The complexity of humanitarian logistics as part of adequate disaster management response

Slobodan Aćimović
University of Belgrade, Faculty of Economics
Belgrade, Serbia
slobodan.acimovic@ekof.bg.ac.rs

Veljko M. Mijušković
University of Belgrade, Faculty of Economics
Belgrade, Serbia
veljko.mijuskovic@ekof.bg.ac.rs

Nikola Milošević
The industrial complex Trepča
Zvečan, Serbia
nikolamilosevic1@yahoo.com

Abstract: Humanitarian logistics and the humanitarian value chain are becoming increasingly important as the number of people exposed to potential disasters increases, whether they are natural or caused by human activity. The aim of the paper is to highlight the importance of humanitarian logistics for disaster response and the complexity of humanitarian value chain. Disaster circumstances create an abundance of challenges that humanitarian organizations face during the relief program implementation. The results show that the complexity of humanitarian assistance is mainly determined by the characteristics of disaster events which are sudden with detrimental effects on people and the environment. Also, the complexity is determined by the number of actors included as well as by the diversity of actors and their backgrounds. In addition to humanitarian organizations, participants include local government institutions, international institutions, economic entities that want to help with their business capacities or experience, and donors who provide financial or non-financial assistance. It can be concluded that among all participants, humanitarian logistic providers are a major factor in disaster response activities, and the whole value chain of humanitarian assistance is highly dependent on the effective functioning of humanitarian logistics. In this paper secondary data sources are used as the basis of research and concluding remarks.

Keywords: humanitarian logistics, disaster response, humanitarian organizations, catastrophes

1. Introduction

The value chain of humanitarian organizations is extremely complex. The reason lies in the fact that the process of humanitarian action involves a large number of participants that include, in addition to humanitarian organizations, local government institutions, international institutions, businesses that want to help with their business capacities or experience as well as donors who provide financial or non-financial assistance. Furthermore, in addition to the employees in the mentioned organizations, volunteers are also present to a greater or lesser extent. Volunteers can be an integral part of operations in the affected area, as well as part of the value chain related to the

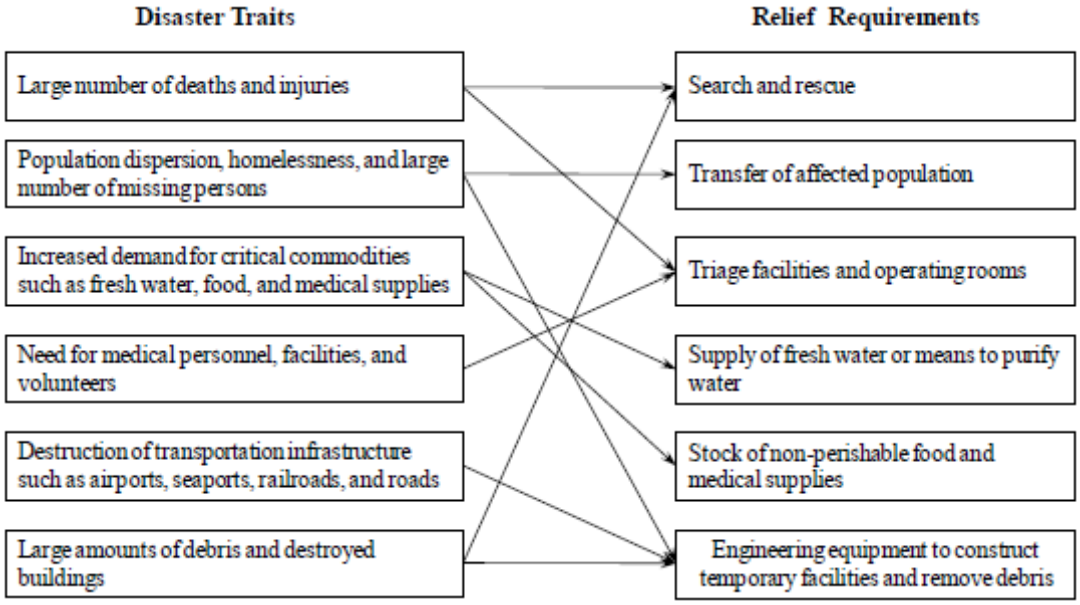
planning and preparation of humanitarian operations, and significantly affect the quality of humanitarian activities.

Humanitarian disasters often create population dislocating and resettlement in refugee camps. Furthermore, clean water and nutrition shortages may occur, as well as poor sanitation and waste management. In addition, disasters also endanger routine health services. The flow of material requires transport infrastructure, storage capacity, and resources such as vehicles. A disaster may damage or destroy local infrastructure even in locations with a high level of preparedness. Thus it is of paramount importance to design and organize adequate relief chains and especially agile humanitarian logistics to make relief chain actions feasible.

2. Literature review

Humanitarian logistics and the humanitarian value chain are becoming increasingly important as the number of people exposed to potential disasters increases, whether they are natural or caused by human activity. Current disaster trends will increase the need for response capacity by global humanitarian organizations (Vaillancourt, 2016). An abundance of international organizations as well as economic entities are joining forces in order to overcome obstacles in achieving humanitarian goals and consequently reduce the risk to the population and the economy. The purpose of the humanitarian value chain is to comprehend disaster response in an adequate way. Figure 1 shows what characterizes a disaster and what kind of relief requirements are necessary to respond and minimize the detrimental effect of disasters.

