A Systematic Review of Humanitarian Logistics Models for Medical and Healthcare Products in Humanitarian Emergencies in Africa

HI2 Research Seed Grants

Final Report

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Final Report of Research Study sponsored by Humanitarian Innovation Initiative (HI2), Watson Institute of International and Public Affairs Brown University

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Executive summary

Background

This final report provides an updated commentary on and summary of the systematic literature review of published humanitarian logistics models for sourcing, delivery and distribution of medical and healthcare products for humanitarian emergencies in Africa from 1990 to 2016. The report reviewed and classified the range of published logistics models for sourcing, delivery and distribution of medical and healthcare products for humanitarian emergencies in Africa from 1990 to 2016 using the systematic literature review methododlogy. The report also assessed and identified effective models based on logistics performance criteria as well as developed a flexible, adaptable high performance model for sourcing, delivery and distribution of medical and healthcare products for humanitarian emergencies in Africa and other developing regions.

Methods

Several databases were searched for empirical studies evaluating and reporting on logistics models for sourcing, delivery and distribution of medical and healthcare products for humanitarian emergencies in Africa from 1990 to 2016 in clinical and field contexts using standardised systematic review methods and independently assessing eligibility of published works, extracting data and evaluating study quality.

Conclusions

Seven relevant studies related to logistics models for sourcing, delivery and distribution of medical and healthcare products for humanitarian emergencies from 1990 to 2016 were found of which five were mathematical models including a conference paper*. We develop a logistics model for sourcing, delivery and distribution of medical and healthcare products for humanitarian emergencies relevant to Africa.

*We decided to include 1 PhD thesis, 1 MSc thesis and 1 conference paper because of their relevance although they were not originally part of the inclusion criteria.

1. Background and introduction

This final report details the progress that has been made regarding the project titled: *A Systematic Review of Humanitarian Logistics Models for Medical and Healthcare Products in Humanitarian Emergencies in Africa*. The project was funded by HI2 through seed funding beginning March 2017. The report details the outcome of the systematic review process undertaken and provides a summary classification of published logistics models for sourcing, delivery and distribution of medical and healthcare products for humanitarian emergencies in Africa from 1990 to 2016. The report also suggests potential strategies for the dissemination of findings to stakeholders in Africa and other developing regions. The rest of the report is structured as follows: section 2 outlines the study's goals and research questions; section 3 summarises the systematic literature review method used and the research process, .i.e., key words adopted and used, databases searched, numbers of articles found, and those selected and excluded. Section 4 is a synthesis of findings, new knowledge and conclusions of the literature review while section 5 outlines an effective logistics model. Section 6 discusses how these findings may be disseminated to stakeholders in Africa and other developing regions with similar conditions.

2. Project research questions and goals

The project's research questions were as follows:

1. What is the range of published academic logistics models for sourcing, delivery and distribution of medical and healthcare products for humanitarian emergencies in Africa from 1990 to 2016?

2. Which models in research question one are effective based on logistics performance criteria published in academic logistics journals; and

3. How can a flexible, adaptable high performance model be developed?

Hence, the first goal of the research project were to use the systematic literature review methodology to review and classify the range of published logistics models for sourcing, delivery and distribution of medical and healthcare products for humanitarian emergencies in Africa from 1990 to 2016 in academic journals. The second goal of the project is to assess identified models based on logistics

performance criteria published in academic journals, and identify effective models. Thirdly, the project uses beneficial features of such effective models to develop a flexible, adaptable high performance model for sourcing, delivery and distribution of medical and healthcare products for humanitarian emergencies in Africa and other developing regions.

