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The Role of Humanitarian Logistics, Supply Chain Traceability, On Quality Healthcare: A Systematic Literature Review and Future Research Agenda

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ABSTRACT

This systematic literature review examines the role of humanitarian logistics and supply chain traceability in delivering quality healthcare, especially in disaster management. The literature search was completed on October 31st, 2023, using the PRISMA method. After combining results, 864 papers were selected, followed by 118 screening based on title and abstract to ensure alignment with review objectives and performance measurement scope. It highlights the importance of timely and efficient responses during crises, focusing on the integration of supply chain traceability systems, technological advancements, and stakeholder collaboration. The review identifies challenges and opportunities, offers insights into best practices, and addresses ethical considerations. The findings aim to inform policymakers and organizations, providing a comprehensive understanding of how the intersection of humanitarian logistics and supply chain traceability enhances healthcare services' resilience and effectiveness in disaster-prone regions. In response to global challenges, this systematic literature review investigates the relationship between humanitarian logistics, supply chain traceability, and quality healthcare. It highlights the significance of supply chain traceability in improving transparency, accountability, and service quality. The review also looks at technological enablers like blockchain, RFID, and IoT, emphasizing stakeholder collaboration for optimal disaster response.

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1. INTRODUCTION

In recent years, the intersection of healthcare, logistics, and disaster management has become critical, particularly in providing quality healthcare during crises(Centobelli et al., 2022). Humanitarian logistics practices, in conjunction with robust supply chain traceability systems, are critical to ensuring the resilience and effectiveness of healthcare delivery in the face of disaster(Biddle et al., 2020; Centobelli et al., 2022). This systematic literature review aims to investigate and synthesize existing research on the interactions between humanitarian logistics, supply chain traceability, and the delivery of quality healthcare, with a focus on disaster management scenarios.

Healthcare supply chains are complex ecosystems that necessitate seamless coordination and adaptability to deliver critical medical services, medications, and equipment, particularly in the face of natural disasters, pandemics, or other emergencies(Biswas et al., 2023). The incorporation of humanitarian logistics practices into healthcare supply chains has been identified as a critical strategy for improving responsiveness and mitigating the challenges posed by unpredictable and often chaotic disaster environments. The purpose of this review is to dissect the benefits, challenges, and lessons learned from integrating humanitarian logistics into healthcare supply chains, providing a more nuanced understanding of its impact on the quality and efficiency of healthcare services during crises. The role of supply chain traceability in healthcare is one critical aspect that has gained prominence in recent literature. As technology advances, the implementation of traceability systems, including blockchain, RFID, and IoT technologies, has emerged as a potential game-changer in improving the transparency, security, and efficiency of healthcare supply chains. (Kelepouris et al., 2007) The purpose of this review is to examine the current state of research on supply chain traceability in healthcare, with a particular emphasis on disaster management contexts, to uncover the contributions and challenges posed by advanced technologies in this domain. This paper aims to consolidate knowledge, identify gaps, and pave the way for future research directions by conducting a systematic review of the existing literature. Furthermore, the ethical concerns and privacy concerns associated with the implementation of traceability systems in healthcare supply chains will be investigated(Bosona & Gebresenbet, 2013). Recognizing the importance of balancing technological advancements with the protection of sensitive healthcare information(Birnbaum et al., 2018). This literature review aims to provide a comprehensive understanding of how humanitarian logistics and supply chain traceability contribute to the provision of quality healthcare in disaster-stricken environments by synthesizing insights from various sources.

Research Gaps: While the current literature recognizes the individual importance of humanitarian logistics, the traceability of supply chains, and the quality of health care in crises, there is a research gap in understanding the synergies and interdependence between these elements. The study aims to provide a comprehensive analysis of how humanitarian logistics and effective supply chain traceability contribute to the provision of quality medical care in emergencies and crises and to bridge this gap.