Figure 1. Basic Disaster Traits and Relief Requirements



Source: Selecting Maritime Disaster Response Capabilities (2013)

Humanitarian organizations are involved in a great diversity of operations because no two disasters are the same and because different disaster situations call for different intervention types (L'Hermitte et al., 2016). Also, humanitarian organizations offering essential services in case of disaster can be broken down into three categories: what is needed to be ready, an awareness of being ready, and a metric for readiness (Apte, 2020).

The value chain of humanitarian organizations is more complex than the value chain of companies engaged in lucrative activities. Furthermore, the complexity is determined by the goals towards which the value chains are directed, the participants in the chain itself, the way of financing, as well as the environment. The significant differences are that humanitarian organizations generally operate in a context of voluntary contributions of finance and labor, that the "end consumers" are people who will not be party to any commercial transaction, that final delivery will be in countries without any established logistics community or infrastructure (conceivably no functioning transport infrastructure), that governments and the military may be involved at a significant level and the environment may be both politically and militarily unstable (Pettit & Beresford, 2009). As it can be seen in Figure 2, differences among the two types of supply chains are significant so humanitarians and managers should take these differences into consideration very seriously.

Figure 2. Categorization of the relief items

Model attribute	*Commercial supply chain*	*Humanitarian supply chain*
Objective	Maximise profits by minimising labour costs	Maximise task completion by minimising shortages
Key constraint	Required tasks	Committed labour
Labour pool size constraint	Assumed to be sufficient or unconstrained	Determined by size of committed labour
Labour costs	Non-trivial	Low yet still non-trivial
Labour preferences	Some models consider time preferences	Models must consider volunteers' time and task preferences
Task labour shortages	Not an issue	Shortages need to be balanced

Source: Humanitarian supply chain management: A critical review (2012)

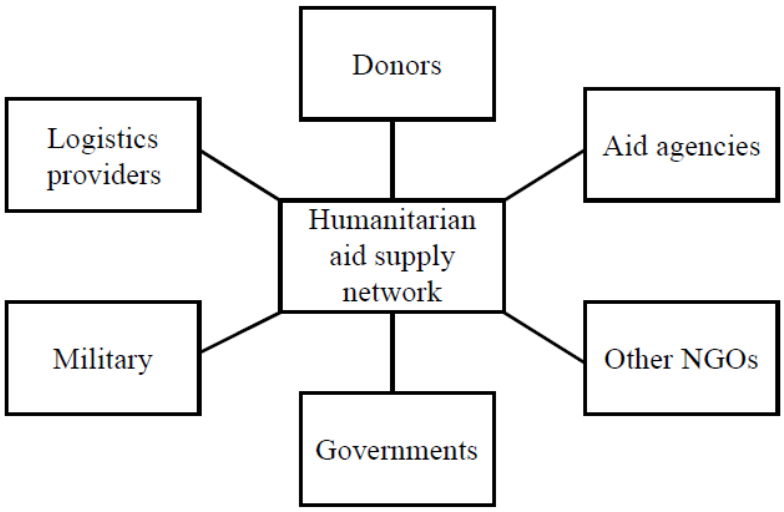
In the future, actors from both commercial and humanitarian supply chains should exchange information aiming to enhance humanitarian response abilities.

3. Defining and managing the humanitarian value chain

Many actors compose the humanitarian supply chain. The number of actors is defined by the type of catastrophe (Shu et al., 2021). Additionally, approaches toward relief chain design and response strategy of countries or regions influence the number of relief chain actors. Firstly, donors provide help in terms of money or items needed for disaster response as well as for the process of

rehabilitation of the region (Wei et al., 2019). They can be both individuals and organizations. Secondly, aid agencies are organizations dedicated to providing aid. Many professional aid organizations exist, both within government, between governments as multilateral donors, and as private voluntary organizations or non-governmental organizations. Thirdly, governments may be local or regional depending on the countries' political system. They can hinder or encourage humanitarian activities. Fourthly, non-government organizations can be dedicated to humanitarian activities or other activities with the desire to provide help in some situations. Finally, the military is used globally in humanitarian actions as a significant help, because militaries have well-skilled and well-equipped organizations. Also, military medical forces may be the only medical services available in the immediate aftermath of conflict and are often required to coordinate the re-establishment of civilian services (Bricknell & MacCormack, 2005). All aforementioned actors can be both domestic and international.