3. Method

3.0 Systematic literature review

Systematic literature reviews often follow six steps: (1) defining the research question and study goals (2) determining the required characteristics of primary studies to be reviewed (3) retrieving a sample of potentially relevant literature (4) selecting the relevant literature, (5) synthesizing the literature and (6) reporting the findings and results. Hence, section 3 of the report comprises a description of the systematic literature review methodological steps that have been undertaken in bringing the research to a successful attainment of its broader goals. Section 3 comprises sub-sections on: adopted keywords (3.1); data bases searched and articles found (3.2); and studies selected for inclusion and exclusion (3.3). Section 3 concludes with sub-section 3.4 that summarizes the research process undertaken and the time research tasks were completed (see Figure 2).

3.1 Adopted keywords

The search strategy involved the identification and selection of 28 key words (listed below) each of which was in turn inserted into each search engine and searched in the titles, abstracts and bodies of texts of refereed journal articles published in English. The keywords selected are closely aligned with humanitarian logistics/supply chain models for medical and healthcare products in humanitarian and disaster emergencies/disasters in Africa. Selected keywords identify articles that are focused on typical logistics and supply chain activities undertaken by the public and private sector agencies responsible for provision of medical and healthcare products and/or charged with the role of planning for, preventing, leading,

coordinating, and responding to disasters and other emergencies with a focus on healthcare.

Selected key words also target articles focused on activities such as the logistics of disaster response and emergency relief delivery, and methods. Hence, the selection strategy for the keywords was aimed at ensuring maximum capture across the range of literature and all functional activities of logistics and supply chain management. Also, a rationale for choosing the key words is that they are the same key words used by authors in many published refereed articles on humanitarian logistics/supply chain models for medical and healthcare products in humanitarian and disaster emergencies/disasters in Africa. Hence, the increased likelihood that selected keywords will capture most or all relevant articles in the disaster databases searched.

Some compound keywords were also used to broaden the search as well as words that are often used interchangeably such as ‘disaster’, ‘emergency’, ‘distribution,’ ‘sourcing,’ ‘delivery,’ ‘distribution,’ ‘logistics’ etc. It may be said that the English language literature on this topic is scant and mostly relates to operations research (OR), operations management (OM), management, social sciences, humanities and medicine however, no attempt is made to present all that has ever been established by research or published.

Keywords

- *Humanitarian logistics model* OR *supply chains logistics model*
- OR *humanitarian aid logistics frameworks* OR *humanitarian aid sourcing models*
- OR *humanitarian aid delivery models* OR *humanitarian aid delivery logistics models*
- OR *humanitarian aid distribution models* OR *humanitarian aid emergencies*
- OR *humanitarian aid medical products* OR *disaster relief logistics model*
- OR *disaster relief logistics frameworks* OR *disaster relief sourcing models*
- OR *disaster relief delivery models* OR *disaster relief logistics models*
- OR *disaster relief distribution models* OR *disaster emergencies*
- OR *disaster emergency delivery logistics models* OR *humanitarian emergency logistics model*
- OR *humanitarian emergency logistics frameworks*
- OR *humanitarian emergency delivery models*
- OR *humanitarian emergency delivery logistics models* OR *humanitarian emergency distribution models*

- OR *humanitarian emergencies* OR *logistics models of distribution* OR *emergency healthcare products*
- OR *medical disaster relief* OR *health supply chains* OR *medical supply chains.*
- *OR vaccine supply chains OR vaccine supply chain models*
- *OR vaccine logistics models OR healthcare logistics models*
  OR therapeutic goods logistics models OR therapeutic goods supply chain models OR medicine supply chain models

3.2 Databases searched and articles found

This sub-section shows the databases searched using the keywords adopted in section 2.1 above and the number of uptake of articles (see Table 1).

	Database	**Number of Articles**
1	ProQuest Central	4809
2	Applied Social Sciences Index and Abstracts (ASSIA)	330
3	Ebscohost - Business Source Complete	469
4	ABI/Inform collection	4526
5	Emerald plus	13
6	Ebscohost - Econ Lit with full text	57
7	INFORMS	221
8	Sage Journals	201
9	Science Direct	47
10	Scopus	82
11	Thomson Reuters - Social Science Citation Index	261
12	Taylor and Francis	496
13	PubMed	546
TOTAL		**12,058 articles**
After removal of duplicates		**5582 articles**

Table 1. Databases searched and articles found

3.3 Number of studies selected for exclusion and inclusion

This sub-section shows the number of studies selected for exclusion and inclusion using exclusion and selection criteria (see Figure 1).

