

Digital transformation capabilities in humanitarian supply chains: a theory driven crossbreed literature review

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Abstract

Purpose – Despite the increasing adoption of digital technologies in humanitarian supply chains (HSCs), existing research remains largely descriptive and lacks theoretical explanation of how these technologies translate into sustained organizational capabilities. This study aims to address this gap by examining how information technologies and information systems contribute to the development of dynamic and socio-technical capabilities in humanitarian contexts.

Design/methodology/approach – This study operationalized Dynamic Capabilities Theory (DCT) and Socio-Technical Systems (STS) theory to guide data extraction, coding, classification and interpretation. A crossbreed literature review (CBLR) approach was then employed, integrating systematic review procedures, bibliometric analysis and thematic synthesis. The review analyzed 94 peer-reviewed articles published between 2013 and 2025.

Findings – The results identify six major domains of digital transformation in HSCs, including digital transparency, coordination and collaboration; decision support and cognitive analytics; logistics and inventory automation; facility location intelligence and smart warehousing; autonomous delivery and routing innovation; and digital identification and victim management systems. These domains illustrate how digital technologies may enable sensing, seizing and reconfiguring capabilities when aligned with socio-technical conditions. The findings also highlight critical gaps in under-researched areas, particularly cybersecurity governance, humanitarian robotics and automation, ethical data management, and the limited representation of North American, African and Latin American contexts.

Originality/value – This study views digital transformation as a capability-building process rather than a technology adoption outcome. It contributes theoretically by integrating DCT and STS into humanitarian logistics research, methodologically by demonstrating the application of the CBLR as a structured approach for theory-driven evidence synthesis, and practically by proposing a Digital Transformation Capability Framework that explains how technological, human and institutional elements jointly enable humanitarian performance outcomes.

Keywords Digital transformation, Humanitarian supply chains, Dynamic capabilities, Socio-technical systems, Digital capability development, Humanitarian logistics

Paper type Literature review

1. Introduction

The global frequency and magnitude of disasters natural and human induced have intensified over the last two decades, producing severe disruptions to communities, infrastructure and supply networks. Events such as hurricanes, earthquakes, wildfires, pandemics and industrial accidents continue to expose vulnerabilities in the capacity of humanitarian systems to respond efficiently and equitably. In 2023 alone, more than 380 recorded disasters affected nearly 200 million people and generated direct losses exceeding US\$190bn (Favetti *et al.*, 2025). These escalating shocks have pushed the humanitarian supply chain (HSC) to the forefront of academic and policy interest as an essential yet fragile mechanism for disaster preparedness, response and recovery.

Humanitarian logistics refers to the planning, implementation and control of the efficient flow and storage of

relief goods, services and information from points of origin to affected populations with the objective of alleviating human suffering during disasters and emergencies (Kovács and Spens, 2007; Thomas and Mizushima, 2005). HSCs represent the broader network of organizations, resources, activities and stakeholders involved in disaster preparedness, response, recovery and reconstruction efforts (Beamon and Balcik, 2008; Dubey *et al.*, 2022). While humanitarian logistics primarily focuses on operational activities such as transportation, warehousing, procurement and distribution, HSCs encompass the wider strategic and collaborative system through which humanitarian assistance is coordinated and delivered across

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governments, non-governmental organizations, international agencies, military units and private-sector partners (Beamon and Balcik, 2008; Kovács and Spens, 2007).

HSC operations are inherently complex: they integrate governmental bodies, nongovernmental organizations (NGOs), United Nations agencies, military units, private sector partners and volunteer groups. Each actor possesses distinct objectives, resources and jurisdictions, creating coordination asymmetry and fragmented information flows that hinder timely decision-making (Costa *et al.*, 2012; Paciarotti *et al.*, 2021). In addition, logistical bottlenecks, infrastructure damage and uncertain demand for relief commodities exacerbate these challenges (Beamon and Balcik, 2008; Sahebjamnia *et al.*, 2017). Scholars increasingly argue that traditional command and control structures are inadequate in such turbulent environments and must be augmented by digital and data driven approaches that enable visibility, collaboration and adaptability.

Within this study, information technologies (IT) refer to the technological tools and infrastructures used to generate, process, transmit and store information, including technologies such as artificial intelligence (AI), blockchain, cloud computing, Internet of Things (IoT) devices and mobile communication platforms (Alter, 2008; Laudon and Laudon, 2004). In contrast, information systems (IS) refer to the integrated combination of technologies, data, processes and human actors that collectively support organizational decision-making and operational coordination (Alter, 2008; Pearlson *et al.*, 2024). While IT represents the technological components, IS encompasses the broader socio-technical system (STS) through which these technologies are applied to achieve organizational objectives (Laudon and Laudon, 2004; Pearlson *et al.*, 2024).

Information technology (IT) and IS are no longer auxiliary communication tools but fundamental enablers of humanitarian agility. Technologies such as blockchain, AI, big data analytics, cloud computing, IoT and autonomous delivery platforms are reshaping how information is generated, shared and acted upon across relief networks (Dubey *et al.*, 2022; Mackey and Cuomo, 2020; Patil *et al.*, 2023). For example, blockchain-based platforms have been implemented by humanitarian organizations to improve transparency and traceability in aid distribution, while AI and big data analytics have been used to support disaster forecasting and resource allocation during emergency response operations. Similarly, IoT-enabled monitoring systems have been deployed in disaster-prone regions to provide real-time information on infrastructure conditions, inventory status and population needs, thereby supporting more informed and coordinated humanitarian decision-making. When implemented coherently, these technologies convert fragmented logistics structures into integrated ecosystems capable of predictive analysis, real time coordination and continuous learning. However, despite rapid digitalization, much of the humanitarian logistics literature remains descriptive documenting technologies rather than theorizing the mechanisms through which digital resources evolve into enduring organizational capabilities.

To address this conceptual gap, the present study anchors its analysis in dynamic capabilities theory (DCT) and STS theory. DCT explains how organizations cultivate the capacities to sense, seize and reconfigure resources to maintain

competitiveness in turbulent conditions (Eisenhardt and Martin, 2000; Teece *et al.*, 1997). In humanitarian settings, these dynamic processes translate into the ability to anticipate crises through data driven foresight, mobilize multi stakeholder resources swiftly, and redesign operations as contexts change. STS complements this view by asserting that technological performance depends on the alignment between technical subsystems (digital infrastructures, analytic tools) and social subsystems (people, culture, governance and norms) (Bostrom and Heinen, 1977; Trist and Bamforth, 1951). The intersection of these theories provides a powerful explanatory lens for understanding how digital and human dimensions jointly enable agility, transparency and resilience.

The selection of DCT and STS theory is theoretically grounded in their complementary explanatory strengths (Teece, 2007; Vial, 2021). While alternative perspectives such as the resource-based view (RBV) emphasize valuable organizational resources, they provide comparatively limited insight into how organizations continuously adapt their capabilities in rapidly changing humanitarian environments (Barney, 1991; Teece, 2007). In contrast, DCT offers a process-oriented perspective that explains how organizations sense emerging disruptions, seize opportunities through coordinated action, and continuously reconfigure resources under conditions of uncertainty (Teece, 2007; Teece *et al.*, 1997). However, DCT alone does not fully explain the social, institutional and governance conditions that influence the successful implementation of digital technologies, thereby necessitating complementary socio-technical perspectives (Bostrom and Heinen, 1977; Trist and Bamforth, 1951).

STS theory addresses this limitation by emphasizing the interdependence between technical infrastructures and social subsystems, including human expertise, organizational culture and institutional governance (Bostrom and Heinen, 1977; Trist and Bamforth, 1951). The integration of DCT and STS therefore enables a more comprehensive explanation of digital transformation by simultaneously capturing dynamic capability development and the socio-institutional conditions necessary for successful technology implementation (Vial, 2021; Warner and Wäger, 2019).