Novelty. It combines the interdependencies between humanitarian logistics, supply chain tracking, and healthcare quality in a crisis environment. The study also explores the integration of emerging technologies like blockchain and IoT to improve supply chain

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traceability. The research is based on various humanitarian contexts, including natural disasters, conflicts, and public health emergencies. It provides practical implications for humanitarian practitioners, policymakers, and organizations in crisis responses. The study emphasizes data-driven decision-making in humanitarian logistics and supply chain tracking, aiming to improve informed responses to crises. It contributes to the academic debate by bridging literature gaps on logistics, tracking, and healthcare quality in humanitarian contexts. The research incorporates lessons learned from previous crises into current practices, aiming to form more effective and resilient healthcare delivery systems. The interdisciplinary approach, combining logistics, information technology, public health, and humanitarian research, provides a comprehensive view of the complex relationships between logistics, traceability, and healthcare quality.

The main objective is to explore the role of humanitarian logistics and supply chain traceability in enhancing healthcare service delivery and quality during humanitarian efforts and Disaster response.

Humanitarian Logistics and Health.

Humanitarian logistics entails the planning, implementation, and coordination of goods and services delivery and distribution to people affected by disasters, conflicts, or crises(Kovács & Spens, 2009). Its goal is to ensure that the right resources get to the right place at the right time most cost-effectively and efficiently possible.

Risk Assessment: Before a crisis, humanitarian logisticians conduct risk assessments to identify potential hazards and vulnerabilities in the target regions(Heckmann et al., 2015). This data informs preparedness plans and aids in the pre-positioning of critical resources.

Scenario Planning: Humanitarian organizations use scenario planning to create response strategies for various types of crises(Smith, 2020). When an actual event occurs, this proactive approach allows for a faster and more targeted response.

Logisticians create contingency plans that outline alternative courses of action based on the evolving nature of the crisis(Natarajarathinam et al., 2009). This adaptability is critical in dealing with unexpected challenges.

Coordination and collaboration. Inter-Agency Cooperation: Humanitarian logistics requires collaboration among a variety of actors, including government agencies, non-governmental organizations (NGOs), international organizations, and local partners to coordinate and ensure that resources are pooled and efforts are streamlined.

Establishing effective communication channels and information-sharing platforms is critical for coordinating logistics efforts. This includes real-time data exchange on resource availability, transportation routes, and the status of affected areas.

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Cluster Approach: The United Nations-endorsed cluster approach organizes humanitarian actors into specialized groups or clusters (e.g., health, logistics, shelter) to improve coordination and avoid duplication of efforts(Oueiss, 2021).

Procurement: Humanitarian logisticians engage in strategic procurement to obtain required goods and services. This includes locating trustworthy suppliers, negotiating contracts, and ensuring the items' quality and appropriateness.

Inventory Management: Accurate inventories are essential for efficient resource allocation. Inventory management systems are used by humanitarian organizations to track stock levels, expiration dates, and consumption rates(Beamon & Kotleba, 2006).

Designing effective distribution networks entails taking into account the geographical layout of affected areas, transportation infrastructure, and the accessibility of distribution points(Klibi et al., 2010). This ensures that aid is delivered on time and in an equitable manner.

Last-Mile Delivery: The "last mile" challenge entails traveling to the most remote or difficult-to-reach locations (Ferrer et al., 2018). To overcome these challenges, humanitarian logisticians use innovative solutions such as drones, local partnerships, and community engagement.

Humanitarian Health: In this context, efforts should be made to prioritize emergency medical care, rebuild healthcare infrastructure, and ensure a timely and adequate supply of medical supplies and pharmaceuticals to address health needs in crises, including trauma care, surgery, disease prevention measures, and medical supplies. Humanitarian health interventions emphasize disease prevention and control via public health interventions, surveillance, and psychosocial support(Tol et al., 2012). Vaccination campaigns, hygiene promotion, and sanitation initiatives are examples of these. Counseling, community support, and trauma care are all integrated into healthcare services to address emotional and mental health challenges(North & Pfefferbaum, 2013)

QR1: How policymakers can improve the integration of humanitarian logistics and supply chain traceability into disaster management strategies to ensure timely and effective delivery of healthcare services to affected populations?

