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EDITORIAL

Design and management of humanitarian supply chains for pandemics: lessons from COVID-19

Rameshwar Dubey[1] · **David J. Bryde**[2] · **Cyril Foropon**[1]

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Abstract
The COVID-19 pandemic has been an unprecedented challenge for humanity, causing widespread disruptions to daily life and economies worldwide. However, amidst the challenges, it has also presented an opportunity to reflect on our competencies, capabilities, and objectives. One area that has gained significant attention during this time is the humanitarian supply chain management theories, which offered significant directions to the scholars engaged in operations and supply chain management, practitioners and policy-makers. To further advance the theoretical boundaries of the humanitarian supply chain and expand the scope and boundaries of the discipline, a special issue has been organised. This issue includes 24 carefully selected articles that have gone through multiple rounds of review. The articles are all centred on the humanitarian crisis resulting from COVID-19 and offer a comprehensive understanding of the challenges faced by various stakeholders. Additionally, one relevant article from a previous issue has been included, which explores the potential use of drones in disaster relief operations. The articles included in this special issue have significant implications for theory, practice, and policy, providing valuable insights and direction for further research to expand the scope of the discipline. This particular issue is a crucial contribution to humanitarian supply chain management. It provides a deeper understanding of the complex challenges faced during a crisis and the best practices to overcome them.

Keywords Humanitarian supply chain management · Humanitarian operations management · COVID-19 · Pandemic · Optimisation · Supply chain viability

✉ Rameshwar Dubey
r.dubey@montpellier-bs.com; r.dubey@ljmu.ac.uk

David J. Bryde
D.J.Bryde@ljmu.ac.uk

Cyril Foropon
c.foropon@montpellier-bs.com

[1] Montpellier Business School, 2300 Avenue des Moulins, Montpellier 34185, France

[2] Liverpool Business School Liverpool John Moore's University, Liverpool, Merseyside L3 5UG, UK

1 Introduction

The coronavirus pandemic has disrupted the supply chains of every sector worldwide (Flynn et al., 2021; Ivanov, 2021). The virus, which first emerged in late 2019, spread rapidly, resulting in widespread illness, death, and economic disruption (Handfield et al., 2020). The event caused by COVID-19 has caused severe health problems. To prevent the spread of the disease, governments across the globe took severe measures in the initial days, such as strict lockdowns, isolation, and no mobility (Ivanov, 2020). These measures have had far-reaching consequences, including job losses, school closures, and mental health issues (O'Connor et al., 2020; Flynn et al., 2021). The pandemic also highlighted the need for investment in healthcare systems and international cooperation to prevent future outbreaks (Sigala et al., 2022).

Amidst the severe unprecedented health crisis, it has become evident that commercial supply chains are not the only fragile ones (Lin et al., 2021). The healthcare supply chain is one of the many that the pandemic has severely impacted (Spieske et al., 2022). The shortage of personal protective equipment (PPE) and medical supplies, such as ventilators and testing kits, has put immense pressure on the healthcare industry (Finkenstadt & Handfield, 2021). Many hospitals and healthcare facilities were caught off guard due to the sudden surge in demand, and the lack of preparedness led to chaos and panic (Chowdhury et al., 2021; Harland et al., 2021; Rahman et al., 2022). The crisis has highlighted the need for a resilient healthcare supply chain that can withstand unforeseen events and adapt to changing circumstances (Scala & Lindsay, 2021).

The ongoing health crisis has brought to light several concerns regarding the efficiency and resilience of global supply chains. This has highlighted the need for supply chain professionals to adopt an approach inspired by the principles of the humanitarian supply chain (Kovács & Sigala, 2021). This means focusing on delivering essential goods and services in a timely and cost-effective manner while prioritising the needs of vulnerable populations (Altay et al., 2021). By doing so, supply chain professionals can help ensure that critical supplies, such as medical equipment and personal protective gear, reach those who need them most (Spieske et al., 2022). Additionally, by following the principles of the humanitarian supply chain, companies can build more agile and flexible supply chains that can better adapt to unexpected disruptions in the future (Saïah et al., 2023).