The selection of these theories is also supported by their growing application in digital transformation and supply chain research. DCT has been widely employed to explain how organizations develop adaptive capabilities under conditions of environmental uncertainty and technological change, while STS theory has been extensively used to examine the interaction between technological infrastructures, organizational processes and human actors. Together, these theories provide complementary explanatory mechanisms, enabling the analysis of both capability development processes and the socio-institutional conditions that influence the successful deployment of digital technologies in humanitarian environments.

The integration of DCT and STS allows this paper to conceptualize digital transformation capability as a multi layered construct that unites technological enablers, human competencies and institutional mechanisms. From a dynamic capabilities' perspective, IT and IS constitute resource bases that, when orchestrated effectively, foster organizational agility and adaptation. From a socio technical perspective, success requires compatible governance structures, cross agency collaboration,

and ethical standards ensuring that technology serves humanitarian objectives rather than administrative efficiency alone. Thus, digital transformation is conceived here as a *capability building process*, not a technology deployment event.

While digital humanitarianism is increasingly represented in studies from Asia and Europe, important geographical asymmetries remain. The present review found that 77.7% of the identified studies originated from these two regions, whereas North America, Africa, Latin America and Oceania collectively accounted for only 22.3% of the reviewed literature. This uneven distribution limits the generalizability of existing knowledge and highlights the need for greater empirical attention to humanitarian contexts operating under different institutional, technological and socioeconomic conditions. North American contexts despite advanced emergency management infrastructures such as FEMA (USA) and Public Safety Canada remain under examined. This gap limits generalization of findings and obscures the influence of institutional maturity, data protection regimes and decentralized governance on digital capability formation. Addressing this imbalance enriches the theoretical scope of humanitarian logistics research and grounds its insights in a wider set of sociopolitical realities.

Accordingly, this paper seeks to map, synthesize and theorize the evolution of digital transformation in HSCs while also identifying geographical imbalances in the existing body of knowledge and their implications for capability development across different humanitarian contexts. It asks: How do information technologies and information systems contribute to the development of dynamic and socio technical capabilities within humanitarian supply chain operations?

To answer this question, the study employs the crossbreed literature review (CBLR) method, which merges the transparency of systematic review protocols with the interpretive depth of thematic analysis and the quantitative validation of bibliometric mapping (Sentia *et al.*, 2025; Tranfield *et al.*, 2003). Ninety-four peer reviewed articles retrieved from the Scopus database (2013–2025) form the analytical corpus. The review identifies six dominant thematic domains that collectively depict the digitalization trajectory of humanitarian logistics. Each theme is interpreted through the integrated DCT–STS framework to explain the interplay between technological innovation and socio institutional adaptation. In this study, digital transformation capabilities are conceptualized as dynamic processes (sensing, seizing and reconfiguring), while outcomes such as agility, resilience and coordination effectiveness are treated as performance results enabled by these capabilities.

This paper contributes to the literature in three primary ways. First, it conceptualizes digital transformation as a dynamic capability system, highlighting the processes by which IT and IS foster organizational agility and resilience. Second, it demonstrates the application of the CBLR as a structured hybrid review methodology that integrates systematic review procedures, bibliometric techniques and theory-driven thematic synthesis. Third, it presents a Digital Transformation Capability Framework linking technological infrastructures, human competencies and institutional governance. The remainder of this article proceeds as follows: Section 2 details the methodology and CBLR protocol; Section 3 presents the bibliometric and thematic findings; Section 4 articulates research gaps and proposes a future research

agenda; Section 5 discusses the theoretical, methodological, and practical implications of the findings, while Section 6 concludes with managerial and policy insights.

2. Methodology

This paper employs a customized methodological design called the CBLR. The CBLR framework integrates three complementary methodological traditions systematic literature review, bibliometric analysis and thematic interpretation to create a comprehensive, theory-driven synthesis (Snyder, 2019; Tranfield *et al.*, 2003). Traditional literature reviews frequently provide valuable descriptive insights but may offer limited methodological transparency, quantitative mapping or explicit theoretical integration (Snyder, 2019). By combining systematic review procedures, bibliometric techniques and theory-driven thematic synthesis, the CBLR approach enhances methodological transparency, analytical depth and theoretical coherence, thereby providing a more comprehensive understanding of complex and multidisciplinary research domains (Donthu *et al.*, 2021; Tranfield *et al.*, 2003).

The selection of the CBLR approach was motivated by the multifaceted nature of digital transformation research in HSCs. Systematic literature reviews emphasize procedural rigor and transparency but are less effective in visualizing intellectual structures and thematic evolution (Snyder, 2019; Tranfield *et al.*, 2003). Bibliometric reviews provide robust quantitative mapping of publication trends, collaboration networks and knowledge structures but often offer limited theoretical interpretation (Donthu *et al.*, 2021). Integrative reviews facilitate conceptual synthesis and theory development but may lack the methodological transparency associated with systematic review protocols (Snyder, 2019). The CBLR approach combines the complementary strengths of these methodologies by integrating systematic search procedures, bibliometric mapping and theory-driven thematic analysis within a single framework, thereby providing a more comprehensive and theoretically grounded synthesis than any single review approach alone (Donthu *et al.*, 2021; Tranfield *et al.*, 2003). Furthermore, because CBLR remains an emerging review protocol, this study demonstrates its application within a theory-driven review context by operationalizing theoretical lenses throughout data collection, coding, classification and synthesis stages.

2.1 Review design and theoretical alignment

The purpose of the CBLR is to map how digital technologies contribute to dynamic capabilities in HSCs. DCT focuses on the processes of *sensing*, *seizing* and *reconfiguring* resources (Eisenhardt and Martin, 2000; Teece *et al.*, 1997), while STS highlights the socio institutional context that shapes technological outcomes (Bostrom and Heinen, 1977; Trist and Bamforth, 1951). Integrating these theories ensures that both technical innovation and organizational adaptation are considered simultaneously. The theoretical lenses were explicitly operationalized to guide the review design and analytical procedures. DCT informed the structuring of the analytical framework by categorizing evidence according to three core capability processes: sensing (identifying and interpreting emerging risks and information flows), seizing (mobilizing and coordinating resources and responses) and reconfiguring (adapting structures, processes and assets in dynamic environments). These dimensions were embedded into

the data extraction and coding framework to ensure that each identified theme could be systematically linked to a specific capability-building mechanism.

In parallel, STS theory guided the classification of findings into technical and social subsystems. Technical components included digital infrastructures, IS and analytical tools, while social components encompassed organizational routines, governance mechanisms, institutional norms and human competencies. The interaction between these subsystems was used as a coding logic to assess the degree of socio-technical alignment within each study. This dual-theory operationalization ensured that the review moved beyond descriptive mapping toward a structured explanation of how digital technologies contribute to capability development in HSCs. The analytical process therefore proceeds in five iterative stages – strategic planning, data acquisition, thematic coding, theoretical synthesis and validation – summarized in Table 1. Table 1 integrates both procedural steps and theory-driven elements, explicitly embedding DCT and STS constructs within each stage of the review process.

2.2 Data collection and screening

To operationalize Stage 2, nine Boolean search queries were constructed to combine humanitarian logistics concepts with

digital technology and IS keywords. Searches were limited to the Scopus database, covering the period 2013–2025 to capture post Industry 4.0 and post COVID-19 developments. Scopus was selected because it provides broad multidisciplinary coverage across logistics, supply chain management, IS and humanitarian research while also supporting robust bibliometric analysis. Its extensive indexing coverage and citation metadata make it particularly suitable for theory-driven review studies that combine systematic screening with bibliometric mapping. The starting year of 2013 was selected because it coincides with the early emergence of Industry 4.0 technologies, including IoT, cloud computing and advanced analytics, which subsequently became central drivers of digital transformation in HSCs. Only journal articles written in English and peer reviewed were retained; conference papers, book chapters and nonempirical reviews were excluded.