The integration of humanitarian logistics and supply chain traceability into disaster management aims to reduce response time, optimize resource allocation, and improve resilience(Masudin et al., 2021). It also addresses healthcare priorities and supports integration through legal and regulatory frameworks, data privacy concerns, and cross-border collaboration. The healthcare supply chain should adopt advanced traceability technologies like blockchain, and IoT(Dutta et al., 2020). Data standardization should be created for information sharing. Workforce development should focus on humanitarian logistics, disaster management, and healthcare delivery(Rodríguez-Espíndola et al., 2018). Interdisciplinary collaboration is encouraged for comprehensive understanding. Inter-agency and public communication are critical components of disaster management, ensuring seamless information sharing among agencies and building trust in response efforts through the use of

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dedicated platforms and standardized reporting mechanisms(Scholl & Klischewski, 2007).The importance of evaluating and monitoring integrated humanitarian logistics and supply chain traceability strategies through key performance indicators (KPIs), regular evaluations, and international collaboration(Patidar et al., 2023). It also highlights the need for collaboration with international organizations and donor agencies to secure funding and resources for disaster response.

QR2: What technologies such as blockchain, RFID, and IoT contribute to enhancing traceability and resilience in healthcare supply chains during disasters?

Blockchain is a decentralized ledger that records transactions across a network of computers, ensuring secure and transparent chains(Abeyratne & Monfared, 2016). It improves traceability, data integrity, and authentication by enabling smart contracts(Leal et al., 2021). Blockchain also prevents counterfeiting by verifying product authenticity at each stage of the supply chain(Montecchi et al., 2019). Its decentralized nature reduces reliance on central authorities, ensuring critical information remains accessible even during disasters. RFID technology allows for the tracking of individual items in real time, which aids inventory management during disasters (Ozguven & Ozbay, 2013). By eliminating manual data entry, it also improves data accuracy and efficiency(Khan & Manzoor, 2021). RFID technology automates processes such as receiving, storage, and distribution, allowing for faster response times(Angeles, 2005). It also helps to monitor the temperature of temperature-sensitive medical supplies, ensuring their integrity during transport and storage(Kartoglu & Ames, 2022). The Internet of Things (IoT) is a technology that collects real-time data on environmental conditions and the status of medical equipment, allowing for proactive maintenance and damage reduction during disasters(Thibaud et al., 2018). It establishes a connected ecosystem, ensuring stakeholders have access to comprehensive healthcare supply information. IoT data can be analyzed for predictive modeling using advanced analytics(Islam et al., 2015). By combining blockchain, RFID, and IoT, a comprehensive traceability system is created, ensuring data integrity and transparency(Centobelli et al., 2022). Data cross-verification improves reliability, especially in disaster situations, Finally, incorporating technology, collaboration, and lessons learned from previous disasters into a multifaceted approach to data cross-verification improves the reliability of information in disaster situations. Ethical considerations are critical in ensuring that the cross-verification process is carried out responsibly and with the well-being of affected populations in mind.

QR3: How ethical and privacy concerns should be addressed when implementing traceability systems in healthcare supply chains in humanitarian efforts and disaster response?

Healthcare supply chain management is crucial for humanitarian aid and disaster response(Van Wassenhove, 2006). Implementing traceability systems can improve efficiency and transparency, but ethical and privacy concerns must be addressed(Maon et al., 2009). Ethical supply chain traceability should prioritize equitable access to healthcare resources, ensuring equitable and just distribution without unintentionally favoring certain populations over others(Tursunbayeva et al., 2022). The significance of implementing a traceability system

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to address healthcare disparities and bridge access gaps(Cyril et al., 2015). It recommends real-time monitoring to detect and respond to emerging disparities while taking into account geographical diversity and challenges in disaster-affected areas(Andrienko et al., 2007). The system should include a wide range of stakeholders, maintain transparency in resource allocation, create adaptive protocols, and involve communities in the implementation process(Lockwood et al., 2010). It also emphasizes the importance of ongoing evaluation to identify and correct any unintended consequences during disaster response efforts(Cardona, 2013). The system should respond to local needs, adapt to changing circumstances, and empower communities to participate actively in their healthcare(Zimmerman, 2000). The importance of obtaining informed consent before collecting and using health data, as well as prioritizing data security, fostering transparency and accountability, taking cultural sensitivities into account, and implementing anonymization and de-identification processes(Andrew & Baker, 2021). It also emphasizes data minimization, secure transmission of health data across the supply chain, and limiting sensitive information storage(Andrew & Baker, 2021). It also emphasizes the importance of open communication channels, strong encryption, and long-term data retention policies to protect personal privacy and prevent unauthorized access.