Although there is an increasing interest within the academic community to address the issues related to supply chain designs inspired by humanitarian supply chains, there remains a significant lack of literature on this topic (Wagner & Thakur-Weigold, 2018; Kovács & Sigala, 2021; Dubey, 2022). This lack of research hinders the development of effective and efficient supply chain designs that address the unique challenges of humanitarian operations, such as unpredictable demand, limited resources, and complex logistics (Dubey et al., 2022; Urbaczewski & Lee, 2020). Therefore, it is crucial to conduct further research to improve the effectiveness of humanitarian supply chain designs, which will ultimately help save lives and improve the well-being of affected communities.

Due to the immense challenges posed by the pandemic, we have identified several research gaps in managing and designing humanitarian supply chains. We have decided to organise a particular issue focusing exclusively on this topic to address these gaps. This special issue aims to provide a comprehensive understanding of the challenges that arise during pandemics and to explore strategies for managing them effectively. The lessons we learned

from the COVID-19 pandemic will be used to build a theoretical framework to guide future pandemics. We believe this framework will be invaluable for policymakers, supply chain managers, and researchers interested in developing more robust and resilient systems for managing pandemics. In summary, this special issue will provide a platform for researchers to share their insights and experiences in managing and designing humanitarian supply chains during pandemics. We hope this will lead to a better understanding of the challenges and help us build more effective systems for managing pandemics.

The preface is structured in the following way. The second section of the outlines the need for a special issue focused on designing and managing humanitarian supply chains. The third section explains how we attracted submissions and our approach to handling them. In the fourth section, we present a detailed analysis of the accepted articles for the special issue. Finally, we discuss the theoretical contributions, implications for practitioners and policymakers, and limitations of the special issue that motivate further research to advance the current body of knowledge to the next level.

2 Need for the study on the design and management of humanitarian supply chains

Over the past three decades, there have been remarkable improvements in the humanitarian supply chain. These developments are primarily attributed to the tireless efforts of scholars engaged in management science, decision analytics, healthcare operations management, humanitarian supply chain, and other interdisciplinary areas (Van Wassenhove, 2006; Altay & Green, 2006; Kovács & Spens, 2007; Kovács & Spens, 2011). Humanitarian supply chains are complex systems that deliver essential goods and services to people affected by natural disasters, conflicts, or other crises (Balcik et al., 2010). NGOs and government bodies are the primary actors responsible for managing these supply chains (McLachlin & Larson, 2011). The process involves various activities, such as procurement, transportation, warehousing, and distribution of supplies to the affected areas (Van Wassenhove, 2006). Due to the challenging nature of these events, virtual teams are often employed to manage humanitarian supply chains (Tatham & Kovács, 2010). Virtual teams are individuals working together remotely, using technology to communicate and collaborate (Dubey et al., 2019). They are an effective solution for managing humanitarian supply chains as they allow for quick and efficient decision-making, regardless of the location of team members (Ruesch et al., 2022). Moreover, virtual teams bring together experts from different fields, such as logistics, procurement, and information technology, to achieve a common goal (Adsanver et al., 2023). This interdisciplinary approach enhances the efficiency and effectiveness of humanitarian supply chains, ultimately enabling relief efforts to reach those in need more quickly and efficiently (Altay et al., 2021).

The COVID-19 crisis brought attention to the need for a comprehensive and effective supply chain that combines commercial and humanitarian aspects (Saïah et al., 2023). The supply chain must address the market's commercial and the affected population's humanitarian needs (Kovács & Sigala, 2021). The role of technology in tracing and tracking victims has become increasingly important (Urbaczewski & Lee, 2020). This allows for better identification and isolation of infected individuals, ultimately reducing the spread of the

virus. Additionally, technology has ensured timely treatment for those affected (Phillips et al., 2021).

The humanitarian aid supply chain has been redefined due to the pandemic, and it now requires an increased reliance on emerging technologies (Friday et al., 2021; Xu et al., 2023). These technologies can optimise supply chain processes, increase transparency, and improve efficiency (Choi, 2021). By combining the commercial and humanitarian aspects of the supply chain and leveraging emerging technologies, we can create a more robust and effective supply chain that is better equipped to handle crises like the COVID-19 pandemic.