The inclusion criteria required studies to:

- focus on humanitarian logistics, HSCs, disaster response or emergency operations;
- examine IT, IS or digital transformation applications;
- be published as peer-reviewed journal articles;
- be written in English; and
- provide sufficient conceptual, empirical or methodological relevance to the study objectives.

Table 1 Revised crossbreed literature review (CBLR) framework applied in this study

CBLR stage	Purpose and rationale	Operational activities	Outputs / deliverables
Stage 1 – Strategic Planning	Establish theoretical foundation and define analytical scope	• Formulate the research question linking digital transformation and humanitarian logistics • Justify DCT and STS as complementary interpretive lenses • Identify core constructs derived from Dynamic Capabilities Theory (sensing, seizing, reconfiguring) and Socio-Technical Systems Theory (socio-technical alignment)	Theoretical scaffolding guiding data retrieval and interpretation
Stage 2 – Data Acquisition and Bibliometric Mapping	Achieve comprehensive and reproducible coverage of relevant literature	• Execute nine Boolean search queries in Scopus (2013–2025) • Apply inclusion/exclusion filters: peer reviewed, English, direct relevance to IT/IS in HSCs • Conduct bibliometric mapping using VOSviewer to identify keyword clusters, authorship, and regional networks • Finalize corpus of 94 articles	Quantitative structure of humanitarian digitalization research (keywords, regions, authors)
Stage 3 – Thematic Coding and Interpretation	Extract qualitative insights beyond bibliometric indicators	• Import corpus into NVivo and conduct inductive coding following (Sentia et al., 2025) • Validate intercoder reliability ($\kappa = 0.86$) • Consolidate recurring topics into six core digital transformation themes	Thematic framework linking digital tools to DCT capability dimensions (sensing, seizing, reconfiguring) and STS socio-technical components
Stage 4 – Theory Integration and Synthesis	Merge quantitative and qualitative findings under DCT and STS	• Map thematic results explicitly onto DCT processes (sensing, seizing, reconfiguring) and STS dimensions (technical and social subsystems) • Develop the Digital Transformation Capability Framework showing interactions among technology, people, and institutions • Identify conceptual overlaps and unexamined areas	Integrated conceptual model linking DCT capability processes with STS socio-technical alignment and structured research agenda
Stage 5 – Validation and Reporting	Ensure transparency, replicability, and contribution to scholarship	• Cross-checks findings against recent publications (2023–2025) • Present analytical tables summarizing methods, results, theoretical synthesis, and implications • Ensure transparent reporting, theoretical consistency, and reproducibility of findings	Transparent, theory-driven synthesis suitable for future replication and extension

Source(s): Author's own design (2025), adapted from (Tranfield et al., 2003) and (Sentia et al., 2025) with integration of DCT and STS principles

Studies that did not satisfy these criteria were excluded from further analysis. Studies were excluded if they:

- focused on commercial supply chains without a humanitarian or disaster-response context;
- examined digital technologies without clear implications for humanitarian logistics or supply chain operations;
- were conference papers, book chapters, editorials, dissertations or non-peer-reviewed publications;
- were not published in English; or
- lacked sufficient conceptual, empirical or methodological relevance to the objectives of the review.

Journal articles were prioritized because they typically undergo more rigorous peer-review processes and provide greater methodological and theoretical detail than conference papers, editorials or book chapters. This criterion was adopted to enhance the reliability, consistency and scholarly quality of the review corpus. To enhance transparency and replicability, the complete review corpus comprising the 94 articles retained for analysis is provided in Supplementary File S1.

The final corpus of 94 articles was considered sufficient because it provided broad coverage of the major technological, organizational and humanitarian themes relevant to the study objectives while also allowing meaningful bibliometric and thematic analysis. The retained studies represented diverse geographical contexts, technological applications and humanitarian settings, enabling a comprehensive synthesis of the existing body of knowledge. The queries and screening outcomes are shown in Table 2.

2.3 Data analysis and validation

The final corpus of 94 articles was analyzed in two complementary stages. Bibliometric analysis was performed using *VOSviewer 1.6.20* to identify keyword cooccurrence

networks, publication trends and geographical authorship distribution. The analysis revealed an accelerating growth of digital humanitarian studies since 2018, with dominant clusters around transparency, coordination and automation technologies. *VOSviewer* was selected because of its established capability to visualize keyword cooccurrence networks, thematic clusters and intellectual structures within large bodies of literature.

Subsequently, a thematic analysis was applied using *NVivo 12 Plus*. *NVivo* was employed to facilitate systematic coding, theme development and transparent management of qualitative evidence across the reviewed studies. The analysis followed the six phase procedure of [Sentia et al. \(2025\)](#) familiarization, initial coding, theme identification, review, naming and reporting. Each article was coded for its methodological orientation, technology domain, and contribution to humanitarian capability development. In addition, a theory-driven coding scheme was applied to align the analysis with the DCT and STS frameworks. Each article was systematically examined to identify whether its contributions related to sensing, seizing or reconfiguring capabilities. Simultaneously, the analysis distinguished between technical elements (e.g. digital platforms, analytics tools, automation technologies) and social elements (e.g. coordination mechanisms, governance structures, human expertise).

For each thematic category, representative studies were selected based on their conceptual relevance, empirical richness, citation influence and contribution to understanding digital transformation within HSCs. These studies were not intended to represent the entirety of the literature within each theme but rather to provide illustrative examples of the dominant concepts, technologies and capability development mechanisms identified during the review process.

Table 2 Updated boolean search queries and screening results

No.	Search query	Articles retrieved	Excluded	Included
1	("humanitarian logistics" OR "relief logistics network" OR "emergency supply chain") AND ("digital technology" OR "information technologies" OR "ICT infrastructure")	14	3	11
2	("humanitarian supply operations" OR "disaster relief chain") AND ("Internet of Things" OR "IoT applications" OR "smart sensors")	33	11	22
3	("humanitarian logistics system" OR "relief distribution network") AND ("artificial intelligence" OR "machine learning" OR "autonomous robotics")	12	5	7
4	("emergency response logistics" OR "disaster transportation network") AND ("unmanned aerial vehicle" OR "UAV system" OR "drone technology" OR "autonomous transport")	10	2	8
5	("humanitarian supply network" OR "relief operations") AND ("information system" OR "management information platform" OR "data analytics" OR "cloud computing services")	32	12	20
6	("disaster logistics" OR "relief operations network") AND ("blockchain applications" OR "distributed ledger systems" OR "smart contract technology")	16	4	12
7	("humanitarian operations" OR "aid distribution network") AND ("radio frequency identification" OR "RFID solutions" OR "digital tracking tools")	9	5	4
8	("humanitarian supply chain" OR "emergency logistics system") AND ("cybersecurity" OR "data privacy" OR "information security")	12	3	9
9	("humanitarian supply chain" OR "relief management system") AND ("digital transformation" OR "digitalisation" OR "technological innovation")	15	4	11
Total		153	49	94

Source(s): Author's own compilation based on Scopus search (2013–2025)

This approach enabled a structured crosswalk between empirical findings and theoretical constructs, forming the basis for the development of the Digital Transformation Capability Framework presented in the results section. To ensure analytical reliability, dual coder cross validation was conducted on 20% of the data set, yielding a Cohen's $\kappa = 0.86$, which denotes substantial agreement (Landis and Koch, 1977). The coding results produced six overarching themes representing the major technological and managerial currents of humanitarian digital transformation, elaborated in Section 3.

