blockchain/BC, cloud computing/CC, information technology infrastructure/IT infrastructure), emergent technologies/ETs and digital technologies/DTs. The study then investigates the common understandings and links, highlights the gaps between literature and practice from reports and examines future research directions. The structure of the study is as follows. Section 2 outlines the methodology; Section 3 analyzes the findings of the articles; and Section 4 examines the report findings. Section 5 addresses the research questions and presents research directions, and finally, Section 6 concludes the study and makes suggestions for future studies.

2. Methodology

This section guided the study's collection of relevant articles and reports. The study conducted a Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) SLR to collect and review the articles. Then, the relevant HO reports were gathered to complement the articles.

2.1 Article collection

SLR is a method for indicating and reviewing the existing works generated by researchers (Fink, 2020). It provides standardized methods to help the researchers formulate research questions, collect findings and assess the research (Booth *et al.*, 2016). This study performed the SLR using the PRISMA guidelines as the primary methodology. PRISMA was chosen because it supports the study in obtaining replicability when extracting the state-of-the-art, gaps and future research agenda (Page and Moher, 2017). In addition, it is a common methodology that provides procedures to review in various supply chain areas, e.g. sustainability (Ülgen *et al.*, 2019), food (Perdana *et al.*, 2022) and blockchains (Sahoo *et al.*, 2022).

The research protocol details were adapted from previous SLR studies that used the PRISMA method to collect articles (Anjomshoae *et al.*, 2022; Karl and Karl, 2022; Trejos *et al.*, 2023). This study gathered existing articles from Scopus and Web of Science (WoS) databases, because they comprise the most highly relevant journals in humanitarian logistics and supply chain management (Trejos *et al.*, 2023). Because digitalization is multi-disciplinary and studied in different fields, the study chose suitable journals to prevent collecting irrelevant articles from different disciplines (Moshtari *et al.*, 2021). Vega and Roussat (2015) suggested gathering articles from ten high-ranking major journals (Table 1) contributing to work in logistics and supply chain management. Dhamija *et al.* (2021) added two journals, the *Journal of Humanitarian Logistics and Supply Chain Management* and *Production and Operations Management*, because of their growing contributions to the HSC field.

The used publications contained articles that were peer-reviewed and written in English. The period of publication ranged from 2013 through June 30, 2023, to capture the current state of the research within the past decade. Furthermore, 2013 was chosen as the starting point source for this SLR because this is the year that HSCPM research entered the development stage and later acknowledged the advancement of digitalization (Anjomshoae *et al.*, 2022). The suggestions for Boolean operators (and, or) followed the existing keywords provided (Anjomshoae *et al.*, 2022; Marić *et al.*, 2022). Boolean operators assisted the study in collecting relevant articles related to the application of digitalization in HSCPM. The inclusion and exclusion criteria assisted the study in screening articles (titles, abstracts and full reading). The research protocol details were subsequently created and shown in Table 1.

Following the research protocol details, 149 peer-reviewed articles were initially collected from Scopus and WoS. The study recorded article information, including the title, author's name and year of publication, which was entered into an Excel spreadsheet. First, the study screened the titles and abstracts based on the inclusion and exclusion criteria in Table 1. Of the initial articles, 110 were eliminated as a result of duplication, or the articles and abstracts did not relate to the digitalization of HSCPM or address the issues in an HSC context (e.g. optimization). Next, a second screening was conducted by thoroughly reading the articles but emphasizing general digitalization of HSCPM, rather than the content of individual articles, to gain a broad perspective (e.g. the study included articles that pertained to topic discussion), in agreement with Moshtari *et al.* (2021). The second screening excluded 14 articles, resulting in 25 articles to be further analyzed (Figure 1).

2.2 Reports collection

The study used secondary data to complement the SLR, similar to previous studies (Vega and Roussat, 2015; Jahre, 2017; Moshtari *et al.*, 2021; Shrivastav and Bag, 2023). Reports were selected as secondary data, because they provide abundant information about HSC actors' activities and are often publicly

Table 1 Research protocol details

Research protocol details	Articles
Research database	Scopus, WoS
Type of publication	Peer-reviewed articles
Journals	*International Journal of Logistics Management* (*IJLM*), *International Journal of Logistics: Research and Applications* (*IJL-RA*), *International Journal of Operations and Production Management* (*IJOPM*), *International Journal of Physical Distribution and Logistics Management* (*IJPDLM*), *Journal of Business Logistics* (*JBL*), *Journal of Operations Management* (*JOM*), *Supply Chain Management*: *An International Journal* (*SCM-IJ*), *Supply Chain Management* (*SCM*), *Transportation Journal* (*TJ*), *Transportation Research Part E* (*TR-E*), *Journal of Humanitarian Logistics and Supply Chain Management* (*JHLSCM*) and *Production and Operations* Management (POM)
Language	English
Publication dates	2013–2023 (June 30, 2023)
Search fields	Titles, abstracts and keywords
Search keywords	("PM" and "digitalization" and "HSC") – in detail: ("performance" or "measurement" or "assessment" or "performance measures" or "performance indicators" or "metrics" or "key performance indicator" or "monitoring and evaluation" or "performance management") *and* ("Industry 4.0" or "smart industry" or "digitalisation" or "digital transformation" or "digitalization" or "information technology" or "IT" or "Internet of Things" or "IoT" or "3D printing" or "advanced manufacturing" or "additive manufacturing" or "robotics" or "augmented reality" or "virtual reality" or "big data" or "big data analytics" or "predictive technologies" or "cloud computing" or "digital platforms" or "social media" or "crowdsourcing" or "unmanned vehicles" or "UAV" or "drones" or "blockchain" or "blockchain technology") *and* ("humanitarian supply chain" or "humanitarian supply chain management" or "humanitarian logistics")
Criteria for inclusion	Connections to the study research purposes, i.e. focused on the HSC field
Criteria for exclusion	No connections to the study research purposes, duplicate sources and not focused on the HSC field

Source: Table created by author

available (Kunz, 2019). The existing reports were sourced from Reliefweb.int, an open database in the humanitarian field provided by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA). This database was selected, because it contains information from over 4000 sources (e.g. reports, infographics and training programs) from various HSC actors (e.g. international and local HOs, government, institutions and media) and allows researchers to access the information freely (Charles *et al.*, 2022). However, the advanced search in this database was not as comprehensive as databases for collecting articles. Thus, the search scope could not be too specific and had to be simplified. For instance, the study simplified the data collection in the reports into two groups. The first group was to type keywords related to performance management, and the second was digitalization. In addition, the scope of the region was worldwide.

Consequently, the report collection could only capture reports in a broader context of humanitarian operations. To overcome such issues, comprehensive readings were conducted, and relevant information for the study topics were selected following the inclusion and exclusion criteria. Furthermore, the publication type included reports, not other documents, e.g. infographics. The years of publication were collected in 2023 because digitalization was rapidly developing in practice. By collecting reports from 2023, the study grasped the most updated information on the current topic, which is in line with Kumar *et al.* (2022).

Initially, 57 reports were collected for abstract screening. A total of 31 were excluded because of duplicate resources or not discussing digitalization and performance management in the abstracts. The next step was to read the full reports. A total of 14 reports were excluded because they did not fit the research purposes, e.g. they only discussed general HSC activities. Ultimately, 12 reports from 10 HSC actors were used for analysis and discussions.

The screening steps for articles and reports are shown in the research processes (see Figure 1). Colleagues who had experience conducting SLRs were consulted on these steps. The study was also presented to internal seminars and a conference to gain feedback, increase transparent data collection and improve the analysis quality, as Tranfield *et al.* (2003) proposed. Selected articles and reports to be reviewed are provided in the references.