2. METHOD

We conducted a Systematic Literature Review (SLR) by employing the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) methodology outlined in (Higgins & Green, 2008)and(Moher et al., 2015). PRISMA involves an iterative process of selecting and reviewing papers to develop a final collection of relevant articles for review. We chose the PRISMA methodology for this review since it is based on systematic and explicit guidelines and procedures to find, select, and critically analyze the relevant papers to incorporate into the review(Moher et al., 2015). It increases the reliability of the review by utilizing predefined procedures for reducing bias and extracting research trends and issues(Kashani et al., 2021). PRISMA has become a well-established and highly used systematic review method in the literature(Liberati et al., 2009). The following subsections describe the steps of our SLR methodology based on the PRISMA method, and the analysis we conducted to identify influential works and extract trends in the research papers.

For paper collection and refinement, we identified papers from two scientific databases: Emerald & Elsevier and Google Scholar. The keyword search was first performed using the Emerald & Elsevier and secondly, the Google Scholar database. The Emerald & Elsevier database was selected as it encompasses a comprehensive range of refereed journals belonging to major publishers. The key selection criterion was peer-reviewed published scientific articles written in English that addressed Humanitarian Logistics, Supply Chain Traceability, and quality Healthcare to Identify relevant papers, we used the following combinations of keywords using Boolean operators (AND, OR): “Quality Healthcare” OR “Humanitarian Logistics”, OR “Supply Chain Traceability” We repeated the exact search in the emerald & Elsevier database to ensure we included all the important papers. The literature search was finalized on October 31st, 2023. Flow Diagram 1: presents our SLR process using the PRISMA method. After combining the results from both databases, we had a selection of 864 papers. Removing duplicate entries led us to a selection of 835 papers. We then

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conducted an initial screening of the resulting 118 papers based on title and abstract to ensure the identified papers matched our review objectives and determine whether performance measurement was included in the scope of the papers. The search was restricted based on the following inclusion criteria:

- articles and journals;
- articles must be published in English;
- The full text of the article must be accessible;
- focus of the study should be on Humanitarian Logistics in developing countries.
- Articles must be published between 2014 - 2023

After studying frequently cited studies and significant writers' work on the topic of humanitarian logistics, the inclusion and exclusion criteria were chosen through a brainstorming session among all of the authors of this article. For the academic community, the Emerald & Elsevier and Google Scholar databases provide broad publishing coverage. To discover published articles on religion, we used specified search phrases in the Emerald & Elsevier and Google Scholar databases. The search was limited to titles, abstracts, and keywords, and was conducted in October 2023

Table 1. Research article distribution

No.	**By Topic**	No. of Articles	First Year	Last Year	
1	Humanitarian Logistics	65	2014	2023	Yes
2	E-Government Services	230	2014	2023	No
3	Supply chain management	54	2014	2023	Yes
4	Digital Innovations and Sustainable Supply Chain Management	198	2014	2023	No
5	Healthcare Delivery and Management	156	2014	2023	No
6	Blockchain-enabled Supply Chain Operations	97	2018	2023	Yes
7	Procurement process risk and performance	64	2014	2023	No
TOTAL		864			

The table displays the number of articles published on various humanitarian logistics and supply chain management topics. With 230 articles, "E-Government Services" is the topic with the most articles."Procurement process risk and performance" has the fewest articles, with 64. The most recent year in which an article on any topic was published was 2023. The first year in which an article on any topic was published was 2014. A column called "Yes" appears in the table. This column's value is "Yes" if the topic is related to humanitarian logistics, and "No" otherwise.