Themes were retained only when they appeared consistently across multiple studies and demonstrated conceptual distinctiveness from other emerging categories during the iterative coding and validation process. To improve methodological transparency, Table 3 presents the theory-driven coding framework used to classify articles according to DCT and STS theory constructs.

2.4 Theory driven synthesis

The theory-driven synthesis stage involved systematically aligning bibliometric and thematic findings with the analytical constructs derived from DCT and STS. Specifically, thematic results were mapped to the sensing, seizing and reconfiguring dimensions of DCT while simultaneously being classified according to the technical and social subsystems of STS. This structured mapping process enabled the identification of recurring patterns across studies and supported the development of an integrated analytical framework. More importantly, by integrating systematic review procedures, bibliometric evidence and theory-driven thematic synthesis, the CBLR approach provides greater methodological transparency, conceptual richness and theoretical coherence than relying on any single review methodology in isolation (Donthu et al., 2021; Snyder, 2019; Tranfield et al., 2003). The conceptual outcomes of this synthesis are presented in the results section.

3. Thematic analysis and results

This section presents the empirical findings of the review, clearly distinguishing between quantitative bibliometric results and qualitative thematic interpretations. The analytical process generated both types of insights. The bibliometric analysis reports publication trends and keyword clustering, while the

thematic analysis provides interpretive insights into capability development processes.

The bibliometric mapping confirmed a consistent upward trend in research on digital transformation in humanitarian logistics after 2018, corresponding with the proliferation of Industry 4.0 technologies and post-pandemic data-driven humanitarian initiatives. Table 4 summarizes the key descriptive bibliometric findings obtained from the analysis of the 94 articles included in the review. Keyword cooccurrence mapping revealed three dominant clusters:

- technological innovation and transparency;
- coordination and decision support analytics; and
- automation and network agility.

The subsequent thematic analysis of the 94 selected studies yielded six interdependent themes that together represent the digital transformation landscape of HSCs. Each theme was interpreted through the dual lens framework of DCT and STS theory, which jointly explain how digital infrastructures and social institutions interact to produce outcomes such as agility, resilience and transparency.

3.1 Digital technologies for transparency, coordination and collaboration

Transparency and coordination remain among the most persistent challenges in humanitarian operations, particularly when multiple stakeholders must exchange data across institutional and geographic boundaries. Twenty-nine of the reviewed articles examined the role of technologies such as blockchain, big data analytics and cloud platforms in fostering inter organizational trust and real time collaboration (Baharmand et al., 2021; Kabra et al., 2025; Mackey and Cuomo, 2020). These systems enhance sensing and seizing capabilities by improving visibility and accelerating information sharing. From the STS perspective, however, technological transparency must be supported by compatible social mechanisms – ethical governance, donor accountability and cross agency communication protocols – to ensure that data openness translates into collaboration rather than friction.

Despite the growing benefits of digital transparency technologies, significant economic barriers continue to limit their adoption among smaller humanitarian organizations and local NGOs. Many advanced digital solutions, including blockchain platforms, integrated analytics systems, and cloud-based coordination infrastructures, require substantial financial investment, technical expertise and ongoing maintenance

Table 3 Theory-Driven Coding framework used for article classification

DCT/STS construct	Coding rule	Illustrative indicators
Sensing capability	Articles discussing risk detection, situational awareness, forecasting, monitoring, information visibility or data acquisition	IoT monitoring, predictive analytics, early warning systems, social media monitoring
Seizing capability	Articles examining resource mobilization, coordination, collaborative decision-making or response execution	Blockchain coordination, AI decision support, cloud-based collaboration platforms
Reconfiguring capability	Articles addressing adaptation, network redesign, process modification, automation or resource redeployment	UAV deployment, warehouse automation, routing optimization, robotics
Technical subsystem	Articles emphasizing digital infrastructure, software, hardware, platforms, analytics or information technologies	IoT, blockchain, AI, cloud computing, RFID
Social subsystem	Articles emphasizing governance, trust, organizational culture, human expertise, institutional arrangements or stakeholder collaboration	Data governance, training, interagency coordination, ethical oversight

Table 4 Summary of descriptive bibliometric findings

Bibliometric dimension	Key findings
Publication trend	Research activity increased substantially after 2018, reflecting growing interest in Industry 4.0 technologies and post-pandemic humanitarian digitalization initiatives
Dominant keywords	Digital transformation, humanitarian logistics, humanitarian supply chains, blockchain, artificial intelligence, internet of things (IoT), big data analytics, coordination, resilience, and transparency
Major keyword clusters	1 Technological innovation and transparency, 2 Coordination and decision support analytics, 3 Automation and network agility
Geographic distribution	Asia accounted for 44.7% (42 studies) of the reviewed literature, followed by Europe with 33.0% (31 studies). Together, these Two regions represented 77.7% of all publications. In contrast, North America contributed 10.6% (10 studies), Africa 5.3% (5 studies), Latin America 4.3% (4 studies), and Oceania 2.1% (2 studies), highlighting a substantial geographical imbalance in humanitarian digital transformation research
Research focus	Strong concentration on transparency, coordination, decision support systems, logistics automation, facility intelligence, routing innovation, and digital identification systems
Emerging themes	Cybersecurity, ethical data governance, robotics, automation, and digital inclusion were identified as emerging but under-researched topics
Source(s): Author's synthesis based on bibliometric analysis of the reviewed literature ($n = 94$)	

resources. Consequently, well-funded international agencies often possess greater capacity to develop digital transformation capabilities, while smaller organizations may face challenges related to funding constraints, limited digital infrastructure, inadequate technical training, and restricted access to specialized expertise. This digital divide may create uneven capability development across humanitarian actors and highlights the need for inclusive digitalization strategies that promote equitable access to technological resources and capacity-building initiatives. Transparency is conceptualized as a performance outcome emerging from the effective deployment of sensing and seizing capabilities within a socio-technical context.

3.2 Decision support and cognitive analytics for humanitarian operations

Another significant research stream concerns decision support systems and analytical intelligence. Studies such as Griffith *et al.* (2019) and Nain *et al.* (2024) demonstrate that integrating IoT sensors, embedded analytics and machine learning models reduces uncertainty and shortens response time. Within DCT, these tools reinforce the *sensing* process by converting fragmented data into actionable insights (Insaurralde and Blasch, 2019). Yet as STS suggests, the real advantage of cognitive analytics lies in augmenting – not replacing – human decision-making. Effective humanitarian analytics therefore

depend on data literacy, user trust and organizational learning cultures that allow humans and algorithms to cocreate knowledge. These systems represent a new hybrid form of human–machine collaboration that extends traditional decision support paradigms.

3.3 Logistics and inventory automation

Fourteen papers examined digital tools for logistics planning and inventory optimization, identifying technologies such as AI, radio frequency identification (RFID) and cloud-based warehouse management as critical enablers of supply chain visibility and prepositioning accuracy (Chen and Zhao, 2019; Cheung *et al.*, 2006; Di Capua *et al.*, 2023). Through the lens of DCT, these technologies operationalize *reconfiguring* capabilities, enabling organizations to adapt stock levels and routing dynamically in response to evolving conditions. The STS framework underscores that success depends on institutional readiness – standardized data formats, cross agency coordination, and shared ethical norms for information exchange. Logistical automation thus becomes an emergent capability built upon both technological precision and organizational cooperation.