Figure 3. Actors of supply network of humanitarian aid



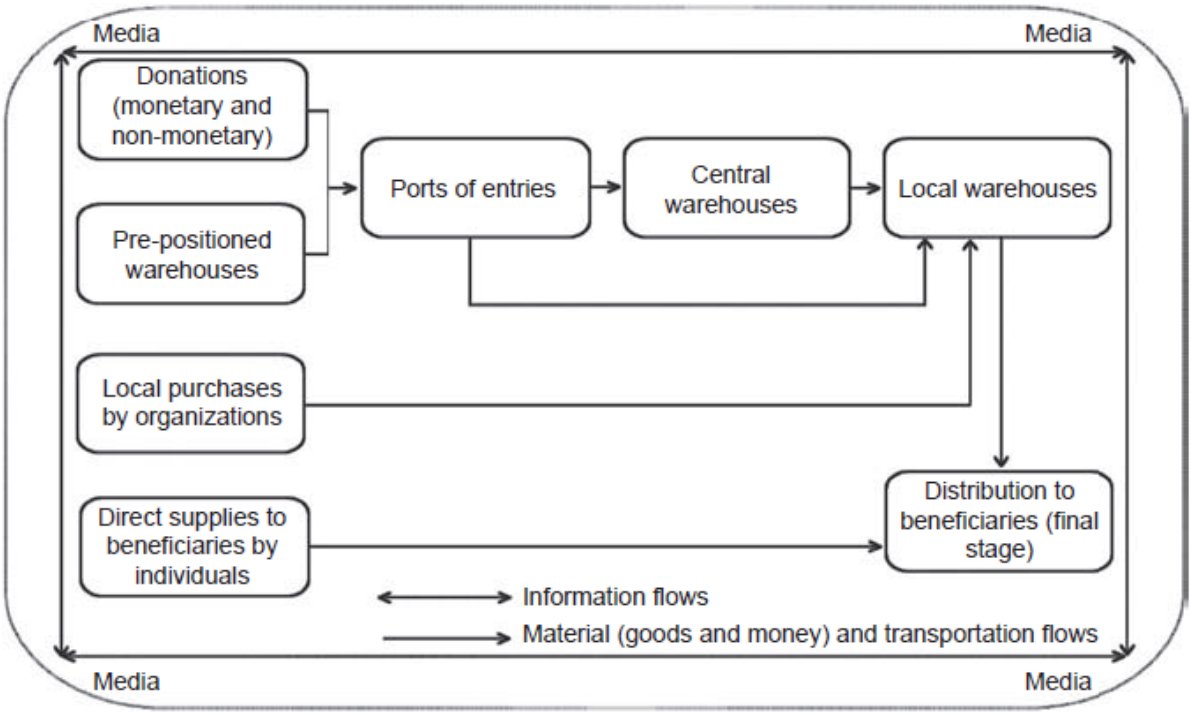
Source: Humanitarian logistics in disaster relief operations (2007).

The funding of humanitarian organizations is very important for carrying out humanitarian activities in all phases of disaster management (Özpolat et al., 2015). Every stage of humanitarian activity creates costs so funding is needed to enable relief chain functioning. Furthermore, activities can be performed by humanitarian organizations or external entities, depending on the quality of the service or activity to be achieved. In some areas of functioning, it is more efficient and effective to engage external entities than to perform in-house. Therefore, the costs that arise are the internal costs of the humanitarian organizations themselves, as well as the costs of hiring external entities (Hein et al., 2020).

In situations where some of the local response systems are operational, they are the first line of response after the crisis, including local governments and non-governmental organizations, but because of the very nature of the humanitarian crisis, local organizations are quickly overwhelmed by the needs, and often lack the necessary resources to face the crisis (Gavidia, 2017). The

complexity of disasters has made coordination both important and challenging (Grange et al., 2020). Humanitarian logistics may include clusters to enhance logistics coordination through the humanitarian value chain (Jahre & Jensen, 2010). Logistics might be the most important part of the humanitarian value chain, but coordination among all participants included in relief operations should be formed and fostered for the benefit of people in danger. Coordination can be vertical, upstream and downstream, and horizontal, where cooperation is formed by actors on the same level. In some cases, chain coordinators are required to monitor the coordination processes. Chain coordinators act as a catalyst and pillar to ensure the effective coordination that is aligned, agile, adaptable, flexible, and productive for all coordinated organizations (Akhtar et al., 2012). The importance of collaboration is widely studied in the humanitarian logistics literature because responding to a disaster inevitably goes beyond the capacity of a single organization (Sabri et al., 2019). Figure 4 shows the flows of information and material through the relief chain.

Figure 4. Structure of humanitarian relief chains



Source: Coordination in humanitarian relief chains: Chain coordinators (2012)

For contemporary humanitarian value chains, the novel blockchain technology may be an enhancing factor. Thus, decentralized last-mile delivery services through advanced technology such as blockchain improve transparency, service quality, and trust in the logistic industry (Choudary et al., 2019). Blockchain technology helps to reduce risks particularly associated with intermediaries' interventions such as hacking, compromised privacy, political disorder, costly compliance with government rules and regulation, instability of financial institutions, and contractual disputes, while other advantages of blockchain are reduced transaction fees, public

transparency, asset integrity, fraud detection and prevention, peer-to-peer connectivity, and better order fulfillment (Min, 2019).