3 Article summaries

The call for papers was developed to attract submissions that throw significant light on the ongoing crisis and reflect on the humanitarian supply chain discipline based on the learnings from the pandemic. The call for papers specifically emphasised the need for submissions that could contribute to advancing theoretical debate on this topic. As part of this initiative, we invited publications that offered a critical literature review, which could serve as a foundation for further research. We also welcomed empirical studies based on either positivistic or interpretivist philosophy, as well as mathematical modelling works that had the potential to shed new light on the existing discourse around humanitarian supply chain design. Our goal was to encourage submissions that provided a nuanced understanding of the complexities of designing and managing humanitarian supply chains, especially during a global health crisis. We were particularly interested in papers that offered rich directions for future research and helped to bridge the gap between theory and practice in this area. In response to the call for papers, we invited several submissions. However, we had to reject most of them at the desk review stage due to poor fit with the call for papers or high similarity, and the remaining ones were mainly rejected during the first or second round of reviews. Finally, after multiple rounds of reviews, we included 25 articles in the special issue. This section presents a critical overview of these articles.

The first article by *Kumar et al.* presents a comprehensive literature review that focuses on the various factors that influence the design of supply chains in the humanitarian sector. They analysed the different models, concepts, and trends that have emerged in this field and critically evaluated their effectiveness in addressing the needs of disaster-affected populations. Moreover, the COVID-19 pandemic has presented new challenges for humanitarian supply chain professionals. The outbreak has created unprecedented demand for medical supplies, equipment, and personnel and has disrupted global supply chains. As a result, supply chain experts have had to devise innovative strategies to manage the logistics of delivering aid and ensure that resources are allocated equitably to those who need them most. The humanitarian supply chain industry has turned to technology to address these challenges. Various digital tools, such as blockchain, artificial intelligence, and the Internet of Things, have been deployed to increase supply chain transparency, enhance inventory management, and improve coordination between stakeholders.

The second article, by *Queiroz & Fosso Wamba*, delves into how emerging technologies have enabled humanitarian organisations to respond more effectively to the evolving needs of disaster-affected populations. They highlight how these technologies have made it possible for organisations to understand better the needs of people affected by disasters and to

deliver assistance more timely and efficiently. The authors also discuss how technology has helped mitigate the pandemic's impact on supply chain operations, which is crucial in ensuring that humanitarian aid reaches those who need it most.

The third article of the same issue, *Altay et al.*, provides a critical overview of innovation in the humanitarian supply chain. They argue that the COVID-19 crisis has significantly shaped humanitarian supply chain activities, as organisations increasingly rely on technology to deal with disaster-affected people and provide humanitarian assistance. The authors discuss the different ways technology has been used in the field, including drones, artificial intelligence, and blockchain.

The fourth article, *Akter et al.*, contributes to micro-foundations of the analytics empowerment capability for humanitarian service systems. The authors provide new and novel insights to humanitarian scholars who are engaged in understanding how the humanitarian sectors can embrace technology to alleviate the suffering that is often due to a lack of visibility and poor coordination among relief actors. They argue that using data analytics can help organisations better understand the needs of people affected by disasters and aid in a more targeted and efficient manner.

The fifth article of the issue, contributed by *Kondraganti et al.*, offers a comprehensive review of big data analytics in humanitarian relief actions. The authors discuss how organisations have used big data analytics to improve their operations, including data to predict which areas are most likely to be affected by disasters and to monitor the impact of relief efforts.

The sixth article, contributed by *Shayganmehr et al.*, provides empirical evidence on how Industry 4.0 technologies help enhance the swift trust among various humanitarian actors. The authors argue that using technologies such as the Internet of Things, cloud computing, and robotics can help improve coordination among relief actors and aid more timely and efficiently. They provide examples of how these technologies have been used in the field and discuss the potential benefits they can bring to humanitarian operations.

The seventh article, *Narayanan and Altay*, comprehensively analyses the humanitarian sector's long-term planning strategies, often overlooked in their operational frameworks. The authors emphasise the importance of developing ambidextrous capabilities that enable relief agencies to manage short-term and long-term disasters effectively. The COVID-19 pandemic has further highlighted the need for humanitarian organisations to prioritise long-term planning in their strategies. The crisis has posed unprecedented challenges for relief agencies worldwide, necessitating the development of agile and flexible approaches that can adapt to rapidly changing circumstances. In response to the pandemic, relief agencies have been compelled to adopt a more comprehensive and integrated approach to disaster management. This involves developing cross-functional teams, collaborating effectively, and coordinating response efforts across multiple sites and agencies. Narayanan and Altay's article contributes to the humanitarian sector's ongoing efforts to improve its long-term planning and response capabilities. Their insights can help relief agencies develop more effective and sustainable strategies that can withstand the challenges of both short-term and long-term disasters.