3.4 Facility location intelligence and smart warehousing

Spatial decision-making is another domain in which IT and IS have transformed humanitarian performance. Studies using geographic information systems (GIS), fuzzy multi criteria analysis, and two stage data envelopment models illustrate how advanced analytics can optimize the siting of warehouses, distribution centers and shelters (Affia and Aamer, 2022; Heng *et al.*, 2025; Jabbar *et al.*, 2018; Tiwari, 2023). These technologies enhance *sensing* and *seizing* capabilities by incorporating geospatial and demographic data into location strategies. Yet purely algorithmic approaches may overlook social legitimacy, community accessibility and environmental constraints. The STS lens reveals that effective facility location planning must reconcile quantitative optimization with participatory, community driven decision processes to ensure sustainable and ethical outcomes.

3.5 Autonomous delivery and routing innovation

A large subset of studies (17) focused on last mile delivery and routing optimization – persistent bottlenecks in post disaster logistics. The most recurrent technologies include unmanned aerial vehicles (UAVs), hybrid truck–drone systems and big data supported routing algorithms (Garus *et al.*, 2024; Lyu *et al.*, 2025; Mohammad *et al.*, 2023; Tetteh *et al.*, 2025). These solutions embody DCT's *reconfiguring* capability by enabling rapid network redesign during infrastructure disruption. However, STS interpretation highlights regulatory barriers, community acceptance and environmental sustainability as decisive socio technical variables. Autonomous delivery becomes most effective when accompanied by human oversight, ethical regulation and stakeholder trust – transforming automation from a mechanical function into a socially adaptive capability.

3.6 Digital identification and victim management systems

The final cluster addresses the application of digital systems for identifying and evacuating disaster victims (Frennesson *et al.*, 2021). Studies employing IoT networks, biometric identifiers and enterprise resource planning (ERP) platforms demonstrate how technology can integrate and secure victim information across agencies (Eke *et al.*, 2022; Park *et al.*, 2011; Sentia *et al.*, 2025). These systems strengthen *sensing* and *seizing* capabilities by providing real time data for evacuation prioritization, while also posing ethical and privacy challenges. STS underscores that responsible data governance – including informed consent, transparency and accountability – is indispensable for ensuring that technological efficiency does not compromise humanitarian principles.

3.7 Synthesis of themes

Collectively, the six themes highlight a paradigmatic shift in HSC scholarship. Digital transformation is no longer conceptualized as the adoption of discrete tools but as the emergence of *digital transformation capabilities* – systemic competences that link technology, people and institutions. Each theme contributes to one or more DCT dimensions (sensing, seizing, reconfiguring) and depends on STS alignment to achieve enduring performance. These findings provide the empirical basis for the Digital Transformation Capability Framework presented in later sections.

The results summarized in Tables 4 and 5 indicate a transition of humanitarian digitalization research from technology-centric inquiry toward theory-driven exploration of organizational capabilities. The following section builds on these findings to outline the remaining research gaps and propose an integrated future research agenda. Building on the structured mapping of themes to DCT and STS constructs, the findings are synthesized into an integrated Digital

Transformation Capability Framework. This framework illustrates how digital technologies, when aligned with social and institutional mechanisms, enable the development of sensing, seizing and reconfiguring capabilities, ultimately leading to improved humanitarian outcomes such as agility, resilience and performance.

Collectively, the six themes provide a direct response to the study's research question concerning how IT and IS contribute to the development of dynamic and socio-technical capabilities in HSCs. Specifically, the themes demonstrate that digital technologies support sensing capabilities through enhanced visibility, monitoring and predictive intelligence; seizing capabilities through improved coordination, collaboration and decision support; and reconfiguring capabilities through automation, adaptive logistics and network redesign. Simultaneously, the findings reveal that the effectiveness of these technologies depends on socio-technical factors including governance structures, human expertise, institutional trust and interorganizational collaboration. The six themes therefore represent complementary dimensions of a broader digital transformation capability system operating within humanitarian environments.

4. Research gaps and future research suggestions

The synthesis presented in Table 5 reveals that although humanitarian logistics has increasingly embraced digitalization, significant conceptual, methodological and contextual gaps remain. While technologies such as blockchain, big data analytics and UAVs have advanced the field, the majority of studies still adopt a descriptive orientation documenting technological use rather than theorizing *how* these technologies evolve into enduring organizational capabilities. The absence of an integrative theoretical model leaves humanitarian digital transformation fragmented across isolated subtopics. This review, anchored in DCT and STS Theory, highlights four central research gaps:

Table 5 Thematic classification of digital transformation research in humanitarian supply chains

No.	Theme / focus area	No. of Articles (<i>n</i> = 94)	Main digital technologies / systems	Representative studies
1	Digital transparency, coordination and collaboration	29	Blockchain, big data analytics, cloud computing, AI chatbots, IoT platforms, social media interfaces	Baharmand <i>et al.</i> (2021); Dubey <i>et al.</i> (2022); Kabra <i>et al.</i> (2025); Mackey and Cuomo (2020)
2	Decision support and cognitive analytics	18	Embedded analytics, IoT sensors, cognitive internet of vehicles, machine learning algorithms	Griffith <i>et al.</i> (2019); Insaurrealde and Blasch (2019); Nain <i>et al.</i> (2024)
3	Logistics and inventory automation	14	AI forecasting, RFID, big data platforms, Cloud-Based systems	Chen and Zhao (2019); Cheung <i>et al.</i> (2006); Di Capua <i>et al.</i> (2023)
4	Facility location intelligence and smart warehousing	9	GIS, fuzzy Multi-Criteria analysis, Two-Stage DEA models, RFID	Affia and Aamer (2022); Heng <i>et al.</i> (2025); Jabbar <i>et al.</i> (2018); Tiwari (2023)
5	Autonomous delivery and routing innovation	17	UAVs, hybrid truck–drone systems, routing algorithms, big data logistics models	Garus <i>et al.</i> (2024); Lyu <i>et al.</i> (2025); Mohammad <i>et al.</i> (2023); Tetteh <i>et al.</i> (2025)
6	Digital identification and victim management systems	7	IoT tracking, biometric identification, ERP-Based refugee management, cloud databases	Eke <i>et al.</i> (2022); Park <i>et al.</i> (2011); Sentia <i>et al.</i> (2025)

Note(s): The thematic categories were derived through iterative coding and cross-comparison of all 94 articles included in the review. Representative studies are presented for illustrative purposes only and do not constitute the full set of articles contributing to each theme

Source(s): Author's synthesis based on the Crossbreed Literature Review dataset (2013–2025, *n* = 94)

- 1 limited theoretical grounding;
- 2 weak methodological diversity;
- 3 insufficient socio technical contextualization; and
- 4 pronounced regional asymmetry.

First, theoretical fragmentation persists. Although some scholars reference resource based or systems perspectives, very few explicitly use DCT or STS to explain capability formation. The literature rarely distinguishes between *resources* (e.g. digital tools) and *capabilities* (e.g. agility or resilience), leading to conceptual ambiguity. Future studies should therefore adopt multi theory integration using DCT to describe adaptive processes and STS to capture the human, institutional and ethical conditions necessary for capability emergence.

Second, methodological homogeneity remains a concern. Most studies rely on conceptual discussions, single case studies or simulation models. Empirical triangulation using surveys, Delphi panels or longitudinal field data remains underrepresented. Such methodological limitations hinder generalizability and reduce explanatory power. Future research should employ *mixed-method* designs, blending quantitative bibliometric mapping with qualitative or experimental methods to reveal causal relationships between digital interventions and performance outcomes.

Third, socio technical misalignment continues to constrain the effective implementation of digital technologies. Many studies emphasize hardware and software while neglecting organizational culture, user competence and governance systems that determine technological success. Understanding how humanitarian organizations balance automation with human oversight is essential. Integrating STS constructs such as human-machine trust, learning loops and institutional adaptation will enhance realism and ethical grounding.