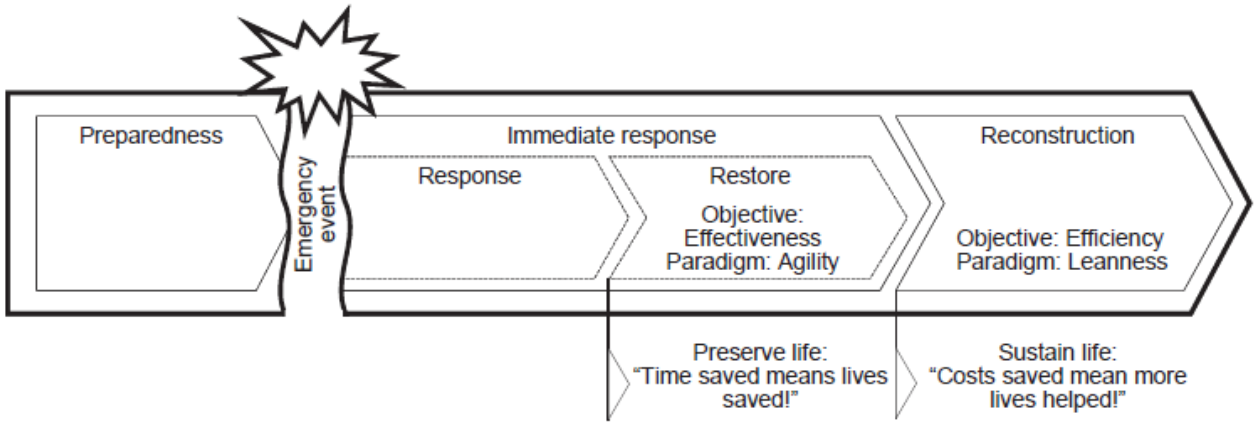
3. Defining and managing the humanitarian logistics operations

The problems that may be caused by a disaster are both telephone and Internet communications disruptions, depriving affected people and humanitarian organizations of efficient flow of information, destruction of logistics infrastructure especially roads and bridges across all affected areas, leaving many communities inaccessible, destruction to most possible storage facilities within the affected districts, and electricity supply disruptions. Humanitarian logistics can be defined as a branch of logistics dealing with logistical aspects of a disaster management system, including various activities such as procuring, storing, and transporting food, water, medicine, and other supplies, as well as human resources, necessary machinery and equipment, and the injured before and after disasters have struck (Nikbakhsh and Farahani, 2011). The agility of the humanitarian logistics is very important, not only for overcoming threats but also for improving the already existing humanitarian relief chain (L'Hermitte et al., 2015). Agility is an essential attribute of any organization operating in an uncertain environment as it underpins the organization's ability to respond more rapidly and effectively to changes (Jermsittiparsert & Kampoomprasert, 2019). Firstly, humanitarian logistics should be able to use different modes of transport at the moment of a disaster and afterward to avoid transportation risks due to infrastructure failures. Secondly, humanitarian logistics should be able to establish temporary warehouses and secure the existing ones. The use of temporary storage for emergency relief items is proven to improve the responsiveness, efficiency and effectiveness of the humanitarian supply chain (Boonmee, 2017). Where to locate a temporary or fixed local relief operation center facility is a strategic decision because it dictates the movement of relief goods and it determines quicker response to the needs of the victims (Gutierrez & Mutuc, 2018). Thus, relief chain flexibility is improved with agile humanitarian logistics.

Stages in the humanitarian logistics process are (Cozzolino, 2012):

- *preparedness*- aims to avoid the gravest possible consequences of a disaster;
- *immediate response*- aims to respond by activating the "silent" network or "temporary networks", and to restore in the shortest time possible the basic service and delivery of goods to the highest possible number of beneficiaries;
- *reconstruction*-aims to address the problem from a long-term perspective.

Figure 5. Humanitarian logistics process



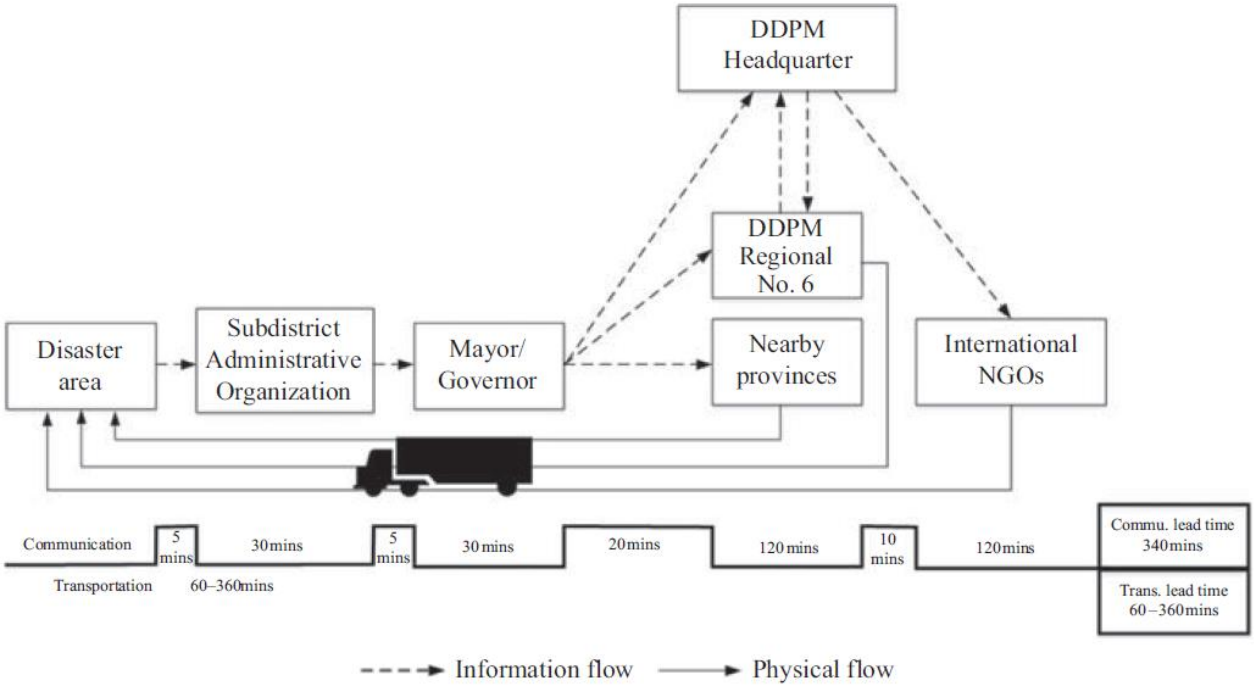
Source: Agile and lean principles in the humanitarian supply chain - The case of the United Nations World Food Programme (2012)