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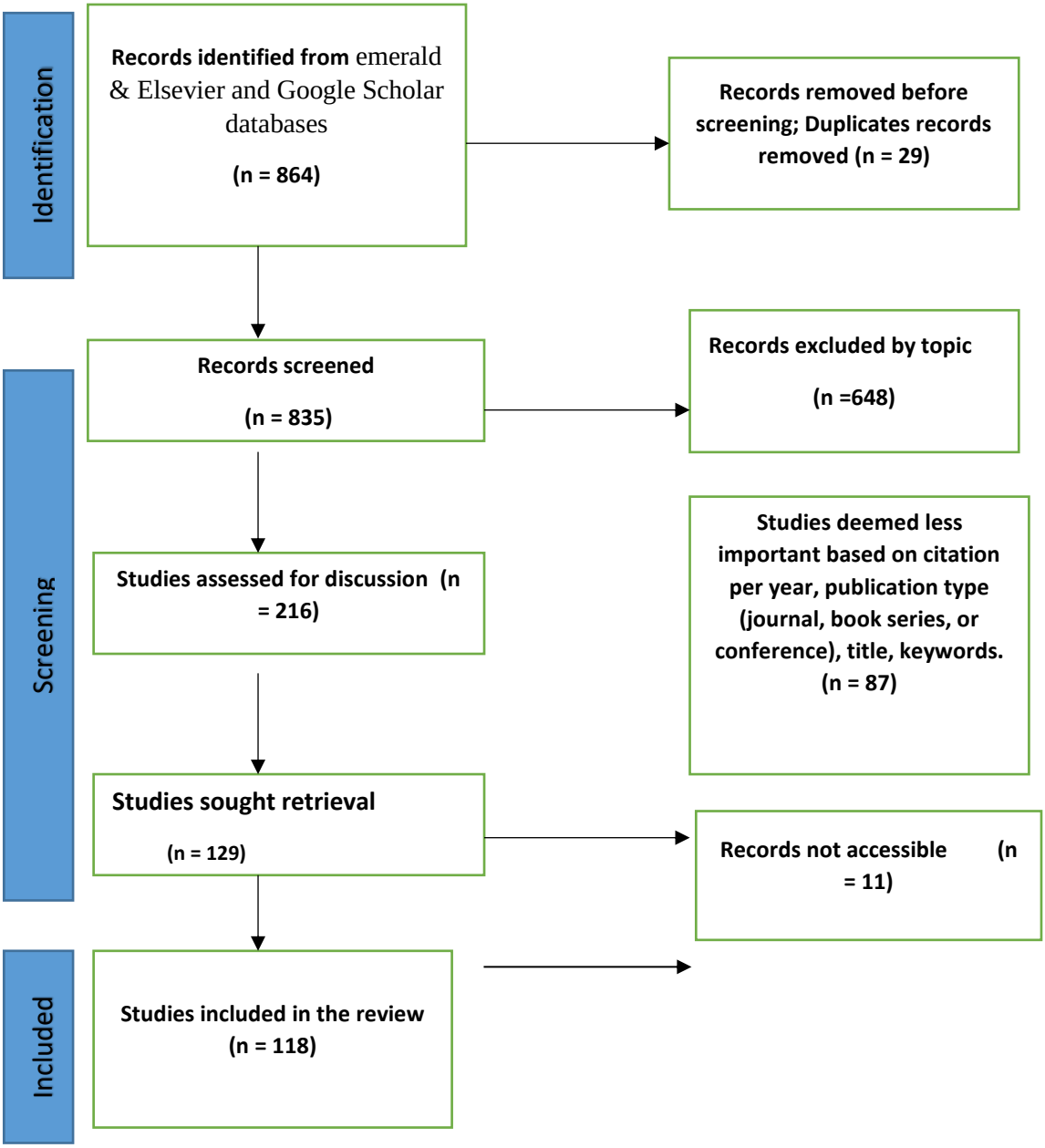

Flow Diagram 1: The search process and selection of articles using PRISMA.