Fourth, regional imbalance is particularly evident. The bibliometric analysis indicates that Asia accounted for 44.7% (42 studies) of the reviewed literature and Europe for 33.0% (31 studies), together representing 77.7% of all publications. In contrast, North America contributed only 10.6% (10 studies), while Africa accounted for 5.3% (5 studies), Latin America for 4.3% (4 studies) and Oceania for 2.1% (2 studies). This imbalance is particularly noteworthy given the advanced emergency management infrastructures operating in North America, including the Federal Emergency Management Agency in the USA and Public Safety Canada, both of which have implemented sophisticated digital technologies to support disaster preparedness, emergency response and humanitarian coordination. Likewise, many countries across Africa and Latin America experience frequent humanitarian crises, natural disasters and climate-related emergencies, yet relatively few studies have examined how digital transformation capabilities are developed and implemented within these contexts. These findings indicate an important geographical gap in the literature and suggest that future research should place greater emphasis on underrepresented regions to develop more context-sensitive and globally applicable theories of digital transformation in HSCs.

Beyond these four broad limitations, several emerging research frontiers demand attention. The increasing complexity of digital ecosystems calls for exploration of robotics, cloud platform interoperability, data ethics and cybersecurity within humanitarian operations. Addressing these themes will extend both theoretical scope and practical relevance. To provide a

structured roadmap, the following table outlines key future research opportunities categorized by theme, theoretical anchor, method and expected contribution.

The structured research agenda in Table 6 transforms the review's qualitative insights into a forward-looking scholarly roadmap. It connects underexplored topics with appropriate theoretical perspectives and methodological pathways. For instance, robotics and automation align with DCT's reconfiguring dimension, while data ethics and cybersecurity correspond to STS's institutional alignment logic. Likewise, regional comparative work will contextualize the generalizability of these theories. By addressing these opportunities, future research can consolidate humanitarian digitalization as a distinct theoretical domain rather than a fragmented subset of IS studies.

Ultimately, this agenda promotes a shift from *technology adoption* to *capability orchestration*, emphasizing that digital transformation in HSCs is a socio technical process that evolves through iterative learning, trust building and institutional integration. Beyond the individual technologies examined, the findings collectively suggest that sustained organizational capabilities emerge through the continuous interaction between technological resources, organizational learning, governance mechanisms and collaborative networks. From a DCT perspective, humanitarian organizations develop long-term adaptability by repeatedly strengthening sensing, seizing and reconfiguring processes in response to changing operational conditions. From a STS perspective, these capabilities are sustained only when technological innovation remains aligned with human competencies, institutional structures and stakeholder expectations. The findings therefore indicate that enduring humanitarian performance depends not on the adoption of individual technologies, but on the organization's ability to continuously orchestrate technological and socio-institutional resources over time. The next section elaborates how these findings contribute to theoretical and methodological development within humanitarian logistics scholarship.

5. Theoretical, methodological and practical implications

The findings synthesized throughout the review offer robust insights into the theoretical, methodological and practical implications of digital transformation in HSCs. By integrating DCT and STS Theory within the CBLR framework, this study bridges two historically separate domains technological innovation and organizational adaptation into a single coherent explanation of how digital transformation capabilities emerge in humanitarian contexts. Whereas DCT conceptualizes how organizations sense, seize and reconfigure resources to respond to turbulence (Eisenhardt and Martin, 2000; Teece *et al.*, 1997), STS complements this by clarifying how social structures, institutional norms and human interactions shape the successful implementation of technological systems (Bostrom and Heinen, 1977; Trist and Bamforth, 1951).

5.1 Theoretical contributions

This study contributes to humanitarian logistics scholarship by proposing a theoretically grounded explanation of how digital

Table 6 Future research agenda for digital transformation capabilities in humanitarian supply chains

Theme	Identified gap	Theoretical lens	Suggested methodology	Expected contribution
Digital transparency and collaboration	Limited validation of blockchain and data sharing models in multi actor networks	DCT (sensing) + STS (trust governance)	Mixed method field studies; inter agency surveys	Empirical evidence on how transparency improves coordination agility
Cognitive analytics and decision support	Need for frameworks on human–AI collaboration in crisis analytics	STS + organizational learning	Delphi studies; ethnographic observation	Socio technical model for human–machine integration in humanitarian decision making
Logistics and automation	Minimal examination of robotics and automation in warehouse operations	DCT (reconfiguring)	Simulation; longitudinal multi case analysis	Framework for adaptive logistics reconfiguration under automation
Facility location analytics	Lack of socio environmental assessment in GIS based models	Institutional theory + STS	Multi criteria decision analysis; stakeholder based participatory research	Green and socially inclusive location models
Routing and delivery innovation	Neglect of ethical, policy and sustainability issues in autonomous delivery	DCT (seizing) + ethics of technology	Policy mapping; scenario and simulation studies	Responsible innovation framework for autonomous humanitarian logistics
Data governance and cybersecurity	Absence of models addressing digital risk and privacy in humanitarian systems	STS + institutional + risk theory	Conceptual modeling; expert validation panels	Secure data governance model ensuring accountability and legitimacy
Regional comparative analysis	Overconcentration on asia/Europe; neglect of North American and global South contexts	Institutional + capability theory	Comparative cross regional surveys; bibliometric + qualitative hybrid	Contextualized theory of digital capability maturity in humanitarian systems

Source(s): Author's synthesis from CBLR dataset (2013–2025, $n = 94$)

transformation capabilities emerge within HSCs. By integrating DCT and STS Theory, the study offers a unified perspective that explains digital transformation as the interaction between adaptive organizational capabilities and socio-technical alignment. Specifically, DCT explains how organizations develop sensing, seizing and reconfiguring capabilities in response to environmental disruption, whereas STS explains how technological infrastructures, human expertise, governance mechanisms and institutional arrangements collectively enable these capabilities to operate effectively. Together, the two theories provide a comprehensive explanation of digital transformation that extends beyond technology adoption toward sustained organizational capability development.

To ensure conceptual clarity, this study distinguishes between dynamic capabilities and their resulting outcomes. Dynamic capabilities are defined as process-oriented routines (specifically sensing, seizing and reconfiguring) that enable organizations to adapt to changing environments. In contrast, outcomes such as agility, resilience, coordination effectiveness, trust and operational continuity represent the performance results achieved through the deployment of these capabilities. This distinction aligns the study with established DCT and enhances the analytical precision of the proposed framework.

Building on this theoretical integration, the study conceptualizes digital transformation as an iterative capability development process rather than a discrete technological event. Within the DCT perspective, sensing capabilities are strengthened through technologies that enhance environmental monitoring and situational awareness, seizing capabilities are reinforced through systems that facilitate coordinated decision-making and resource mobilization, and reconfiguring capabilities enable organizations to continuously redesign processes and

redeploy resources in response to changing humanitarian conditions. These capability processes operate effectively only when supported by the socio-technical conditions emphasized by STS, including organizational learning, governance structures, stakeholder collaboration and institutional trust.

The integration of STS extends this capability-based perspective by situating digital transformation within its broader socio-institutional context. Technological systems alone are insufficient to generate sustained value unless they are aligned with human competencies, governance structures and organizational cultures. Factors such as trust, data governance, ethical standards and interagency collaboration play a central role in determining whether digital technologies translate into meaningful operational improvements. By incorporating these socio-technical dimensions, the study provides a more holistic explanation of how digital transformation capabilities are developed and sustained in humanitarian environments.