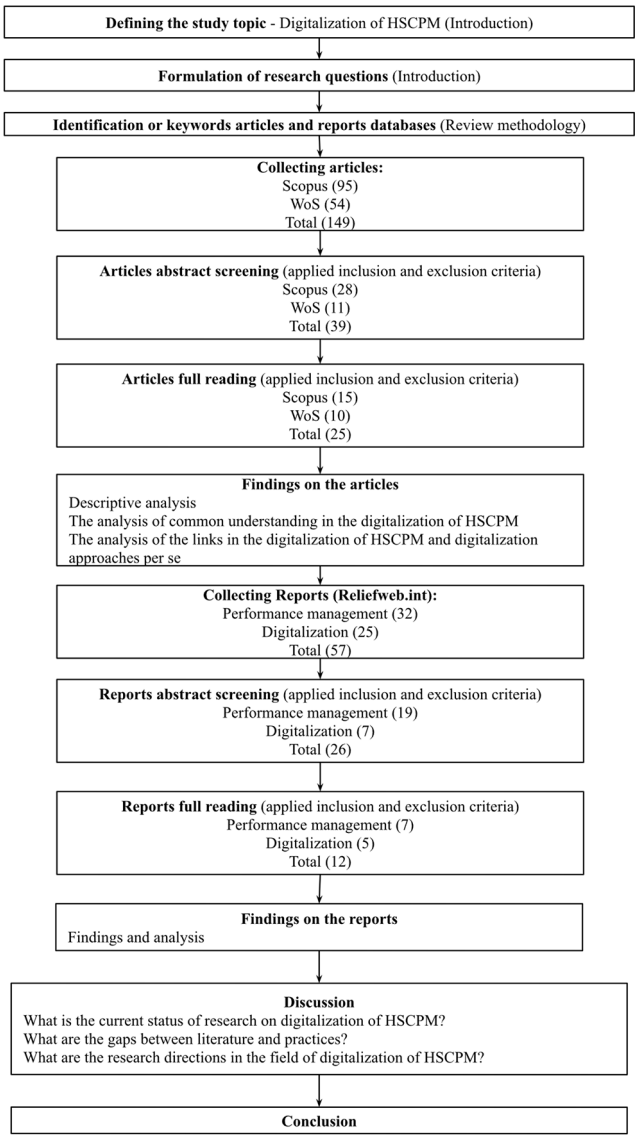
3. Article findings and analysis

This section analyzes the findings, dividing the findings and analyses into three parts: descriptive, the domains in the HSCPM and digitalization and the links between digitalization and HSCPM and digitalization approaches per se.

3.1 Descriptive analysis

There were 25 articles on the current topic published in the HSC field in the past decade, fewer than in the CSC field which had 178 articles (Govindan *et al.*, 2022). Based on Figure 2, the research slightly increased between 2013 and 2023 (see the dotted red line) but not significantly. Furthermore, the distribution of articles in journals is not heterogeneous. The 25 articles are distributed in only 6 of 12 journals, where the *Journal of Humanitarian Logistics and Supply Chain Management* contributes to 72% of article publications (18 out of 25 articles). Researchers naturally gravitate toward publishing in the *Journal of Humanitarian Logistics and Supply Chain Management* because of

Figure 1 The research processes



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the high relevance between the journal's scope and objectives and the study topics (HSCPM and digitalization). The journal also offers significant visibility for other audiences (e.g. practitioners) in the HSC fields. Therefore, it is anticipated that this journal will continue to dominate in terms of the number of publications in this field (Behl and Dutta, 2019).

The articles showed that the research emphasized the response stage, rather than the other disaster stages of mitigation, preparedness and recovery, which is in line with Jahre *et al.* (2016). Based on Figure 3, during the past ten years, the research contributed significantly to the response stages (Shavarani, 2019; Dennehy *et al.*, 2021; Maghsoudi and Moshtari, 2021). On the contrary, research that focused on preparedness and mitigation decreased. There were only a few studies conducted in the mitigation stage, e.g. understanding of mitigation strategies to enhance digitalization in HSCPM (Jahre, 2017) and alignment in managing digitalization across decision-makers (Rodríguez-Espíndola *et al.*, 2018). Research focusing on the recovery stage has slightly increased, but there were still a few articles, e.g. Dubey *et al.* (2022a); Schön *et al.* (2018), which have been conducted on this stage. Focusing on response stages in extant articles within HSC fields is not a new trend. The priority mainly drives this focus to allocate limited resources to addressing immediate needs when disasters strike (Jahre *et al.*, 2016; Stumpf *et al.*, 2023).

The articles used different methods in their research. Figure 4 indicates that most articles used literature reviews (seven articles) or a single/multiple case study (six articles). These methods are commonly used to investigate HSCPM because of the difficulty of HSC researchers obtaining empirical data (Heaslip *et al.*, 2019) and the nature of HSC research that necessitates an exploratory approach to understand specific fields that are often context-specific (Kucukaltan *et al.*, 2022). Another popular methodology is statistical analysis, and five articles used this method. Statistical analysis can allow researchers to collect and analyze data systematically and validate/test it against existing theories, findings and proposed results/models (Hosseini *et al.*, 2023). Correspondingly, it influences the articles to tolerate the lower usage of other methods, e.g. three articles used mixed-method (quantitative and qualitative analysis), three articles used mathematical modeling and one article used action research.

Figure 2 Years of publishing and name of journals

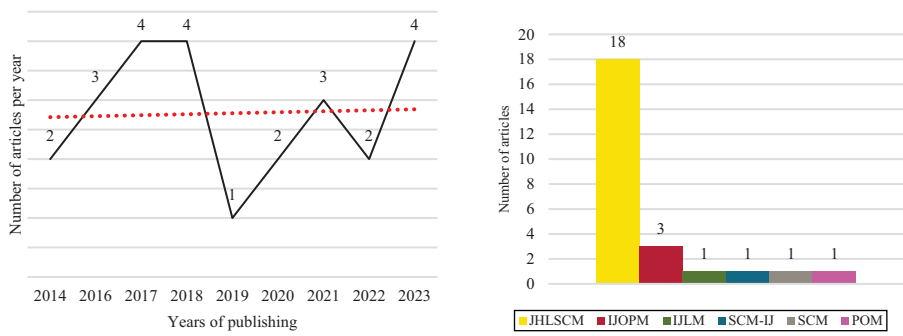

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Figure 3 Research in different disaster stages over time

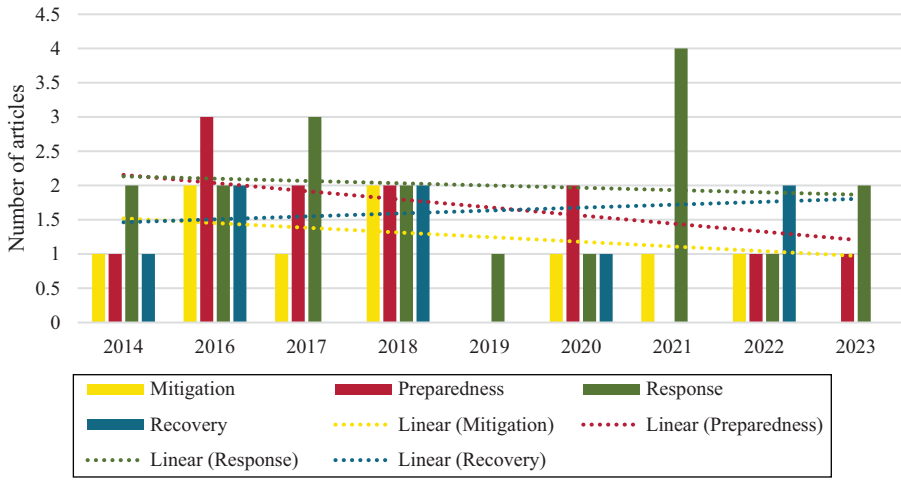

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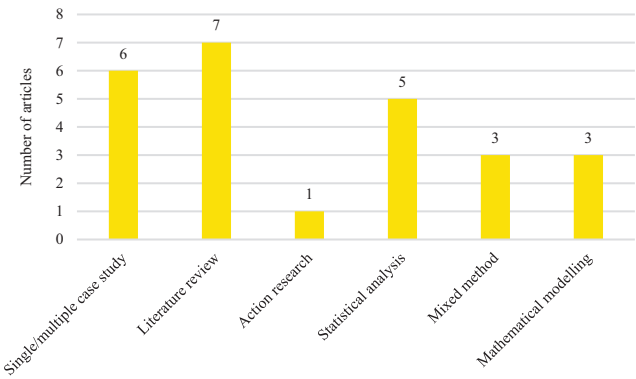
Figure 4 Research methods used by articles