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Table 2. ***shows some developing countries with their humanitarian organizations from Africa and Asia***

Country	Organization	Activities	Type of Disasters
Ghana	National Disaster Management Organization (NADMO)	Coordinates disaster management activities, providing emergency response and preparedness	Conflict, floods, food insecurity.
South Sudan	South Sudan Red Cross	Disaster response, healthcare, community-based programs, particularly in conflict-affected areas	Floods, landslides, droughts, earthquakes.
Uganda	Office of the Prime Minister - Department of Disaster Preparedness and Management	Coordinates disaster response efforts	Floods, landslides, droughts, earthquakes
Tanzania	Tanzania Red Cross Society	Disaster response, healthcare, and community resilience projects	Floods, disease outbreaks
Morocco	Moroccan Red Crescent	Disaster response, community-based programs, addressing challenges such as drought and floods	Drought, floods, earthquakes
Sri Lanka	Disaster Management Centre (DMC)	Coordinates disaster response and management efforts, addressing issues like floods and landslides	Floods, landslides, cyclones
Malaysia	National Disaster Management Agency (NADMA)	Coordinates disaster response efforts, including preparedness for floods and landslides	Floods, landslides, haze
Cambodia	Cambodian Red Cross Society	Disaster response, healthcare, community-based programs, addressing issues like floods and droughts	Floods, droughts, typhoons
Mongolia	National Emergency Management Agency (NEMA)	Coordinates disaster management efforts, including response to dzud (harsh winter) conditions	Dzud, earthquakes, droughts
Philippine	Philippine Red Cross	Provides disaster response, healthcare, and community resilience programs in the Philippines	Floods, public health emergencies & Earthquakes.
Afghanistan	National Disaster Management Authority (ANDMA)	Coordinates disaster response and management efforts, addressing issues like earthquakes and conflict-related crises	Earthquakes, conflict, floods, droughts

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Indonesia	Badan Nasional Penanggulangan Bencana (BNPB)	responsible for disaster risk reduction and response.	Earthquakes, landslides, floods, droughts

The disaster management organizations and their activities in various countries are summarized in this table. The table also details the difficulties that these organizations face in carrying out their missions. In these countries, disaster management is handled by a variety of organizations. Government agencies, non-governmental organizations (NGOs), and Red Cross/Crescent organizations are among those represented. The table above shows, that there is no direct link between these activities of the organization to supply chain traceability on quality healthcare which justifies the gap of the study. The activities of these organizations vary depending on the country's specific needs. Disaster response, healthcare, community-based programs, and disaster preparedness are all common activities.