In the eighth article, *Ruel et al.* have made significant efforts to operationalise the construct of supply chain viability. Their study offers a helpful guide for future scholars investigating the viability of the humanitarian supply chain. In summary, supply chain viability is critical to designing and building a sustainable and resilient humanitarian supply chain.

By considering viability in supply chain design and management, organisations can ensure that their supply chain can adapt to changing situations and sustain its operations over an extended period. Supply chain viability is a term used in the operations management literature to describe the ability of a supply chain to maintain itself and survive in a changing environment. It is considered an extension of supply chain resilience, which focuses on the ability of a supply chain to recover from disruptions. However, viability goes beyond resilience and emphasises the long-term sustainability of the supply chain. Viability is a crucial aspect of designing and building a humanitarian supply chain. In humanitarian operations, the supply chain needs to adapt to changing situations and sustain its operations over an extended period. This requires redesigning the supply chain structures and planning performance with long-term impacts in mind. Despite its importance, viability is still nascent, and further theoretical understanding is needed to advance the concept. Hence, we believe the contribution made by Ruel and the team will be helpful to theoretical work to advance the supply chain viability debate further.

The ninth article, *Dohale et al.*, delves into a detailed examination of the challenges faced by humanitarian supply chains. The authors employed an exploratory method called neutrosophic ISM to analyse the barriers hindering the smooth functioning of these supply chains. This method is known for handling vagueness and uncertainty in decision-making. The study aimed to identify the factors that impact the performance of humanitarian supply chains and to provide insights into how these barriers can be overcome. The research findings can benefit aid organisations and policymakers working towards improving the efficiency and effectiveness of humanitarian supply chains.

The tenth article by *Sharma et al.* provides a detailed analysis of the challenges faced by rural food grain distribution systems during the COVID-19 lockdown. The article is a valuable resource for humanitarian supply chain organisations dealing with similar challenges in aiding victims of disasters such as earthquakes and geopolitical crises. The study presents insightful lessons for these organisations to ensure the efficient distribution of food and medicine to those in need. The research offers a comprehensive guide for humanitarian agencies that are currently grappling with restrictions imposed on Gaza's relief operations by military organisations due to a breakdown of trust between civilians and the military. The study's findings can potentially help such agencies overcome logistical challenges and ensure the smooth delivery of aid to those in need. Furthermore, the research applies not only to the current crisis but also to other relief efforts. The article demonstrates the significance of efficient supply chain management in providing humanitarian aid during crises and the importance of establishing trust between the affected communities and the aid providers.

The eleventh article, authored by *Cunha et al.*, constitutes a significant contribution to the existing body of knowledge. The article sheds light on the challenges faced by citizens residing in developed or developing economies who do not have access to any financial assistance from their respective governments during the ongoing lockdown, which was enforced to prevent the spread of the COVID-19 virus. The lockdown has led to a severe financial crisis for a significant section of society, particularly those employed in informal sectors, who are not entitled to social security benefits. In such a scenario, donations can serve as a helpful way to alleviate the poverty faced by such individuals, especially in developing economies where most of the population resides in low-income households. The article also highlights the importance of effectively distributing donations, ensuring they reach the intended beneficiaries promptly and efficiently. The authors suggest that non-gov-

ernmental organisations (NGOs) can play a critical role by collaborating with local authorities to identify individuals and communities needing assistance and delivering donations to them. Overall, the article provides valuable insights into the impact of the pandemic on vulnerable communities and emphasises the need for collective efforts to address the challenges posed by the ongoing crisis.

The twelfth article by *Yang et al.* develops optimisation models for disaster relief designed to improve the robustness of relief operations in the face of unpredictable crises. The models involve stocking multiple relief items at strategic locations, and they employ distribution-free uncertainty sets to account for deviations from model assumptions. The findings of this study are particularly relevant for humanitarian scholars dealing with unpredictable crises. Optimisation models that can account for uncertainty and adapt to changing conditions can significantly improve the efficiency and effectiveness of disaster relief efforts.

The thirteenth article by *Sharmin et al.* delves into the critical success factors (CSFs) essential for managing multiple emergencies concurrently during the COVID-19 crisis. This is particularly important for building a robust disaster relief chain. The authors employed a revised rough-DEMATEL approach to evaluate the interdependence between the factors ranked based on the average vector length. The study identified the most crucial concurrent emergency management (CEM) factors as *"incremental improvement of proactive measures," "resilient supply chain and logistics network," and "government leadership and military cooperation*." This research can be a foundation for policymakers, managers, and practitioners to develop an effective CEM plan.