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3.2 Analysis of domains in the humanitarian supply chain performance management and digitalization

From a literature perspective, the study divided the digitalization of HSCPM articles into two domains: HSCPM concepts when applying digitalization, and the digitalization approach used. The first domain describes the HSCPM concepts on which the articles focused when applying digitalization. Overall, the emphasis was on digitalizing five HSCPM concepts: performance in general, performance metrics, performance measurement, performance management and performance measurement/management framework. Performance in general refers to articles that focus on applying digitalization to improve the overall HSC performance (Baharmand *et al.*, 2021; Dubey *et al.*, 2018; Hosseini *et al.*, 2023; Iqbal and Ahmad, 2022). For example, Baharmand *et al.* (2021) stated that digitalization can contribute to higher HSC performance, e.g. transparency; by applying digitalization, HSC actors can make performance more visible and traceable, thus improving transparency.

Performance metrics refer to articles using digitalization to support HOs in defining and tracking the metrics, e.g. total logistics cost, financial efficiency, order fulfillment rate and on-time delivery (Gavidia, 2017; Hong, 2023; Stumpf *et al.*, 2023). For instance, Gavidia (2017) found that digitalization could support HSC actors in tracking and informing their employees and even other HSC actors by sharing the defined performance metrics. Performance measurement was found in the articles (Schniederjans *et al.*, 2016; Jahre, 2017), referring to digitalizing performance measurement activities. They agreed that digitalizing the performance measurement can enable information sharing and improve collaboration among HSC actors when conducting performance measurement activities, such as communicating performance measurement reports.

Performance management (PM) refers to articles that consider HSC actors to apply digitalization in the HSCPM practice, e.g. jointly defining performance metrics and setting targets (Abidi *et al.*, 2014; Abidi *et al.*, 2020). Applying digitalization in the PM is important because HSC actors can implement it in different settings, e.g. HOs' PMs in other countries (Abidi *et al.*, 2020). Some studies included digitalization into the HSCPM frameworks, e.g. supply chain operations reference (SCOR) and a balanced scorecard (Lu *et al.*, 2016; Anjomshoae *et al.*, 2017). For example, Anjomshoae *et al.* (2017) highlighted the importance of digitalization in supporting performance measurement from the internal process perspective, including delivery time and accuracy, sourcing and resource utilization. Finally, the study made a concerted effort to extract the current description of topics from the HSCPM domain perspective. However, they were not directly presented because of the articles' significant focus on the HSCPM domain. At times, the aspect of digitalization was not sufficiently elaborated upon. As a result, the study was primarily a descriptive analysis providing a current overview of the research.

The second domain describes which digitalization approaches the articles referred to when improving HSCPM concepts. There

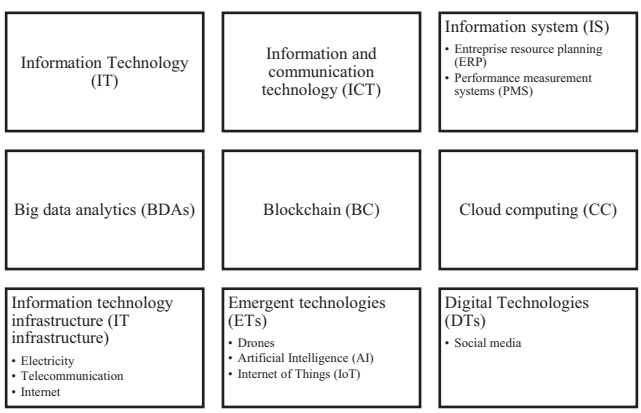
are nine primary digitalization approaches studied in the current articles: information technology (IT), information and communication technology (ICT), information system (IS), big data analytics (BDAs), blockchain (BC), cloud computing (CC), information technology infrastructure (IT infrastructure), emergent technologies (ETs) and digital technologies (DTs). Unlike in the HSCPM domain, it was more challenging to describe the digitalization approaches, especially in the context of HSCPM. The study illustrates the digitalization approaches found in the extant studies in Figure 5 and summarizes the descriptions of the digitalization of HSCPM found in the articles in Table 2.

Based on Table 2, most articles (Dubey *et al.*, 2018; Dubey *et al.*, 2022a; Schön *et al.*, 2018; Baharmand *et al.*, 2021; Dennehy *et al.*, 2021; Maghsoudi and Moshtari, 2021; Hong, 2023) attempted to define primary digitalization approaches, including BDAs, BC, IT infrastructure, ETs (e.g. AI) and DTs, but generally, in HSC contexts. Only a few articles (Comes *et al.*, 2018; Schniederjans *et al.*, 2016; Shavarani, 2019) described the digitalization approaches, e.g. CC and ETs, connected to HSC performance, and the rest of the articles did not describe or define some digitalization approaches at all, either in general or in HSCPM studies, such as IT, ICT, IS (e.g. ERP and PMS) and ETs (e.g. Internet of Things [IoT]). Instead, the articles relied on readers' (e.g. HSC actors and researchers) understanding of digitalization approaches of HSCPM concepts. Furthermore, some articles interchangeably used different digitalization approaches (e.g. IT, ICT and IS). These issues can contribute to misinterpretation and strengthen the idea that digitalization lacks common understanding, especially within the HSCPM context (Abidi *et al.*, 2020).

3.3 Analysis of links between digitalization and humanitarian supply chain performance management and digitalization approaches per se

The study analyzed the links between digitalization approaches and HSCPM concepts in the current articles. The articles used positive relationships, e.g. the digitalization approaches can improve the HSCPM concepts, the roles/benefits of each digitalization approach for each HSCPM concept or applying digitalization of HSCPM to highlight the links between the two domains. The study captured the links between each digitalization approach and the HSCPM concept found in the articles by ticking the box (Table 4). For example, there are links between IT and performance in general (✓), and no links were found in the articles between DTs and performance in general (−).

Figure 5 Digitalization approaches found



Source: Figure created by author

Based on Table 4, each indicated link between two domains in the articles was explained. IT application induced general performance by improving information flow (Stumpf *et al.*, 2023). IT supported the implementation of performance metrics (Lu *et al.*, 2016) and performance measurement by enabling information sharing between HSC actors (Villa *et al.*, 2017). It also provided accurate forecasts and information to promote HSCPM (Abidi *et al.*, 2020) and was used in the HSCPM framework to support internal learning and innovation (Anjomshoae *et al.*, 2017). ICT application in HSCPM generally enhanced performance, e.g. accountability (Iqbal and Ahmad, 2022) and performance measurement (Jahre *et al.*, 2016; Gavidia, 2017) studied IS tools such as enterprise resource planning (ERP) to improve HSC performance, e.g. reliability. Lu *et al.* (2016) investigated IS like performance measurement system (PMS) to improve performance metrics documentation. Jahre (2017) mentioned that IS integrates performance measurement between actors; furthermore, it can help standardize HSCPM activities (Abidi *et al.*, 2020). In the HSCPM framework, Anjomshoae *et al.* (2017) argued that HSC actors require IS to improve knowledge sharing. Applying BDAs could improve performance in general, e.g. visibility (Dubey *et al.*, 2018), adding value and innovation performance metrics and HSCPM (Abidi *et al.*, 2020).