Logistics activities can be provided by humanitarian organizations themselves or by humanitarian service providers. Some international humanitarian organizations- in some cases through specialized logistics units- provide similar services as commercial logistics service providers, and can offer a wider range of value-added and dedicated services to other humanitarian organizations than commercial logistics service providers (Vega & Roussat, 2019).

Current centralized humanitarian aid deployment practices may encourage urbanization thereby weakening the short and long-term resiliency of lower-income countries receiving aid. Introducing a new decentralized model would represent a sustainable aid deployment standard for that country's specific response, recovery, mitigation, and planning opportunities and constraints (Wood & Frazier, 2020). It should be noted that even though the pre-positioning of relief supplies increases the ability of humanitarian organizations to deliver aid faster, not all humanitarian organizations can afford to maintain a network of warehouses and distribution centers. Sovereign nations under duress from a disaster must formally request help from the international community, then the deployment of aid into that country is organized (Wood & Frazier, 2020).

Figure 6 describes information and physical flows of the organization in a disaster situation. Banomyong et al. describe the process: "The information flow starts with a notification about the disaster affecting people in the area. Notification of disaster is received via a phone call by the Sub-district Administrative Organization (SAO). The SAO's role is to evaluate the situation before relaying information to an authorized person (e.g. mayor or governor) and asking for relief effort permission. After permission is granted, the authorized person informs either the director general of the Department of Disaster Prevention and Mitigation (DDPM) in charge at the DDPM headquarters, the DDPM regional office in Khon Kaen Province, nearby provinces or all of them. The lead-time spent in evaluating the disaster situation is approximately 2 h. The identified total communication and transportation lead-time were 340 min and 60–360min, respectively".

Figure 6. Value Stream Mapping: the DDPM regional office



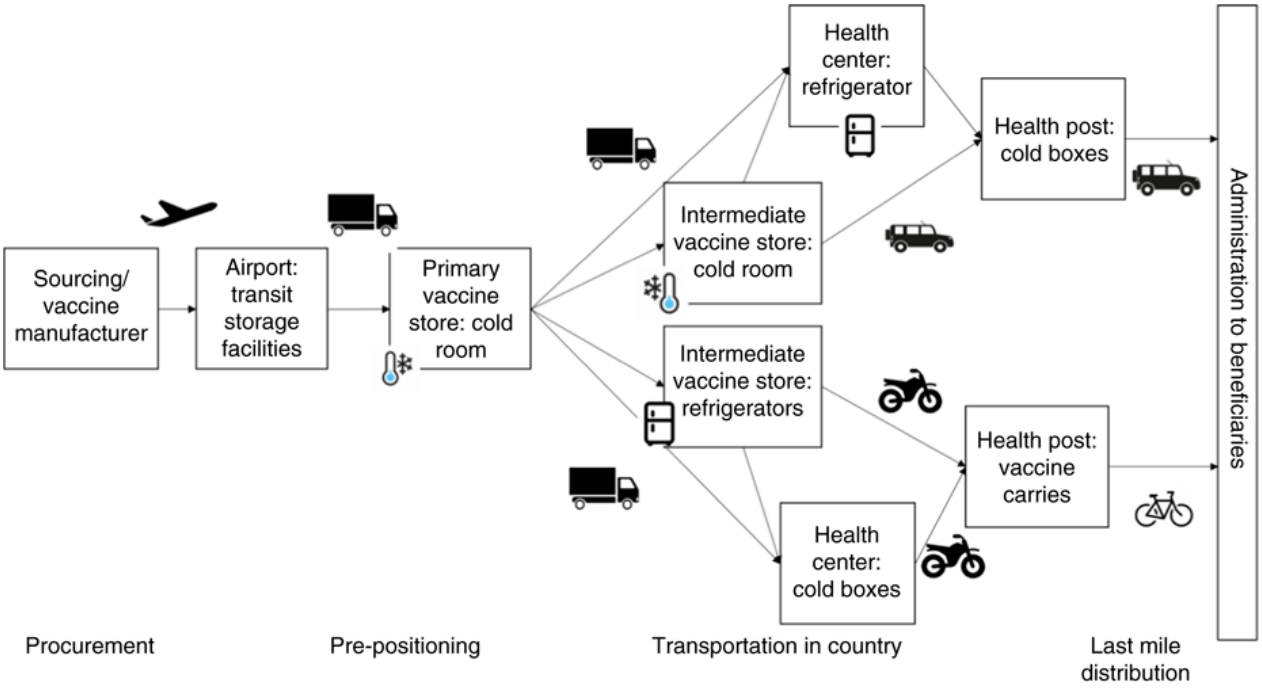
Source: The Humanitarian Supply Chain Assessment Tool (HumSCAT), 2019.