The fourteenth article by *Zhu et al.* proposes a collaborative optimisation model to address the challenges of disaster relief supply chains during large-scale disasters. Existing optimisation models for such operations have certain limitations. The proposed model selects optimal emergency material suppliers and runs a multi-objective fuzzy optimisation in three emergency phases. The authors tested their algorithm in a flash flood disaster event in Yunnan Province. They were able to optimise emergency material planning and maintain reserve material safety inventory at a reasonable level. The results further motivate future researchers to implement the algorithm to tackle complex disaster relief problems in different contexts.

The fifteenth article by *Song et al.* emphasises the importance of an anti-epidemic supply chain to control COVID-19. They studied how technological innovation affects the supply under demand and supply uncertainties. Findings showed that shortage penalties increase costs but improve demand satisfaction. Technological innovation reduces costs, with transportation innovation having the most significant influence. Both supply and demand uncertainties impact costs, but demand uncertainty has a more substantial influence.

The sixteenth article by *Mishra et al.* aims to address a critical problem related to humanitarian relief aid. The disaster relief location problem is considered a significant challenge due to the uncertainties related to supply and demand. In this study, the authors have proposed a two-stage relief distribution location problem to determine the minimum number of DCs required and their optimal location to minimise the total cost. To solve this complex problem, a novel two-phase algorithm has been developed, which is more efficient and effective than conventional metaheuristic methods. The authors have demonstrated this through a comparative analysis with other well-known algorithms.

The seventeenth article by *Cao et al.* addresses a critical problem related to waste management resulting from humanitarian relief efforts during the COVID-19 pandemic. Spe-

cifically, the authors aim to create a sustainable, multi-period system for collecting and disposing medical waste. To achieve this, they use a multi-objective optimisation model to maximise economic benefits, minimise carbon emissions, and reduce social risks. The model is tested using a real-world case from Wuhan, and the results suggest that flexible disaster medical waste treatment systems are necessary to handle increases in waste production over time. Given limited social resources, estimating the minimum budget required to achieve optimal performance is essential.

The eighteenth article by *Aringhieri et al.* attempts to address a daily swab test problem during the COVID-19 crisis. Daily swab tests played a vital role in identifying and tracking the spread of the virus. By testing individuals regularly, healthcare professionals could quickly identify and isolate those infected, helping to slow the spread of the virus. The authors in this study present the daily swab test collection (DSTC) problem to tackle the crisis most effectively. In this article, the authors have formulated the DSTC as a variant of the team-orienting problem and provided new benchmark instances, two efficient algorithms, and managerial insights into the fairness of swab collection during the COVID-19 crisis. The study's findings can help deal with similar challenges, especially with infected diseases.

The nineteenth article by *Eriskin et al.* sheds light on a crucial issue faced by the healthcare sector worldwide during the initial days of the pandemic. The study reveals that hospitals were not adequately equipped to handle such a massive crisis, as they were not prepared in terms of healthcare staff, resources such as PPE, and medicines to deal with the initial wave. By employing advanced analytical techniques, the study aims to improve healthcare authorities' preparedness and response effectiveness in combating pandemics/epidemics in the future. The article provides valuable insight into the importance of prompt action and preparedness of healthcare systems in dealing with crises of such magnitude.

The twentieth article by *Warrier et al.* discusses how disasters can impact human emotions. Due to the COVID-19 pandemic, people have had to rely on virtual communication, affecting their mobility and interaction. The authors conducted a study with 296 participants to understand the influence of emotional intelligence and the way they communicated through virtual platforms on effective decision-making ability. They found that emotional intelligence is crucial in moderating the relationship between virtual communication effectiveness and decision-making. The statistical analyses show that these results can be helpful for professionals who use virtual communication platforms and policymakers who may consider policy amendments to reduce stress caused by virtual communication. The study highlights the importance of emotional intelligence training to enhance virtual communication and decision-making effectiveness during the pandemic. These results can be applied to any disaster-affected situation where emotional stress from isolation causes extreme challenges.