The application of BC could overcome difficulties, e.g. lack of transparency, during the decision-making and monitoring of HSC actors, thus improving performance in general (Baharmand *et al.*, 2021). The application of CC positively influenced performance in general and performance measurement, because it enables communication between HSC actors (Schniederjans *et al.*, 2016). IT infrastructure was pivotal for improving general performance, e.g. accuracy of resource availability (Comes *et al.*, 2018; Miko and Abbas, 2023), performance metrics (Schön *et al.*, 2018) and performance measurement (Abidi *et al.*, 2014). IT infrastructure was depicted in the HSCPM framework as a must-have resource to automate HSCPM practices (Lu *et al.*, 2016). ETs, including drones, AI and IoT, can enhance performance in general and trace performance metrics (Shavarani, 2019; Hong, 2023). Hosseini *et al.* (2023) and Maghsoudi and Moshtari (2021) conceptualized frameworks to explore new ETs and guide the applications of DTs such as social media for better performance in general.

Although the study could capture the links, they went no further than identification. This was due to the article's lacking depth in investigating them. The lack of in-depth/detailed links could indicate that the research in the digitalization of HSCPM was still fragmented, which concurs with Abidi *et al.* (2020). These may be caused by underlying assumptions that digitalization inherently leads to improved performance, as shown by articles arguing that digitalization positively could improve HSCPM without providing much detail about how digitalization exactly can enhance the HSCPM. For example, Stumpf *et al.* (2023) identified IT improved HSC performance by enhancing information flow.

Table 2 Digitalization description in literature

The primary digitalization approaches	Description
Information technology (IT)	No description was found
Information and communication technology (ICT)	No description was found
Information system (IS)	IS in the articles refers to ERP and PMS ERP: no description was found. PMS: no description was found
Big data analytics (BDAs)	BDAs refer to a digitalization approach that analyzes, manages and processes massive, complex, real-time unstructured and structured data to draw meaningful insights. These insights (e.g. trends and patterns) facilitate HSC actors to make better decisions and provide alternatives when HSC is disrupted (e.g. disaster events) (Dubey *et al.*, 2018a; Dennehy *et al.*, 2021)
Blockchain (BC)	BC is a shared record where information exchange is digitally saved, encrypted and connected between HSC actors to increase connectivity (Baharmand *et al.*, 2021)
Cloud computing (CC)	CC is a large and shared storage platform and service that disseminates information effectively and efficiently through the internet. The effective and efficient information flow is the enabler in the success of the HSC performance (Schniederjans *et al.*, 2016)
Information technology infrastructure (IT infrastructure)	IT infrastructure refers to infrastructure, e.g. electricity, telecommunication and the internet, which facilitates HSCs' digitalization (Schön *et al.*, 2018)
Emergent technologies (ETs)	ETs refer to drones, AI and IoT Drones support HSC actors in combatting challenges by enabling data collection accessibility in isolated areas, measuring HSC performance and collecting real-time information (Comes *et al.*, 2018; Shavarani, 2019). AI is an ET that HSC actors use to collect numerous data to learn and predict uncertainties and utilize the insights to make better decisions (Hong, 2023). IoT: no description was found
Digital technologies (DTs)	DTs in the articles refer to social media. Social media is one example of digitalization in the form of platforms to advance the connectivity of rapid information sharing through real-time data collection, sharing and dissemination among HSC actors (Maghsoudi and Moshtari, 2021)

Source: Table created by author

However, it did not discuss what constitutes improved information flow and how this improvement correlates with improved HSC performance. Another cause may be the rapid development of digitalization and complexities, e.g. limited funding, unpredictable events and different HSC actors' goals, which made it difficult for researchers to tap the opportunity to study digitalization (Marić *et al.*, 2022), especially in applying it to the HSCPM.

Additionally, Table 4 implies (−) as no links have been made between the two domains in the extant articles. The missing links showed a shortage of studies in the digitalization of HSCPM areas, particularly in DTs of performance in general; ICT, BC and CC of performance metrics; BDAs, BCs, ETs and DTs of performance measurement; ICT, BC, CC, IT infrastructure, ETs and DTs of improve HSCPM; and ICT, BDAs, BC and CC of the HSCPM frameworks. The absence of some digitalization approaches in the HSCPM concepts is expected because digitalization is an emerging field and relatively new in the HSC studies (Shrivastav and Bag, 2023). Additionally, the scarcity of resources, such as the absence of necessary skills to implement digitalization, along with financial limitations, like the high cost of investment, have contributed to the limited research conducted in this field (Ülkü *et al.*, 2024).

Finally, the study also found that the nine digitalization approaches in extant articles did not stand alone. Instead, they connected and supported each other, strengthening the prior definition that digitalization refers to using diverse digital tools, systems and technologies to support HSCPM, which concurs with Dubey *et al.* (2019). Nevertheless, the current articles did not deeply discuss the links between digitalization approaches *per se*, and the articles relied on the readers to draw the links between multiple digitalization approaches to improve HSCPM concepts. The study attempted to draw the digitalization approaches links *per se* that occurred in the articles in Figure 6.

Figure 6 reveals that some articles combined multiple digitalization approaches to improve HSCPM, and those digitalization approaches support each other, illustrated by two-direction arrows, e.g. IT and IS, IT and ETs and ICT and DTs. Some digitalization approaches needed support from other digitalization approaches, illustrated by a one-direction arrow, e.g. ETs needed BDAs to enable data collection and analysis (Dennehy *et al.*, 2021), and CC needs to be facilitated by good IS so that it can improve the information sharing between HSC actors (Jahre, 2017). Furthermore, the study interpreted more or fewer articles mentioning the multiple digitalization approaches used in the research to draw the degree of links (e.g. stronger or weaker) between the digitalization approaches *per se*. The more articles used the same multiple digitalization approaches, the stronger the links

Table 3 Summary of HOs' reports as insights from practice

HSC actors	Mandate/context/area	The application of digitalization approaches to HSCPM concepts	Challenges
ADEA	Education in Africa	ICT and IT infrastructure → Performance measurement	Poor IT infrastructure, electricity, financial constraints, digital divide and literacy and lack of accessibility
CHA	Human security, national and local empowerment	DTs → Performance in general	Digital harm, people-centered perspectives, political willingness, resource constraints, data privacy, cyberattacks, isolated DTs application, lack of integration and context-specific views
EUAA	Asylum reinforcement	ETs → Performance in general	Data privacy, security, protection, digital divide and literacy, unreliable databases, cyberattacks and geopolitical tensions
GICHD	Mining	IS → Performance metrics and HSCPM	Data standardization, remote areas and operational costs
GNWP	Women's rights	IT → Performance metrics and performance measurement	Digital harm, divide and literacy
IGAD	Agriculture and environment, economics, health and social, peace and security and services in Eastern African countries	ICT and IS → Performance measurement and HSCPM	Trust and political willingness
OCHA	Global emergency response monitoring	DTs and ETs → HSCPM	Organizational culture, data standardization, availability and security, digital harm, divide, financial constraints, people-centered perspectives
UNDP	Sustainable development, democratic governance, peacebuilding and disaster resilience	IS and IT infrastructure → performance metrics and HSCPM	Geopolitical tensions, financial constraints, digital divide and context-specific views
UNICEF	Children's rights and protection	IS → performance in general and HSCPM	Financial constraints, data availability and dissemination and lack of documentation
WHO	Health aid	IT and IS → performance metrics, performance measurement and HSCPM	Financial constraints, organizational culture, alignment, data dissemination and accessibility, lack of documentation and political willingness

Source: Table created by author

that are represented (e.g. between ETs and BDAs or IS and IT infrastructure links), illustrated by thicker lines in Figure 6. Likewise, the less that articles cooperated in multiple digitalization approaches, the less strong the represented links (e.g. IS and CC or IT and DTs), illustrated by the thinner lines in Figure 6. Finally, by drawing the links and indicating the degree of the links between the digitalization approaches, the study discovered the possibilities of combining more than one digitalization approach to improve HSCPM, e.g. combining IT and IS. This also showed the necessity of another digitalization approach connected to the intended digitalization approach to be applied in the HSCPM concepts, e.g. future studies strongly need to understand BDAs before studying ETs.