Furthermore, the study contributes to theory by conceptualizing digital transformation as a dual-loop capability system, in which technological mechanisms drive resource reconfiguration while social and institutional mechanisms ensure alignment, legitimacy and long-term sustainability. This perspective moves beyond technology-centric explanations and positions digital transformation as a higher-order organizational capability that integrates technological, human and institutional elements. The relationships among these constructs are synthesized in [Table 7](#) and visually represented in [Figure 1](#), which together provide a structured foundation for future empirical research.

The classification of technologies into sensing, seizing and reconfiguring capabilities followed the theory-driven coding framework developed from DCT. Technologies were classified as sensing mechanisms when their primary function involved

Table 7 Mapping of dynamic capabilities and socio technical systems constructs to digital transformation dimensions in humanitarian supply chains

Digital transformation dimension	Dynamic capabilities construct	Socio technical systems subsystem	Illustrative digital technologies	Resulting humanitarian outcomes
Predictive awareness and early sensing	<i>Sensing</i> – detecting and interpreting emerging risks	Technical: IoT, big data analytics Social: knowledge sharing and learning culture	IoT platforms, predictive analytics, social media mining	Proactive risk detection and information visibility
Coordination and collaborative response	<i>Seizing</i> – mobilizing and coordinating resources rapidly	Technical: blockchain, decision support dashboards Organizational: trust and data governance mechanisms	Blockchain, AI based coordination systems, cloud platforms	Real time coordination, inter agency collaboration and strengthened interagency trust
Adaptive logistics and reconfiguration	<i>Reconfiguring</i> – redeploying assets and redesigning processes	Technical: automation, robotics, UAVs Organizational: flexible hierarchy, agile governance	Robotics, UAVs, warehouse automation systems	Improved network agility, enhanced operational continuity and flexibility
Decision intelligence and continuous learning	<i>Learning</i> – transforming experience into new routines	Social: training programs, analytical literacy Organizational: institutionalized feedback systems	AI decision dashboards, cognitive analytics	Continuous improvement and evidence-based adaptation
Ethical governance and resilience	<i>Sensing + reconfiguring</i> – anticipating institutional risks and adapting norms	Social: ethics culture, stakeholder legitimacy Technical: cybersecurity, data protection infrastructure	Cybersecurity systems, biometric identity, privacy architectures	Trustworthy digital operations and sustainable legitimacy

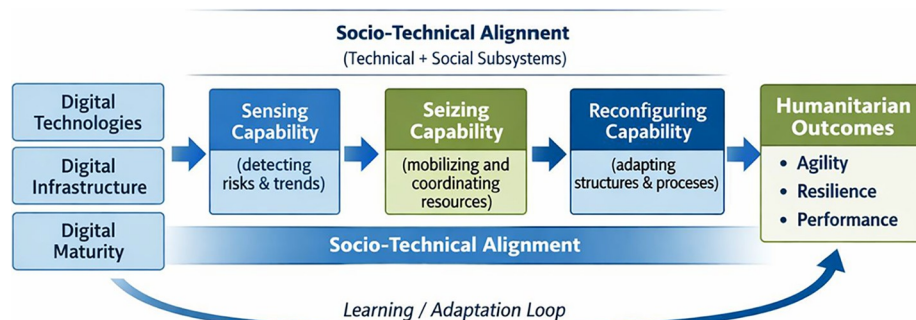
Source(s): Author's synthesis based on DCT (Eisenhardt and Martin, 2000; Teece et al., 1997) and STS (Bostrom and Heinen, 1977; Trist and Bamforth, 1951)

information acquisition, monitoring, forecasting or situational awareness. Examples include IoT platforms, predictive analytics and social media monitoring systems that support the identification of emerging risks and operational conditions. Technologies were classified as seizing mechanisms when they facilitated coordination, decision-making, resource mobilization or collaborative action. Examples include blockchain platforms, cloud-based coordination systems, and AI-enabled decision support tools. Technologies were classified as reconfiguring mechanisms when they enabled operational adaptation, process redesign, resource redeployment or structural transformation. Examples include UAVs, warehouse automation systems, robotics and adaptive routing technologies. These classification rules ensured consistency between the empirical coding process and the theoretical constructs of DCT.

While digital transformation capabilities can enhance adaptability and resilience, DCT also recognizes the potential risks associated with capability development. Over time,

successful routines and digital practices may become institutionalized to the extent that they create path dependencies or core rigidities, reducing organizational flexibility and limiting responsiveness to novel situations. In humanitarian contexts, excessive reliance on established digital infrastructures, automated decision systems, or standardized data processes may constrain improvisation and local adaptation during unforeseen crises. Consequently, organizations must continuously evaluate and renew their digital capabilities to avoid capability rigidity and ensure that technological advancement remains compatible with changing operational requirements and humanitarian needs.

This table demonstrates that digital transformation in humanitarian logistics functions as dual loop capability system technological mechanisms drive the dynamic reconfiguration of resources, while social and institutional mechanisms ensure alignment, trust and ethical compliance. The model contributes theoretically by uniting dynamic and structural perspectives,

Figure 1 Integrated digital transformation capability framework for humanitarian supply chains

Source: Author's synthesis based on DCT and STS integration (2025)

providing a foundation for future empirical testing. Researchers can operationalize the constructs in [Table 7](#) as measurable variables e.g. sensing capability through analytics adoption, or socio technical alignment through inter agency trust and training programs to build predictive models of humanitarian performance. Consistent with DCT, the framework explicitly recognizes environmental turbulence and disaster shocks as external triggers that activate sensing, seizing and reconfiguring processes within HSCs. The integrated relationships among these constructs are illustrated in [Figure 1](#), the Digital Transformation Capability Framework for Humanitarian Supply Chains.

[Figure 1](#) illustrates the integrated Digital Transformation Capability Framework developed from the synthesis of DCT and STS Theory. The framework begins with environmental turbulence and disaster-related disruptions, which serve as external stimuli that activate organizational adaptation processes. Consistent with DCT, humanitarian organizations first develop sensing capabilities to identify emerging risks, collect real-time information, and improve situational awareness. These capabilities subsequently enable seizing processes, through which organizations coordinate stakeholders, mobilize resources, and make timely operational decisions. The framework then progresses to reconfiguring capabilities, reflecting the organization's ability to redesign operational processes, redeploy resources, and continuously adapt HSC structures in response to evolving disaster conditions.

From the STS perspective, these dynamic capability processes can generate sustained value only when technological infrastructures remain aligned with human competencies, governance mechanisms, institutional arrangements and collaborative practices. This socio-technical alignment ultimately enables humanitarian outcomes such as agility, resilience, coordination effectiveness, operational continuity and sustainable humanitarian performance. The framework therefore illustrates that digital transformation is not a linear technology adoption process but a continuous capability development cycle through which technological and organizational resources are repeatedly integrated to strengthen HSC performance.

5.2 Methodological contributions

Methodologically, this paper applies the CBLR as a hybrid review protocol that integrates systematic review procedures, bibliometric techniques and theory-driven thematic synthesis to examine digital transformation in HSCs. By combining systematic searching, bibliometric mapping and theory guided thematic analysis, the CBLR transforms the literature review from a summarizing exercise into a structured mechanism for conceptual discovery. The process documented in [Table 1](#) ensures that each methodological phase produces analytical outputs quantitative structures, thematic patterns and theoretical synthesis forming a transparent and reproducible workflow. This approach responds to recurring critiques in humanitarian logistics regarding the lack of methodological triangulation and insufficient theoretical articulation ([Frennesson et al., 2021](#)).