The second example is a vaccine campaign. A typical vaccine campaign has three phases, dedicated to (Comes et al., 2018):

- planning- The planning phase is dedicated to the design of the vaccine campaign, including sourcing, network planning, and distribution or inventory management policies.
- implementation- In the implementation phase, vaccines are transported from national warehouses through a chain of district and regional warehouses until they are distributed.
- evaluation respectively- The post-campaign phase is dedicated to an evaluation with the purpose to inform advocacy, strategic planning, and training.

Here the importance of humanitarian logistics can be noticed, especially because this type of goods requires special logistics treatment through the supply chain. Figure 7 shows the flow of vaccines from sourcing to the beneficiaries. Vaccines must remain within the approved temperature range from arrival at the airport until last-mile distribution.

Figure 7. General structure of a cold chain in a vaccination campaign

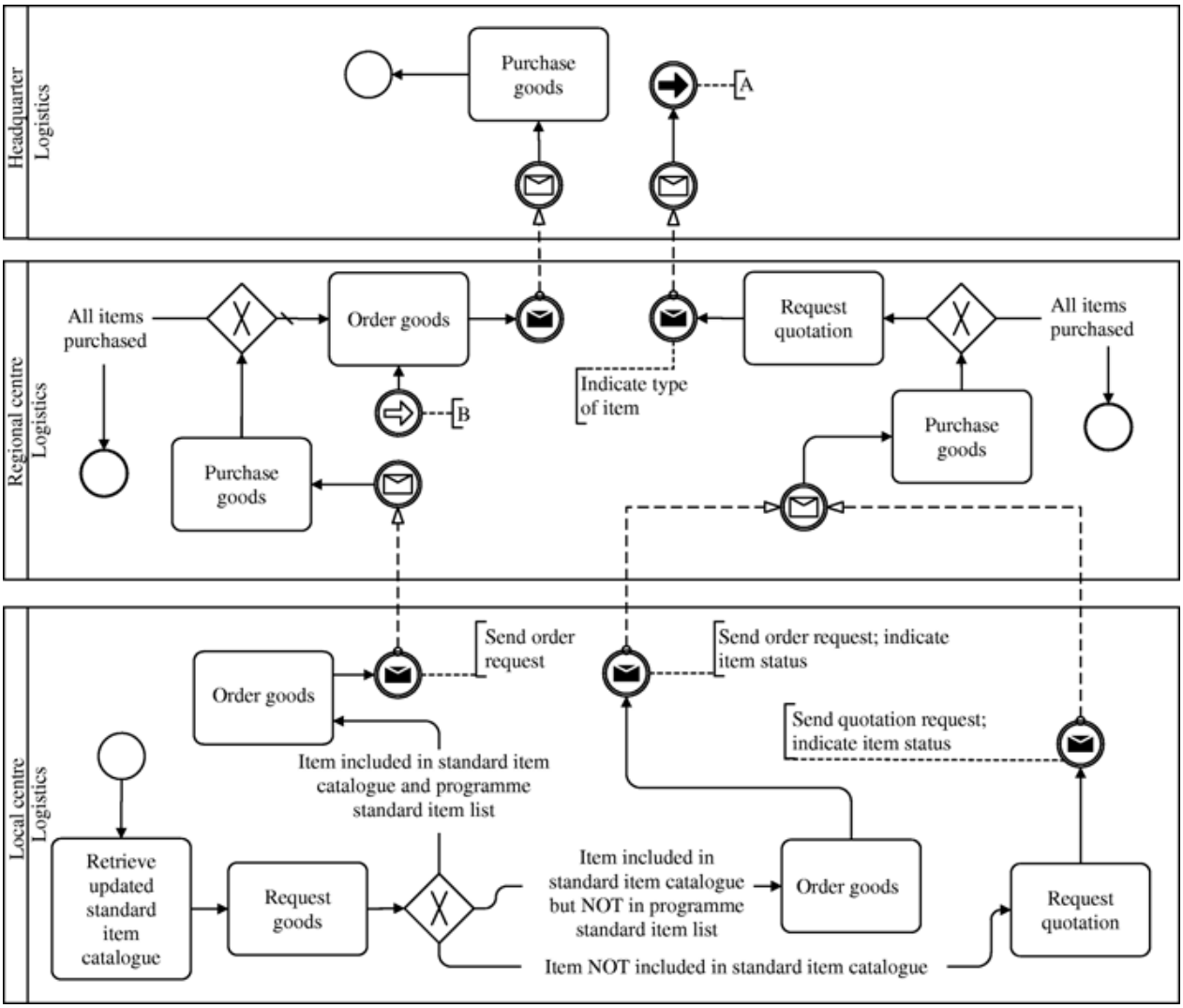


Source: Cold chains, interrupted - The use of technology and information for decisions that keep humanitarian vaccines cool, (2018)

COVID-19 impacts the medical value chain in the way shortages may appear as countries' demand suddenly increase (Broadbent, 2020). Also, COVID-19 can hinder the possibilities of international humanitarians primarily to provide required goods timely (Chen & Cook, 2020).