4. Reports findings and analysis

Section 4 analyzed findings gathered from reports to represent the current state of digitalization of HSCPM in all disaster stages from practical perspectives. Table 3 summarizes the insights from reports to complement the discussion and divide them into three groups: mandate/context/area, the digitalization of HSCPM and challenges.

Based on Table 3, the study analyzed that HSC actors have different mandates/contexts/areas (e.g. women's rights, health aid and children's rights and protection) when working together to combat disasters in different stages. These differences were part of the HSC characteristics and complexities that can hinder HSC actors from performing HSCPM activities (Patil *et al.*, 2021). For example, owing to different prioritized mandates/contexts/areas, HSC actors would have different objectives, priorities, systems and performance measurements, which hinders them from integrating HSCPM and improving the CE and LTE (Jayadi and Forslund, 2023).

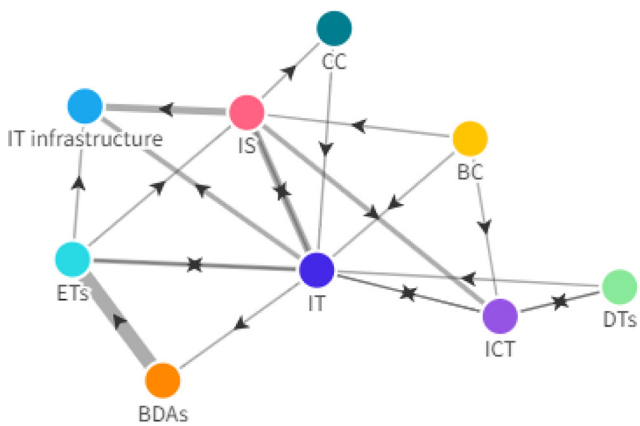
The digitalization of HSCPM was an applicable alternative for addressing HSC characteristics, e.g. HSC actors' different mandates/contexts/areas in integrating HSCPM and encountering the complexity of HSCs (Anjomshoae *et al.*, 2022). The importance of digitalization of HSCPM was recognized in the HO reports. HSC actors have been aware of and invested in digitalization approaches (e.g. ICT, DTs, ETs, IT, IT infrastructure and IS) to improve HSCPM. They used the digitalization of HSCPM in conducting activities, including measuring and managing training programs, people mobilization, aid and food delivery. However, HSC actors applied different digitalization approaches to improve the HSCPM concepts. For

Table 4 The links between digitalization and HSCPM in the literature and practice

HSCPM concepts						
HSCPM framework	**HSCPM**	**Performance measurement**	**Performance metrics**	**Performance in general**		**Digitalization approaches**
✓ (Anjomshoae *et al.*, 2017)	✓ (Abidi *et al.*, 2020; WHO, 2023a; WHO, 2023b)	✓ (Villa *et al.*, 2017; Schiffling *et al.*, 2014; Miko *et al.*, 2023; GNWP, 2023; WHO, 2023a; WHO, 2023b)	✓ (Lu *et al.*, 2016; GNWP, 2023; WHO, 2023a; WHO, 2023b)	✓ (Stumpf *et al.*, 2023)	**IT**	
-	- (IGAD, 2023)	✓ (Jahre *et al.*, 2016; Villa *et al.*, 2017; ADEA, 2023; IGAD, 2023)	-	✓ (Iqbal *et al.*, 2022; Hosseini *et al.*, 2023)	**ICT**	
✓ (Anjomshoae *et al.*, 2017)	✓ (Abidi *et al.*, 2020; GICHD, 2023; IGAD, 2023; UNDP, 2023; UNICEF, 2023; WHO, 2023a; WHO, 2023b)	✓ (Jahre, 2017; Gavidia, 2017; WHO, 2023a; WHO, 2023b)	✓ (Lu *et al.*, 2016; GICHD, 2023; UNDP, 2023; WHO, 2023a; WHO, 2023b)	✓ (Gavidia, 2017; Sigala *et al.*, 2020; Rodríguez-Espíndola *et al.*, 2018; Stumpf *et al.*, 2023; UNICEF, 2023)	**IS**	
-	✓ (Abidi *et al.*, 2020)	-	✓ (Abidi *et al.*, 2020)	✓ (Dubey *et al.*, 2018a; Dennehy *et al.*, 2021)	**BDAs**	
-	-	-	-	✓ (Baharmand *et al.*, 2021)	**BC**	
-	-	✓ (Schniederjans *et al.*, 2016; Jahre, 2017)	-	✓ (Schniederjans *et al.*, 2016)	**CC**	
✓ (Lu *et al.*, 2016)	- (UNDP, 2023)	✓ (Abidi *et al.*, 2014; ADEA, 2023)	✓ (Miko *et al.*, 2023; Schön *et al.*, 2018; UNDP, 2023)	✓ (Comes *et al.*, 2018; Miko *et al.*, 2023)	**IT Infrastructure**	
✓ (Hosseini *et al.*, 2023)	- (OCHA, 2023a; OCHA, 2023b)	-	✓ (Hong, 2023)	✓ (Shavarani, 2019; Hosseini *et al.*, 2023; Dubey *et al.*, 2022; Comes *et al.*, 2018; EUAA, 2023)	**ETs**	
-	- (OCHA, 2023a; OCHA, 2023b)	-	-	✓ (Maghsoudi *et al.*, 2021; CHA, 2023)	**DTs**	

Source: Table created by author

Figure 6 The links between digitalization approaches per se



Source: Figure created by author

instance, WHO applied IT and IS in the performance metrics, performance measurement and HSCPM. Meanwhile, OCHA applied DTs and ETs of HSCPM. The various applications of digitalization of HSCPM were common in the HSC field, as HSCs are often context-specific (e.g. different mandate/context/area, objectives and needs), and thus HSC actors selected and invested in appropriate digitalization approaches to boost the HSCPM practice, which concurs with Abidi *et al.* (2014), Jayadi and Forslund (2023).

Furthermore, HSC actors indicated that digitalization has the potential to improve HSCPM but also poses challenges when applied to the HSCPM. HSC actors believed that digitalization could improve HSCPM through strengthening the performance measurement report system (IGAD, 2023), evaluating performance measurement (OCHA, 2023a), monitoring performance metrics and gathering relevant data (GICHD, 2023), supporting clear targets (WHO, 2023a) and enabling real-time information sharing (UNICEF, 2023). However, challenges when applying digitalization in HSCPM in different stages were evident. HSC actors highlighted challenges regarding resources (e.g. lack of IT infrastructure, financial, electricity and resources), security (e.g. the risk of data privacy, cyberattacks, data protection and digital harm), accessibility (e.g. lack of data availability, accessibility in remote areas and dissemination and digital divide), data management (e.g. lack of reliable database, data standardization and documentation) and organizational issues (e.g. lack of political willingness, integration and goal alignment between HSC

actors, trust, people-center perspectives and organizational culture constraints).