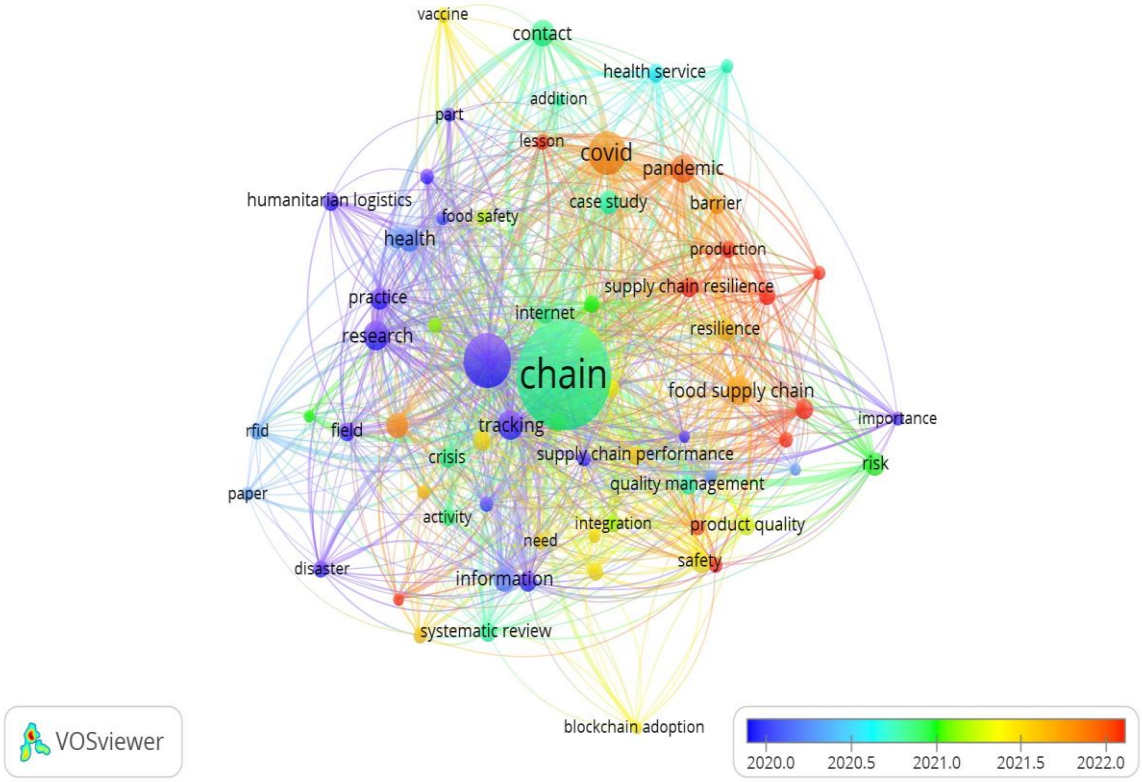

Figure 1. The Vos viewer shows the relationship between humanitarian logistics, supply chain traceability, and healthcare.

The purple circle in the Vos viewer highlights the significance of traceability in humanitarian logistics supply chains, while the yellow circle emphasizes its role in improving healthcare quality. As seen in the purple node “traceability” and the yellow node “quality healthcare”, the lines indicate relationships between concepts, with thicker lines indicating stronger connections. Traceability is crucial in humanitarian logistics and quality healthcare by ensuring product movement, preventing counterfeiting, and proper storage and transportation, thus improving safety, effectiveness, and efficiency in healthcare delivery.

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Humanitarian logistics entails delivering aid to those in need, a complex and difficult process that benefits from traceability. For efficiency and effectiveness, the supply chain, which includes organizations that donate, transport, and distribute aid, is critical. The ability to trace vaccines, food, and medical devices is critical to ensuring their safety and effectiveness. It aids in the identification and isolation of contaminated items, thereby preventing serious illness or death. It also aids in the sterility of medical devices, thereby preventing infections and complications. As a result, traceability is critical in humanitarian work. Overall, the Vos viewer demonstrates that humanitarian logistics supply chain traceability is a critical tool for improving healthcare quality. Aid workers can ensure that the right products are delivered to the right people at the right time by tracking the movement of products through the supply chain. This has the potential to save lives and improve the lives of those in need. The demonstration from the VOS viewer shows that blockchain plays a major role in humanitarian crises but faces several challenges hence its isolation or not being closed to chain activities to give effect to quality healthcare. Blockchain in humanitarian emergencies is hindered by a lack of understanding, complexity, regulatory ambiguity, cost considerations, interoperability challenges, stakeholder resistance, short-term focus, and a fragmented environment. The technology requires substantial investment in capacity building and training, and understanding these intricacies is crucial for successful implementation. Although it requires greater knowledge, capacity building, regulatory compliance, cost-effective solutions, interoperability standards, stakeholder engagement, and collaboration, blockchain technology has enormous promise for humanitarian endeavors. To establish a responsible, significant environment, technologists, legislators, and humanitarians must work together.

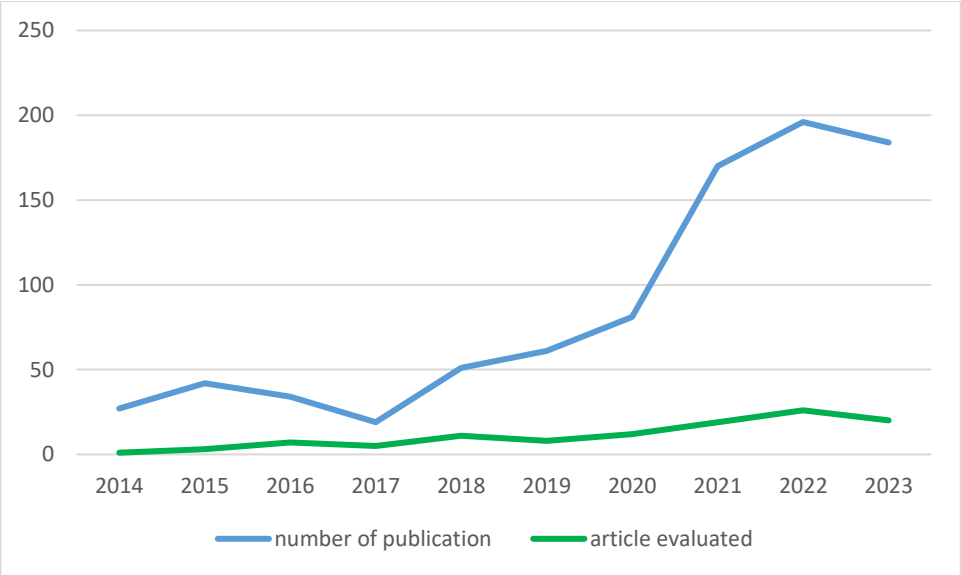

Figure 2. shows the number of articles published and articles evaluated.