In humanitarian logistics, the ordering process begins when there is a requirement for particular items. Immediately after a disaster occurs, relief organizations perform an initial assessment (usually within one day of the occurrence of the disaster) to estimate the expected amount of supplies required to meet the relief needs of the affected population (Falasca & Zobel, 2011). The need can arise as a result of anticipated demand based on the number of recipients or initiated by current stock levels. Also, the demand for humanitarian relief supplies depends on the magnitude, the criticality, and the type of disaster. When the order is made, order status information is available to the field staff so they can plan their activities. The field part of the ordering process for standard and non-standard items is shown in Figure 8.

Figure 8. Process "field ordering"



Source: Supply chain process modeling for humanitarian organizations, 2010.

After the requested items are delivered to the field, the field staff delivers items to beneficiaries, but the main logistics processes are not finished. Reverse logistics is also an important factor in the overall humanitarian action because environmental and ethical factors must be taken into account when creating the entire value chain. Reverse logistics goes hand in hand with green logistics. Disposal of material used to prepare and rehabilitate affected areas is a crucial aspect of people's quality of life during the recovery period and return to normal lifestyle (Jilani et al., 2018). The biggest problem in front of local and state governments and various humanitarian agencies is the lack of an instrument to integrate sustainability in the traditional HSC framework (Bag et al., 2020).

4. Conclusion

Disasters can be man-made or natural, and all of them have their own characteristics and risks. In addition, numerous and diverse actors are involved in humanitarian operations. The humanitarian value chain starts with donors who provide money and necessary goods and ends with beneficiaries who receive the help. So, humanitarian value chains are complex and characterized by high levels of risks.

As it can be seen from the examples aforementioned there are a few different humanitarian distribution requirements that relief chains face. Also, for all of them to be able to come into action it is important to have a well-established humanitarian logistics process. The agility of humanitarian logistics is also highlighted as a crucial factor in relief chain flexibility. Firstly when it comes to transport modes shift and secondly when it comes to warehouse locations and the ability to establish temporary warehouses. The importance of humanitarian logistics lies in the fact that logistics makes relief items and beneficiaries physically connected.

5. Literature

1. Akhtar, P., Marr, N.E., Garnevska, E. V. (2012). Coordination in humanitarian relief chains: Chain coordinators. *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 2. pp. 85-103.
2. Apte, A., Yoho, K. D., Greenfield, C. M., Ingram, C. A. (2013). Selecting Maritime Disaster Response Capabilities. *Journal of Operations and Supply Chain Management*, Vol. 6(2). pp. 40-58.
3. Apte, A. (2020). Understanding readiness metrics for the humanitarian operations through literature review. *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 10(3). pp. 321-345.
4. Bag, S., Luthra, S., Venkatesh, V.G., Yadav, G. (2020). Towards understanding key enablers to green humanitarian supply chain management practices. *Management of Environmental Quality: An International Journal*, Vol. 31(5). pp. 1111-1145.
5. Banomyong, R., Julagasigorn, P., Varadejsatitwong, P., Piboonrungroj, P. (2019). The Humanitarian Supply Chain Assessment Tool (HumSCAT). *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 9(2). pp. 221-249.
6. Blecken, A. (2010). Supply chain process modelling for humanitarian organizations. International *Journal of Physical Distribution & Logistics Management*, Vol. 40(8/9). pp. 675-692.
7. Boonmee, C., Arimura, M., Asada, T. (2017). Facility Location Optimization Model for Emergency Humanitarian Logistics. *International Journal of Disaster Risk Reduction*, Vol. 24. pp. 485-498.
8. Bricknell, M. C., MacCormack T. (2005). ABC of conflict and disaster: military approach to medical planning in humanitarian operations. *British Medical Journal*, Vol. 330. pp. 1437-1439.
9. Broadbent, M. (2020). Covid-19 Demand Shock and Preparedness Response Securing Medical Supply Chains: TheTrusted Trade Partner Network. Center for Strategic and International Studies (CSIS). Available at: https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/201221_Broadbent_Covid19_Shock.pdf