5. Discussion

The discussion addresses RQ1 *in Section 5.1,* RQ2 *in Section 5.2 and* RQ3 *in Section 5.3.*

5.1 What is the current status of research on digitalization of humanitarian supply chain performance management?

Findings show diversity in conducting the digitalization of HSCPM, which is understandable because it is considered a relatively new theme in HSCPM research (Shrivastav and Bag, 2023). Thus, the topic opens opportunities for researchers to explore the potential of digitalization in HSCPM, which is in line with Anjomshoae *et al.* (2022). However, despite the enormous opportunities of this topic, there has been limited research on different disaster stages. The lack of research on different disaster stages can be caused by the complex characteristics of HSC that use different PM practices among HSC actors, the unpredictable environment and the lack of data availability to measure performance (Patil *et al.*, 2021). Some challenges include applying digitalization to fit the HSCPM frameworks and limited resources, and these can also contribute to difficulty in implementing research in the HSC context (Kabra and Ramesh, 2016; Ülkü *et al.*, 2024). Consequently, recent research and investigations into digitalizing various HSCPM concepts remain in the broader context of IT applications to improve general performance. Marić *et al.* (2022) pointed out that the diversity in the research prompts acknowledgment of digitalization, but it also contributes to a slow adoption of the HSC context and a low degree of research maturity.

Furthermore, the current research shows a lack of empirical testing. Most articles identified and investigated the digitalization of HSCPM, but few articles provide evidence and examples in their study, e.g. Baharmand *et al.* (2021) conducted a pilot study of the application of BC in improving general performance. Because researchers must produce knowledge quickly to capture rapid digitalization development and contextualize it to HSCPM, it is challenging to rapidly acquire sophisticated knowledge of digitalization due to the lack of resources (Dennehy *et al.*, 2021). Moreover, few HSC actors have actively contributed to investing in the digitalization of HSCPM research, as the research outcomes are uncertain, and they have other priorities (Sigala *et al.*, 2020). Consequently, the research is often considered completed before further applications.

There was no consensus on a common understanding of digitalization approaches to improve HSCPM. For instance, existing studies introduced ICT applications but did not explain their meaning. Furthermore, some articles interchangeably used digitalization approaches (between IT and IS) to improve PM. Only a few articles articulated an understanding of the digitalization approaches of HSCPM, e.g. BDAs (Dennehy *et al.*, 2021), BC (Baharmand *et al.*, 2021) and IT infrastructure (Schön *et al.*, 2018). Anjomshoae *et al.* (2022) mentioned that such issues are caused by a lack of prioritization in building a shared understanding or standardizing the application of digitalization in HSCPM.

Furthermore, previous studies linked digitalization and HSCPM vaguely among the digitalization approaches *per se*, resulting in fragmented studies of two domains. The main causes are that both domains share enormous multidimensional perspectives, and numerous digitalization approaches have emerged to address HSCs' issues (Perano *et al.*, 2023). As a result, the causes can hinder the extant studies from providing detailed relationships between digitalization and HSCPM and digitalization approaches *per se* in improving HSCPM. In addition, the causes can hamper the researchers and HSC actors from gathering information on digitalization contributions in supporting HSCPM activities and measuring expected LTE and CE, which is in line with Khan *et al.* (2022).

Overall, based on the systematic literature review, the research has started recognizing the advancements in the digitalization of HSCPM, in line with Anjomshoae *et al.* (2022). However, the progress of the research has been slow and fragmented during the past decade. Furthermore, there is a lack of in-depth studies of links between digitalization and HSCPM, as well as, digitalization approaches *per se*. These gaps hamper the research to gather contributions on how digitalization can support HSCPM activities, capture the latest updates on the digitalization of HSCPM, define the digitalization of HSCPM and measure expected LTE and CE.

5.2 What are the gaps between literature and practice?

Based on the findings of the articles, although the awareness of this topic has increased, e.g. new digitalization approaches were introduced to advance HSCPM started in 2018 (Anjomshoae *et al.*, 2022), the study shows that the existent research and its relevancy to the practical field have yet to be addressed. Some gaps contribute to the underrepresented research, and these are described below.

Benefits and challenges. Most articles have positively argued that applying digitalization in the HSCPM is beneficial. For example, the appropriate application of IT can improve learning and financial performance measurement (Schiffling and Piecyk, 2014). Jahre (2017) stressed the importance of IS in increasing collaboration in HSCPM activities. ICT application improves the accountability of performance metrics (Jahre *et al.*, 2016). BDAs support HSC actors in managing their performance metrics at all levels (Abidi *et al.*, 2020). BC can improve HSC actors' trust when implementing HSCPM (Baharmand *et al.*, 2021), and IT infrastructure, ETs and DTs facilitate a sustainable performance measurement system (Maghsoudi and Moshtari, 2021; Schön *et al.*, 2018).

Despite the previous articles encouraging digitalization for HSCPM, the challenges were less emphasized. If the articles discussed the challenges, it was often limited to discussion from a financial and organizational perspective. Abidi *et al.* (2014) indicated that the main challenge of digitalization applications in HSCPM was a result of financial constraints. HOs often encounter investment issues as they receive funding from donors. Applying digitalization produces other expensive concerns, e.g. IT infrastructure construction (Schön *et al.*, 2018) and maintenance costs (Baharmand *et al.*, 2021). Schiffling and Piecyk (2014) mentioned that HSC actors (donors) demand a direct impact of their investment in the digitalization of HSCPM; however, the outcomes are difficult to identify. Consequently, this

decreases their engagement to invest. Additionally, the nature of the HSC field is context-specific (e.g. organization culture, mandates and type of disasters), which hinders the application of digitalization of HSCPM at the organizational level. This is consistent with Anjomshoae *et al.* (2022) and Jayadi and Forslund (2023).

HSC actors emphasized potential challenges over benefits (CHA, 2023), which the articles have not addressed. For instance, data accessibility among HSC actors, lack of HSCPM documentation (UNICEF, 2023), risks of digital harm (GNWP, 2023; OCHA, 2023a), issues of application in remote areas (GICHD, 2023), data reliability, privacy and security (EUAA, 2023), political tensions (UNDP, 2023) and digital divide and literacy (IGAD, 2023) have been indicated as specific challenges. In summary, there are different focuses in terms of benefits and challenges between the theories and practice. Articles indicate benefits and challenges related to financial and organizational issues, while practice enlightens other challenges. This gap may hinder the research to leverage the potential of digitalization and affect HSC actors' willingness to invest in the digitalization of HSCPM, which is in line with Schniederjans *et al.* (2016).

Discussion between technical and non-technical perspectives. The articles highlighted technical perspectives (Dubey *et al.*, 2019), while HSC actors emphasized non-technical viewpoints. Abidi *et al.* (2020) stated the importance of applying digitalization by fostering technical resources to implement HSCPM projects, e.g. workshops and training, IT capabilities and infrastructure, technical skills, detailed modules of ERP, communication equipment and power supplies (Baharmand *et al.*, 2021; Dubey *et al.*, 2018; Comes *et al.*, 2018; Dennehy *et al.*, 2021; Gavidia, 2017). On the other hand, HSC actors included more non-technical perspectives, including organizational culture and gender equality in accessing and applying digitalization to improve HSCPM, cybersecurity policies and strategic planning and integration activities (EUAA, 2023; OCHA, 2023a). Thus, it is challenging for HSC actors to apply digitalization if the research has not been expanded to study non-technical perspectives.