The graph shows a steady increase in publications and articles evaluated from 2014 to 2023, with over 200 articles evaluated in 2023. The blue line indicates the number of publications, while the green line indicates the number of articles evaluated.

This indicates that the field's popularity and importance are growing, while the slower growth in articles could be due to the time it takes for new research to be published.

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Furthermore, the field is becoming more selective, with articles being evaluated more slowly than publications. However, the graph only displays data for one field, and its trends may not be representative of the entire field.

3. RESULTS AND DISCUSSION

The systematic review of 118 articles explores the intricate dynamics of humanitarian logistics, supply chain traceability, and healthcare delivery in challenging environments. The paper synthesis highlights the critical role of logistics in humanitarian healthcare, emphasizing efficient supply chain management for timely delivery. Supply chain traceability positively impacts healthcare quality, leading to better inventory management, reduced waste, and higher efficiency, facilitating better decision-making and resource allocation. In times of crisis and disaster, the quality of healthcare is significantly impacted by humanitarian logistics(Organization, 2021). Its impact is wide-ranging and addresses important facets of the provision of healthcare. The logistics and traceability challenges and barriers such as infrastructure issues, political instability, and stakeholder interoperability(Hastig & Sodhi, 2020). The impact of humanitarian logistics on healthcare quality is complex and includes infrastructural support, information management, coordinated healthcare operations, prompt response, effective supply chain management, and assistance for medical personnel(Adams et al., 2015). In disasters and crises, a well-executed humanitarian logistics plan helps to improve the general efficacy and caliber of healthcare services(Van Wassenhove, 2006). Healthcare needs, local infrastructure, and the sociopolitical environment are all context-specific factors that must be considered for the successful implementation of humanitarian logistics and supply chain strategies(Kotsi et al., 2014). The literature highlights the growing integration of technological innovations in humanitarian logistics, such as blockchain, IoT, and data analytics, for improved traceability and decision-making(Beamon & Kotleba, 2006). However, gaps in existing literature exist, requiring further investigation into long-term impacts, challenges, and emerging technologies' role in future crises. The findings have significant implications for practice and policy. The 118 articles systematically reviewed emphasize the significance of humanitarian logistics and supply chain traceability in ensuring quality healthcare in crisis situations. It recommends further research on regional challenges, emerging technologies, and longitudinal studies to evaluate the long-term impact of logistics interventions on healthcare quality. This discussion provides a structured and comprehensive overview of the systematic literature review's key findings, highlighting the nuances and complexities inherent in the relationship between humanitarian logistics, supply chain traceability, and quality healthcare.

4. CONCLUSION

This systematic literature review provides a thorough examination of the complex relationship between humanitarian logistics, supply chain traceability, and the provision of quality healthcare in difficult environments. A review of numerous studies reveals a general agreement on the critical importance of well-organized logistics and transparent supply chains in ensuring the delivery of timely, efficient, and high-quality healthcare services during humanitarian crises. The findings highlight the importance of a comprehensive approach to

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humanitarian healthcare delivery, including logistics and supply chain management. According to the reviewed literature, improved traceability within the supply chain not only optimizes resource allocation but also improves the overall quality and safety of healthcare interventions. Access to accurate and timely information promotes better decision-making, allowing stakeholders to navigate the complex challenges inherent in humanitarian settings. This systematic review of the literature confirms the significance of humanitarian logistics and supply chain traceability in ensuring quality healthcare. It emphasizes the evolving relationship and suggests addressing gaps to improve healthcare supply chain resilience. The findings help to shape evidence-based practices and policies.

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