10. Chari, F., Ngcamu, B. S., Novukela, C. (2021). Supply chain risks in humanitarian relief operations: a case of Cyclone Idai relief efforts in Zimbabwe. *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 11(1). pp. 29-45.
11. Chen, C., Cook, A. D. B. (2020). Humanitarian Assistance in the Asia-Pacific during COVID-19. NTS Insight, No. IN20-06 (Singapore: RSIS Centre for Non-Traditional Security Studies (NTS Centre), Nanyang Technological University Singapore).
12. Choudary, S., Alstyne, M., Parker, G. (2019). Platforms and blockchain will transformlogistics. *Harvard Business Review*. Available at: https://hbr.org/2019/06/platforms-and-blockchain-will-transform-logistics
13. Comes, T., Sandvik, K. B., Van de Walle, B. (2018). Cold chains, interrupted: The use of technology and information for decisions that keep humanitarian vaccines cool. *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 8(1). pp. 49-69.
14. Cozzolino, A., Rossi, S., Conforti, A. (2012). Agile and lean principles in the humanitarian supply chain. *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 2(1). pp. 16-33.
15. Falasca, M., Zobel, C. W. (2011). A two-stage procurement model for humanitarian relief supply chains. *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 1(2). pp. 151-169.
16. Gavidia, J. (2017). A model for enterprise resource planning in emergency humanitarian logistics. *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 7(8). pp. 246-265.
17. Grange, R., Heaslip, G., McMullan, C. (2020). Coordination to choreography: the evolution of humanitarian supply chains. *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 10(1). pp. 21-44.
18. Gutierrez, M. T., Mutuc, J. (2018). A Model for Humanitarian Supply Chain: An Operation Research Approach. *7th International Conference on Building Resilience; Using scientific knowledge to inform policy and practice in disaster risk reduction, ICBR2017, 27 – 29 November 2017, Bangkok, Thailand*. pp. 659-666.
19. Hein, C., Behrens, F., Lasch, R. (2020). Insights on the Costs of Humanitarian Logistics: A Case Study Analysis. *Logistics Research*, Vol. 13. pp. 1-17.
20. Hokey, M. (2019). Blockchain technology for enhancing supply chain resilience. *Business Horizons*, Vol. 62(1). pp. 35-45.
21. Jahre, M., Jensen, L. (2010). Coordination in humanitarian logistics through clusters. *International Journal of Physical Distribution & Logistics Management*, Vol. 40. pp. 657-674.
22. Jermsittiparsert, K., Kampoomprasert, A. (2019). The Agility, Adaptability, and Alignment as the Determinants of the Sustainable Humanitarian Supply Chain Design. *Humanities & Social Sciences Reviews*, Vol. 7(2). pp. 539-547.
23. Jilani, A., Ali, Y., Khan, M. (2018). Greening of humanitarian supply chain with focus on logistics. *International Journal of Business Performance and Supply Chain Modelling*, Vol. 10(1). pp. 49-66.
24. John, L., Anbanandam, R., Sridharan, R. (2012). Humanitarian supply chain management: A critical review. *International Journal of Services and Operations Management,* Vol. 13(4). pp. 498-524.
25. Kovacs, G., Spens, K. (2007). Humanitarian logistics in disaster relief operations. *International Journal of Physical Distribution & Logistics Management*, Vol. 37(2). pp. 99-114.

26. L'Hermitte, C., Bowles, M., Tatham, P., Brooks, B. (2015). An Integrated Approach to Agility in Humanitarian Logistics. *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 5(2). pp. 209-233.
27. L'Hermitte, C., Tatham, P., Brooks, B., Bowles, M. (2016). Supply chain agility in humanitarian protracted operations. *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 6(2). pp. 173-201.
28. Nikbakhsh, E., Farahani, R. Z. (2011). "Humanitarian logistics planning in disaster relief operations", Logistics Operations and Management: Concepts and Models, Elsevier Inc., London, UK. pp. 291-332.
29. Özpolat, K., Rilling, J., Altay, N., Chavez, E. (2015). Engaging donors in smart compassion: USAID CIDI's Greatest Good Donation Calculator. *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 5(1). pp. 95-112.
30. Pettit, S., Beresford, A. (2009). Critical Success Factors in the Context of Humanitarian Aid Supply Chains. *International Journal of Physical Distribution & Logistics Management*, Vol. 39(6). pp. 450-468.
31. Sabri, Y., Zarei, M. H., Harland, C. (2019). Using collaborative research methodologies in humanitarian supply chains. *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 9(3). pp. 371-409.
32. Shu, J., Lv, W. Na, Q. (2021). Humanitarian relief supply network design: Expander graph based approach and a case study of 2013 Flood in Northeast China. *Transportation Research Part E: Logistics and Transportation Review*, Vol. 146.
33. Vaillancourt, A. (2016). Kit management in humanitarian supply chains. *International Journal of Disaster Risk Reduction*, Vol. 18. pp. 64-71.
34. Vega, D., Roussat, C. (2019). Toward a conceptualization of humanitarian service providers. *The International Journal of Logistics Management*, Vol. 30(4). pp. 929-957.
35. Wei, J., Wang, A. Wang, F. (2019). Humanitarian Organizations in International Disaster Relief: Understanding the Linkage Between Donors and Recipient Countries. *VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations*, Vol. 30. pp. 1212–1228.
36. Wood, E., Frazier, T. (2020). Decentralized humanitarian aid deployment: reimagining the delivery of aid. *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 10(1). pp. 1-20.