The emergence of the digital divide at the beneficiaries' side. The digitalization of HSCPM research is often assumed to be applied to the HSC actors' but not the beneficiaries' side. The present articles show the importance of how digitalization relates to HSCPM at the organizational level, e.g. leadership (Dubey *et al.*, 2022b), strategic planning (Dennehy *et al.*, 2021), standard operating procedures (Maghsoudi and Moshtari, 2021), integration of ERP (Sigala *et al.*, 2020), alignment among HSC actors (Rodríguez-Espíndola *et al.*, 2018) and a pilot project of BC application to benefits HOs but not beneficiaries (Baharmand *et al.*, 2021). However, there is still a lack of focus on the digitalization of HSCPM from the beneficiaries' perspective. It is essential to consider beneficiaries, as they are the center of all HSCPM activities (Schiffling and Piecyk, 2014). HSC actors have suggested decreasing the digital divide by adopting beneficiaries' perspectives of ethics, community resilience and gender (CHA, 2023; WHO, 2023a).

The effectiveness of digitalization applications in the HSCPM field. Articles addressed the potential of HSCPM digitalization, but the discussion around the effectiveness of digitalizing is thin with only a few studies considering its effectiveness (Schniederjans *et al.*, 2016; Villa *et al.*, 2017; Abidi *et al.*, 2020). Furthermore, it is difficult to generalize a single digitalization approach to HSCPM, as HSC actors have different characteristics, e.g. systems, capacity and resources (OCHA, 2023a; WHO, 2023 b). There has also been an ongoing discussion about whether the digitalization of HSCPM should be centralized or decentralized to achieve effectiveness (Gavidia, 2017; Hosseini *et al.*, 2023; Stumpf *et al.*, 2023).

Although funds have been invested in digitalizing the HSCPM, some risks may occur during the application, for example, cyberattacks on IT infrastructure (EUAA, 2023), loss of electricity (ADEA, 2023), the abandonment of digitalization project development (Schniederjans *et al.*, 2016), damaged/destroyed IT infrastructure due to disasters (UNDP, 2023), incomplete data (OCHA, 2023b) and high staff turnover (Iqbal and Ahmad, 2022). Thus, this raises questions for research and practical fields regarding which digitalization approach is most effective and how it can be maintained in context-specific and uncertain HSCPMs at different disaster stages.

Lack of application from study to practice. Finally, gaps may result in the lack of application to practice. The study found that articles suggested various digitalization approaches to improve HSCPM compared to what HSC actors have invested/applied, resulting in Table 4. The green labels show that digitalization approaches have been studied in the articles and applied in the practical fields. The yellow labels indicate that digitalization was studied but not applied in practical fields, and the red labels indicate vice versa. Thus, it provides insights that HSC actors do not use all digitalization approaches, as suggested by the articles. In addition, the articles overlook ICT, IT infrastructure, ETs and DTs of HSCPM.

5.3 What are the research directions in the field of digitalization of humanitarian supply chain performance management?

The application of digitalization has gained attention in HSCPM research. However, there are many gaps and challenges that researchers have yet to address. The research in the articles should advance the closing of those gaps and challenges in supporting the HSC actors to apply digitalization in HSCPM to improve LTE and CE. Some insights are discussed in the following sections:

Boosting the contributions of different journals, disaster stages and research methods. Based on the findings, the growth of research on the current topic is slow and lacking examples, which calls upon researchers to contribute studies to various relevant journals (Fosso-Wamba *et al.*, 2021). Furthermore, the research on the digitalization of HSCPM emphasizes the response stage. Therefore, it should advance to different disaster stages, especially in the mitigation, preparedness and recovery stages, in keeping with Banomyong *et al.* (2017), Behl and Dutta (2019). Literature reviews and multiple case studies have been widely used during the past decade. The current study encourages exploring and investigating the topic by using more diverse methods, e.g. observation and secondary data reviews, surveys, mathematical modeling, content and statistical analyses. Moreover, future research can scrutinize empirical studies, e.g. action, participatory and pilot studies, to increase the number of examples regarding applications of digitalization of HSCPM, consistent with Agarwal *et al.* (2019); Anjomshoae *et al.* (2022); Marić *et al.* (2022).

Progressing to build a common understanding of digitalization in HSCPM and in-depth investigation in studying links between digitalization and HSCPM as well as digitalization approaches per se. Future research should attempt to conceptualize and standardize the understanding of digitalization approaches to improve HSCPM. Frennesson *et al.* (2021) identified the importance of building a common understanding because it can help HSC actors to synchronize their knowledge before conducting further research. Dennehy *et al.* (2021) suggested operationalizing the digitalization of HSCPM using CSC knowledge. Furthermore, involving experts from the digitalization field can support the development of understanding regarding the application of digitalization to boost HSCPM (Baharmand *et al.*, 2021). In addition, future studies can conduct an in-depth investigation into studying links between digitalization and HSCPM and among digitalization approaches *per se* by providing conceptual frameworks to apply digitalization of HSCPM and identify the links between digitalization approaches to seek the right combinations of digitalization approaches of HSCPM, which concurs with Perano *et al.* (2023). It is essential to recognize which digitalization approaches are needed or to be linked in the HSCPM to plan the investment, which is consistent with Rasool *et al.* (2022).

Considering potential challenges, non-technical issues and beneficiaries' perspectives derived from practical fields. The lack of focus on various challenges, non-technical and beneficiaries' perspectives has impacted the HSC actors' willingness to apply digitalization to their HSCPM activities, which concurs with Schniederjans *et al.* (2016). Thus, it is crucial to research digitalization in HSCPM and reflect on challenges, non-technical and beneficiaries/people-centered perspectives expressed in HO reports. Some authors have reflected on these gaps and proposed future research. For example, Jahre (2017) proposed developing a framework to evaluate the costs, benefits, challenges and return on investment of applying the digitalization of HSCPM. Dubey *et al.* (2018) considered a non-technical perspective (human capital) in BDAs' application to enable HSC performance. Schiffling and Piecyk (2014) emphasized that HOs need to think from the beneficiaries' perspectives in applying digitalization to HSCPM.

Examining the effectiveness of the application of digitalization in HSCPM. Future studies should consider the lack of research investigating the effectiveness of digitalization in HSCPM, in keeping with Kabra and Ramesh (2016). Research can investigate the effectiveness between centralized and decentralized digitalization, contextual factors that affect effectiveness and how to maintain digitalization effectiveness in HSCPM (Gavidia, 2017; Villa *et al.*, 2017; GICHD, 2023). Other insights from HSC actors, e.g. financial resources, digital divide and literacy, data privacy and security, political tensions, data dissemination, cyberattacks and digital harm, add value for future research examining effectiveness. Several methods are available to examine this, including pilot, evaluation and empirical studies (Schön *et al.*, 2018; Baharmand *et al.*, 2021; Stumpf *et al.*, 2023).

Exploring different digitalization approaches of HSCPM based on the relevancy in practice. Based on Table 4, some digitalization approaches have yet to be addressed [marked with (−) to boost the applications in improving HSCPM, which agrees with Anjomshoae *et al.* (2022) and Patil *et al.* (2022)]. For example, there is a possibility of investigating ICT, BC and CC applications using performance metrics and exploring the utility of BDAs, CC, ETs and DTs using performance measurements. Last but not least, the research should prioritize what is needed in practice: ICT, IT infrastructure, ETs and DTs of HSCPM. These have been marked with red labels in Table 4.

In the end, based on the findings, analysis and discussion, this study has summarized the gaps and research directions for future studies, as seen in Table 5. The table also represents the gaps, the detailed description of gaps and the suggestions for possible research directions as pathways for future investigation.