In addition, by embedding theoretical reasoning directly within the coding process, the CBLR demonstrates how theory can be used actively rather than retrospectively. DCT and STS guided theme development, ensuring consistency between

theoretical constructs and empirical findings. This theory driven synthesis strengthens construct validity and mitigates subjectivity in qualitative interpretation. The dual validation achieved through bibliometric analysis (quantitative confirmation) and thematic analysis (qualitative depth) demonstrates the potential value of combining quantitative and qualitative evidence within theory-driven humanitarian logistics reviews.

5.3 Practical and academic implications

From a practical perspective, the integrated framework outlined in [Table 7](#) May serve as a diagnostic tool for humanitarian managers. It allows organizations to assess digital readiness across both technical and social dimensions highlighting whether capability gaps arise from inadequate infrastructure, weak governance or limited human competence. For academics, the framework establishes measurable indicators for future hypothesis testing, enabling comparative studies across regions, technologies or organization types.

Theoretically, this paper situates digital humanitarianism as a meta capability phenomenon a higher order competence that encompasses sensing, seizing and reconfiguring within an ethically grounded socio technical environment. Methodologically, it provides a scalable model for future reviews that seek to integrate bibliometric data with interpretive theory building. Together, these contributions advance HSC scholarship toward greater analytical depth, empirical rigor and theoretical coherence.

From a managerial perspective, the findings suggest that humanitarian organizations should view digital transformation as a capability-building process rather than a technology acquisition initiative. Managers should prioritize investments that simultaneously strengthen technological infrastructure, employee competencies, data governance mechanisms and interorganizational collaboration. First, organizations should develop digital sensing capabilities through real-time visibility systems, predictive analytics and information-sharing platforms. Second, they should strengthen seizing capabilities by establishing collaborative decision-making processes and interoperable digital coordination mechanisms across humanitarian actors. Third, organizations should enhance reconfiguring capabilities through flexible logistics networks, automation technologies and adaptive resource allocation systems. Policymakers and humanitarian agencies should also address digital inequalities by supporting smaller organizations with funding, training and access to shared digital infrastructures. These actions can help ensure that digital transformation contributes to sustained humanitarian responsiveness, resilience and operational effectiveness.

5.4 Limitations and future research

Despite its contributions, this study has several limitations. First, the review was restricted to peer-reviewed journal articles indexed in the Scopus database and published in English, which may have excluded relevant studies from other databases, languages or practitioner sources. Second, although the CBLR approach enhances methodological transparency through systematic screening, bibliometric analysis and thematic synthesis, the findings remain dependent on the scope and quality of the available literature. Third, the proposed

Digital Transformation Capability Framework represents a conceptual synthesis derived from existing studies and has not been empirically tested. Future research should validate the framework across different humanitarian contexts, organizational settings and geographical regions. Particular attention should be given to underrepresented regions such as North America, Africa and Latin America, as well as emerging topics including cybersecurity, robotics, automation and ethical data governance.

6. Conclusion

The HSC continues to face mounting complexity as disasters become more frequent, unpredictable and globally interconnected. This paper has explored how digital transformation through IT and IS is reshaping the operational and strategic architecture of humanitarian logistics. Using the CBLR methodology, 94 peer reviewed articles published between 2013 and 2025 were analyzed through systematic, bibliometric and thematic integration. The results reveal a steady evolution of humanitarian digitalization from technology centered applications toward the formation of systemic digital transformation capabilities organizational competences that integrate technological agility, human adaptability and institutional governance.

The synthesis produced six dominant thematic clusters digital transparency and coordination, decision support analytics, logistics and inventory automation, facility location intelligence, routing and delivery innovation, and digital identification and victim management. These themes illustrate how digital technologies support dynamic processes of *sensing*, *seizing* and *reconfiguring* resources while depending on socio technical alignment to sustain ethical, efficient and adaptive operations. The integrated framework developed in this study confirms that digital transformation is not a discrete technological event but a capability building continuum that links infrastructure, data, people and governance across multiple organizational levels.

Importantly, this study distinguishes between dynamic capabilities and their resulting outcomes, where sensing, seizing and reconfiguring represent process-oriented capabilities, and agility, resilience and coordination effectiveness reflect the performance outcomes enabled by

these processes. By combining DCT and STS Theory, this review advances the theoretical understanding of how humanitarian organizations acquire and institutionalize digital competence. DCT captures the dynamic evolution of technological and organizational agility, while STS contextualizes this evolution within the social, ethical and institutional fabric that supports it. Together, these theories explain why successful digital transformation requires both technical efficiency and human institutional maturity.

The findings also highlight key research and practice gaps. Robotics, cloud integration, cybersecurity and digital ethics remain underexplored areas of inquiry. Regional asymmetry persists, with limited evidence from North America and the Global South. Addressing these gaps will advance the field toward more inclusive, evidence-based humanitarian digitalization. To translate theoretical insights into actionable guidance, [Table 6](#) summarizes the managerial and policy implications across multiple stakeholder levels.

6.1 Theoretical, methodological and practical synthesis

Theoretically, this study redefines humanitarian digital transformation as an interdependent capability system a dynamic mechanism by which organizations sense external shocks, seize technological opportunities, and reconfigure processes in alignment with human and institutional factors. This reconceptualization contributes to ongoing efforts to elevate humanitarian logistics into a theory driven discipline capable of explaining adaptation and resilience under uncertainty.

Methodologically, the study establishes the CBLR protocol as an integrated review approach that unites systematic transparency, bibliometric quantification and theory driven qualitative reasoning. By embedding DCT and STS within every analytical stage from data coding to synthesis the CBLR demonstrates how theoretical integration can generate deeper insight than either descriptive mapping or isolated empirical studies.

Practically, the study offers a roadmap for humanitarian leaders, policy makers and donors. As shown in [Table 8](#), digital transformation should be managed not as a collection of tools but as a strategic orchestration process requiring continuous learning, governance reform and inter agency cooperation. Investment decisions should prioritize socio technical readiness balancing infrastructure spending with workforce capability development and regulatory alignment.

Table 8 Managerial and policy implications of digital transformation capabilities in humanitarian supply chains

Stakeholder level	Strategic focus	Managerial / policy actions	Expected outcome
Operational (agency level)	Integrating digital tools within field operations	Adopt interoperable platforms, IoT enabled tracking, and data literacy training for staff	Faster situational awareness, minimized coordination delays
Organizational (NGO / government level)	Strengthening socio technical alignment	Implement governance frameworks, ethical AI standards, and unified data protocols	Enhanced transparency, accountability, and donor confidence
Interorganizational (network level)	Enabling cross agency data sharing	Deploy blockchain based coordination hubs and shared cloud repositories	Real time information exchange and synchronized logistics responses
National / regional policy level	Building data governance and digital resilience	Establish interoperability standards, privacy laws, and cybersecurity response frameworks	Secure, compliant, and resilient digital humanitarian systems
Global humanitarian ecosystem level	Promoting equitable access to digital capabilities	Create global funding incentives for technology transfer and training in resource limited regions	Narrowed digital divide and improved global disaster response capacity

Source(s): Author's synthesis based on insights from [Tables 3–5](#) and CBLR dataset (2013–2025)

6.2 Concluding remarks

In conclusion, the humanitarian sector's ability to anticipate, coordinate and recover from crises increasingly depends on its capacity to cultivate digital transformation capabilities the institutionalized ability to leverage technology, knowledge and collaboration under uncertainty. By advancing a dual theoretical foundation, a replicable methodology, and a set of actionable managerial guidelines, this paper provides both a conceptual and a practical contribution to humanitarian logistics scholarship. The findings underscore that digital transformation is neither a technological inevitability nor an administrative reform it is a strategic, socio technical evolution that determines the agility, transparency and legitimacy of humanitarian operations in the 21st century.

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Supplementary material

The supplementary material for this article can be found online.

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