The twenty-first article by *Han et al.* addresses the major shipping industry problem during the challenging times resulting from COVID-19. The COVID-19 pandemic has had a major impact on the shipping industry, causing significant disruptions to the global supply chain. As a result, companies operating in the cross-border e-commerce market are finding it increasingly challenging to stay competitive. In response, many businesses have begun offering free shipping to attract and retain customers and boost their profits. The authors have analysed the impact of raising the free shipping threshold on consumer behaviour and corporate profits, providing valuable insights on determining the optimal threshold. The study found that increasing the threshold within a specific range can positively impact

average order prices and gross profit margins while reducing costs. However, setting an excessively high threshold can lower the customer conversion rate, making attracting and retaining customers challenging. This study offers practical guidance for companies developing effective free shipping policies in cross-border e-commerce. By using this information, businesses can find the optimal threshold that balances the need for profitability with the desire to attract and retain customers. This can ultimately help businesses stay competitive in a challenging market environment.

The twenty-second article by *Kapoor et al. (2021)* explores the complex relationship between the humanitarian crisis caused by the COVID-19 pandemic and its impact on the manufacturing industry. The authors provide a thorough analysis of how the humanitarian supply chain crisis and the commercial supply chain crisis are interconnected, emphasising the need for a comprehensive approach. The COVID-19 pandemic has significantly disrupted the manufacturing sector, leading to extensive consequences for production networks and supply chains. This research highlights the importance of adopting a holistic perspective when addressing the challenges of the humanitarian crisis in supply chain management.

The twenty-third article by *Robert et al.* delves into the challenges organisations face in maintaining their efficiency during times of humanitarian crisis. The authors highlight the importance of management innovation in enabling organisations to remain competitive amidst the unprecedented scale of disruption caused by such crises on various economic activities. The study provides a comprehensive analysis of the efforts made by commercial organisations to remain effective and efficient during such crises. The authors demonstrate how these organisations have successfully navigated the challenges of crises, utilising innovative management practices to ensure business continuity. The article is particularly relevant for humanitarian scholars, as it offers valuable insights on how commercial organisations have contributed to society's overall resilience during times of crisis. The authors emphasise the need for further research in this area to better understand the potential roles of different stakeholders in mitigating the impact of humanitarian crises.

In the twenty-fourth article by *Ivanov*, the author discusses solutions for commercial manufacturers dealing with the COVID-19 crisis. Due to the pandemic, supply chains have been disrupted, creating significant business challenges. Ignoring the "*disruption tails*" risk can lead to decreased performance, product deficits, and high inventory costs. In this study, the authors used a simulation technique to model the current scenario using several possibilities to provide a robust solution to tackle the COVID-19 crisis. The study offers a direction to future organisations grappling with humanitarian crises.

In the twenty-fifth article by *Edwards et al.*, an investigation was carried out on the application of drones in humanitarian crises. While this article was not originally part of the special issue, it was included due to the relevance of its findings. The authors highlight the significant role that drones can play in providing solutions to humanitarian crises, particularly in situations where traditional modes of transportation are not feasible or safe. The article sheds light on using drones where access to affected areas, such as dense forests or disaster-hit locations, is limited. Drones can provide a bird's eye view of the situation, which can help assess the extent of the damage and the number of people affected. This information can then be used to plan and execute relief operations more efficiently.

During the COVID-19 pandemic, when strict lockdowns were imposed, drones were used to transport essential medical supplies to remote areas where traditional transportation was restricted. They also monitored compliance with lockdown rules and ensured that

people followed social distancing protocols. This helped to limit the virus's spread and keep people safe. In conclusion, drone technology offers significant solutions to humanitarian crises, and their potential should be further explored. The article by *Edwards et al.* provides valuable insights into the application of drones in such situations and highlights their potential to provide effective and efficient relief operations.

4 Contribution to theory, practice, and policy

This special issue comprises articles that can be broadly categorised into two main sections. Firstly, the articles explore the various problems and challenges that humanitarian actors encounter during disaster relief operations. These challenges can range from logistical difficulties, such as accessing remote or dangerous areas, to coordinating with local authorities and stakeholders and managing limited resources like workforce, funds, and supplies to provide timely and practical assistance to those in need. Secondly, the articles focus on the impact of humanitarian crises on a nation's economic activities. These crises can disrupt the normal functioning of market systems, leading to a decline in agricultural output, a rise in commodity prices, and a reduction in trade and tourism. They can also cause a loss of livelihoods, decreased workforce productivity, and increased poverty and inequality. This special issue provides valuable insights into the complex and interconnected problems surrounding humanitarian relief and crisis management. In this section, we further classify the contributions made by the published articles in this issue to theory, practice, and policy. We discuss each one of them in detail.