6. Conclusion

This study used a systematic literature review related to the application of digitalization in HSCPM. It gathered relevant articles from 2013 to 2023, and HO reports in 2023 from different databases. The study provided an overview of previous articles to identify the current research status, reports to complement insights gained from articles and a discussion of gaps and research directions. The study contributes to existing knowledge in the field by highlighting state-of-the-art articles and reports and thus presenting research gaps in the literature. These gaps include a lack of publications in more diverse journals, limited research on the current topic in different disaster stages, lack of diverse methods and empirical studies, lack of shared understanding of digitalization in HSCPM, the links between digitalization and HSCPM and digitalization approaches *per se*.

In addition, the study found the gaps between literature and practice regarding benefits and challenges, technical and non-technical perspectives and beneficiaries' perspectives, lack of investigation of research effectiveness and application from research to practice. These gaps contributed to the gradual and fragmented research in the digitalization of HSCPM and enabled the study to offer research directions in the digitalization of HSCPM that are related to the practical field. A discussion of these gaps provided insights for the study to predict future research directions, which have been consolidated in Table 5. Table 5 could be used to influence suggestions/pathways for future studies in the research community to work hand-in-hand (e.g. among multi-disciplinary researchers or with practitioners) in researching the digitalization of HSCPM not only to improve LTE and CE but also to offer high relevancy in its application to the practical field. In other words, the study can enable its contribution to the social implications.

The research implications of the study were first to contribute to the digitalization of HSCPM research through the development of the methodology for gathering and reviewing documents in both literature (articles) and practical (HO reports) fields. Methodological development was explained in detail in the research protocol (Table 1) and the research processes (Figure 1). Hence, the research community could replicate the methodology for similar future studies. However, the study encountered some limitations. First, the current study collected articles from 12 high-ranking logistic and supply chain management journals and two well-known journal databases. Future studies can widen the data collection from other databases (e.g. Science Direct and JSTOR) and other journals

Table 5 The gaps and future research directions in the digitalization of HSCPM

The gaps	Detailed description of gaps	Possible research directions
Diversity of journal publications	1. The lack of studies in the digitalization of HSCPM in diverse journals	1. The contribution of research in various relevant journals (Fosso-Wamba *et al.*, 2021)
Focus on the different disaster stages	2. The focus of the extant studies in the digitalization of HSCPM is in the response stage (Jahre *et al.*, 2016)	2. The focus of future research in the digitalization of HSCPM especially in mitigation, preparedness and recovery stages (Banomyong *et al.*, 2017; Behl and Dutta, 2019)
Research methods	3. The most current research methods used in the digitalization of HSCPM are single/multiple case studies and literature reviews (Heaslip *et al.*, 2019; Kucukaltan *et al.*, 2022)	3. Future research methods can employ empirical studies (e.g., action, participatory and pilot studies) (Agarwal *et al.*, 2019; Anjomshoae *et al.*, 2022; Marić *et al.*, 2022)
Common understanding	4. The lack of common understanding regarding the digitalization approaches of HSCPM (Abidi *et al.*, 2020)	4. Future studies that conceptualize and standardize the understanding of digitalization of HSCPM (Frennesson *et al.*, 2021). Also, future studies can adapt the common understanding of the topics from the CSC field and involve experts in the digitalization field (Baharmand *et al.*, 2021; Dennehy *et al.*, 2021)
Links	5. The lack of detailed/in-depth investigation of the links between digitalization approaches to improve HSCPM concepts (Abidi *et al.*, 2020; Perano *et al.*, 2023) 6. The shortage of investigation of the links in several digitalization approaches to improve HSCPM 7. The lack of links between digitalization approaches per se (Perano *et al.*, 2023) 8. The different focus of the links between what are studied in the literature and what is practiced in the HSC fields	5. The development of frameworks to investigate links between digitalization approaches and HSCPM as well as among digitalization approaches to improve HSCPM (Rasool *et al.*, 2022; Perano *et al.*, 2023) 6. Future studies are encouraged to deepen the investigation on the links between the digitalization approaches and HSCPM concepts, indicated by (✓) in Table 4. Rule of thumb: Focus first on green (✓) and then on yellow (✓) labels. 7. The links between digitalization approaches per se to improve HSCPM that can be investigated for future studies are shown in Figure 6. Rule of thumb: Focus first on the thicker lines and then the thinner lines 8. Future studies can open new research areas on links between digitalization approaches and HSCPM concepts, as indicated by (–) in Table 4. Rule of thumb: Focus first on the red (–) and then the white (–) labels
Benefits and challenges	9. The literature focuses on benefits and financial and organizational challenges, while practice focuses on other challenges (Schniederjans *et al.*, 2016; CHA, 2023)	9. Future studies can consider developing a framework that considers the benefits but also the challenges (Jahre, 2017)
Considered perspectives	10. The literature focuses on technical and organizational (HSC actors) perspectives (Dubey *et al.*, 2019) and the focus of practice is non-technical and on beneficiaries' perspectives	10. Future studies can consider the focus of the current topic from the non-technical (e.g. human capital) and beneficiaries' perspectives (Schiffling and Piecyk, 2014; Dubey *et al.*, 2018b)
Effectiveness	11. There is a lack of research investigating the effectiveness of digitalization in HSCPM	11. Future studies can consider investigating centralized/decentralized digitalization effectiveness, contextual factors that affect the effectiveness and how to maintain the digitalization effectiveness of HSCPM (Gavidia, 2017; Villa *et al.*, 2017; GICHD, 2023). Also, future studies can consider research methods in Research direction number 3 to conduct empirical studies
Application	12. The different focus on digitalization approaches of HSCPM are studied in the literature and used in practice, as well as the lack of investigation of the effectiveness of digitalization in HSCPM. As a result, this leads to the lack of application from literature to practice	12. Future studies can increase the relevancy of applications and prioritize the research on the digitalization approaches of HSCPM, as indicated in Table 4, following the rule of thumb in research directions 6–8

Source: Table created by author

(e.g. *International Journal of Disaster Risk Reduction*, *Journal of Management Information Systems* and the *International Journal of Productivity and Performance Management*), which can collect more articles to capture a broader perspective and increase the generalizability of findings. Furthermore, future studies can consider other types of sources (e.g. books, conference proceedings and peer-reviewed articles in languages other than English), and the data collection period could be expanded to include more recent studies.

Second, the present study also collected HO reports from one sole database and simplified the scope of data collection due to the limitations of the database. Future studies can collect data from practice from other databases (e.g. logcluster.org and preventionweb.net) and improve the precision regarding the scope of data collection (e.g. locations, organization size and types of HSC projects). Future research can consider collecting HO reports from different years to gain greater insight into the development of digitalization in the HSCPM over time. It is also suggested that future studies boost the quality and relevance of the literature review studies to practice by combining other types of analyses (e.g. bibliometric analysis and content analysis), aligning the findings and analysis with the practice by adding primary data collection (e.g. interviews) and collaborating with multi-disciplinary researchers and practitioners in, e.g. disaster relief, computer science and business and management.

6.1 Executive summary

This systematic literature review is intended to review the current research in the digitalization of HSCPM by using two perspectives, literature and practice, to analyze the gaps and discuss the research direction for future research. The study revealed the gaps in and between literature and practice that led to gradual and fragmented research on the current topic. The gaps are related to the diversity of journal publications, the focus on disaster stages, research methods, common understanding, links, benefits and challenges, perspectives, effectiveness and application. The study obtained insights into possible research directions based on the indicated gaps. Possible research directions can be used by the research community to build pathways and conduct future studies. The main contribution is summarized in Table 5, which covers the gaps, their detailed description and possible research directions. To better use the future research directions in Table 5, the readers are encouraged to view Table 4 to understand the links between digitalization and HSCPM and Figure 6 to understand the links between digitalization approaches *per se* used in HSCPM concepts. Additionally, future studies could replicate the current study's research protocols (Table 1) and processes (Figure 1) to conduct similar systematic literature reviews.

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