4.1 Contributions to theory

Over the past few decades, the humanitarian supply chain has undergone significant changes due to the increasing need for specialised knowledge and skills to address the unique challenges faced by disaster relief workers. However, unlike commercial supply chains, the humanitarian supply chain is typically temporary and poses many challenges that can be difficult to address. These challenges may include cultural differences, language barriers, conflicting goals, and lack of trust between various actors involved in the operations. In contrast, commercial supply chains are typically designed to maximise profitability and tend to be more stable and long-lasting than their humanitarian counterparts. However, the COVID-19 pandemic has brought to light the need for a supply chain design that combines the strengths of these two isolated disciplines. As a result, researchers and practitioners have been exploring ways to improve collaboration, viability, and effectiveness in highly uncertain situations where information exchange is often limited and challenging.

This special issue on Humanitarian Supply Chain Management has played a critical role in advancing our understanding of the challenges and opportunities associated with this complex field. Several articles published in this issue have significantly contributed to this goal by exploring new collaboration, coordination, and information-sharing approaches in humanitarian supply chains. Additionally, emerging technologies such as blockchain, artificial intelligence, and the Internet of Things (IoT) can potentially address some of the most pressing issues related to visibility, transparency, and trust in humanitarian supply chains.

Despite these promising developments, many questions still need to be addressed. For example, how can we ensure that emerging technologies are accessible and affordable to all actors involved in humanitarian supply chains, including small- and medium-sized organisations? How can we ensure that the benefits of these technologies are distributed fairly and equitably? These and other questions will require ongoing research and collaboration to address effectively.

4.2 Contribution to practice

The special issue includes articles offering comprehensive guidance to humanitarian relief workers and healthcare sectors facing significant challenges during the COVID-19 crisis. The articles highlight the two unique supply chains that can be utilised to deal with future crises– one that prioritises empathy and a life-saving mentality and another that focuses on cost-effective and efficient solutions. Both supply chains are crucial in managing crises and can be used to provide aid to those in need. The articles in this issue offer valuable insights into how the two supply chains can be integrated and used together to achieve a balanced approach. The life-saving supply chain focuses on providing immediate assistance to those in need, while the cost-effective supply chain aims to provide long-term support and sustainability. Integrating these two supply chains can be a powerful tool in managing future crises effectively.

Additionally, this special issue highlights the importance of trust, transparency, and the ability to handle conflicts resulting from information asymmetry in crisis management. The articles emphasise the need for practitioners to build trust with their stakeholders, be transparent in their actions, and effectively communicate with all parties to ensure smooth operations. Overall, the special issue provides a wealth of information and practical guidance for humanitarian relief and healthcare practitioners. It emphasises the importance of being proactive, collaborative, and flexible in managing crises. It offers valuable insights into utilising the unique supply chains to aid those in need.

4.3 Implications for policy

The articles offer detailed and rich insights into the strategies and approaches that can be used to deal with future health crises. The articles provide practical guidance on building a robust healthcare supply chain that can withstand the impact of any health crisis without affecting the nation's economic progress. Moreover, some articles offer in-depth analysis and directions to nations involved in geo-political conflicts. These articles highlight the humanitarian supply chain's challenges in such situations and offer practical solutions to ensure the seamless flow of disaster relief materials to the victims. The articles detail the importance of proper humanitarian supply chain strategies to ensure that the victims receive much-needed aid and support promptly and efficiently.

5 Conclusion

This special issue offers valuable insights, but several complex issues require further exploration. One such issue is the challenge of forecasting unprecedented events and assessing their potential impact on the world economy. This is particularly important in light of recent events, such as the COVID-19 pandemic, highlighting the need for effective disaster preparedness measures. Moreover, it is essential to consider how the healthcare sector can be better equipped to deal with such immense challenges. This includes ensuring adequate supplies of medical equipment and personnel to handle the needs of affected communities. Additionally, some countries must develop their capabilities to meet their own needs rather than relying on aid from other countries.

Despite efforts to build trust and facilitate better communication, political issues often undermine these efforts, making humanitarian supply chain management more challenging. Unfortunately, this is beyond the control of scholars in this field. Nevertheless, they must consider broader issues, including inputs from other disciplines, to develop more robust modelling techniques that rely on Generative Artificial Intelligence (Gen AI). This will help to ensure that the humanitarian supply chain is better able to respond to crises and that aid reaches those who need it most.

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