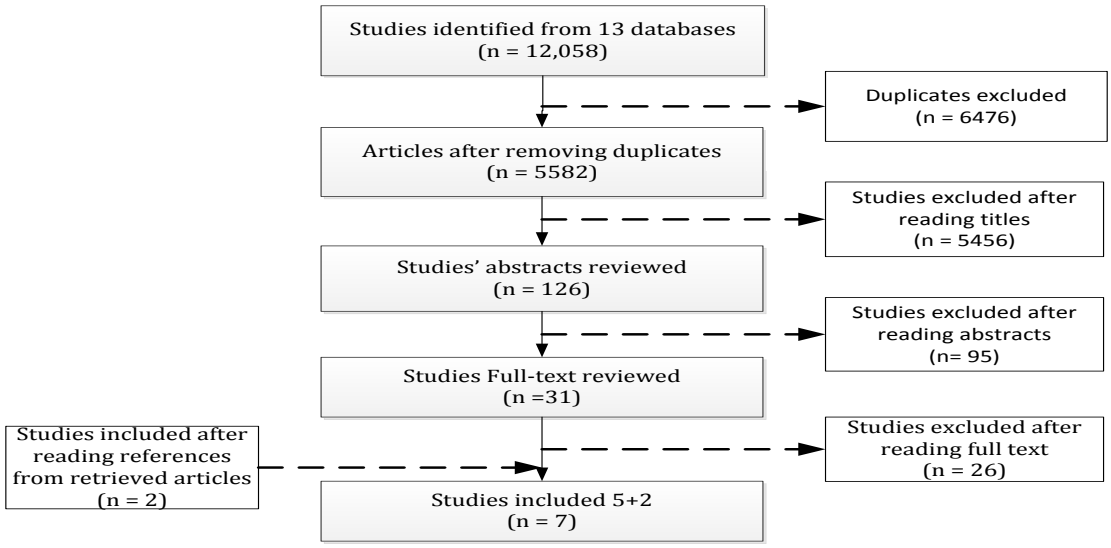

Figure 1. Flowchart of study selection

3.4 Summary of the research process

Sub-section 3.4 summarizes the research process undertaken and the time research tasks were completed (see Figure 2).

- **Search of databases completed**.
  A total of 12,058 articles were retrieved from 13 databases using relevant keywords. After the removal of duplicates, 5582 articles were retained.
- **Screening of titles completed**.
  A screening of the retained articles based on their titles resulted in the exclusion of 5456 articles (126 articles were retained).
- **Screening of abstracts completed.**
  The abstract of the resulting 126 articles were read and screened. Studies were retained if they reported on logistics models (31 studies retained).
- **Screening of full texts completed**.
  The full-text of the retained 31 studies was reviewed and 26 articles were further excluded (5 studies were retained).

- Finally, **5 studies** evaluating and reporting on logistics models for sourcing, delivery and distribution of medical and healthcare products for humanitarian emergencies from 1990 to 2016 were retained.
- A **manual search** of the bibliographic references of the final retained articles identified additional 2 studies thereby giving a total of 7 studies.

Research Activity	Date Completed
Search of databases	24th April, 2017
Removal of duplicates	1st May, 2017
Screening of titles	15th May, 2017
Screening of abstracts	29th May, 2017
Screening of full texts	12th June, 2017
Compilation of results	26th June, 2017
Submission of interim report	15th July, 2017
Submission of final report	19th March, 2018

Section 4 comprises a synthesis of findings based on the articles reviewed while section 5 outlines an effective logistics model that draws upon the beneficial features of effective models from the literature. Section 6 discusses how these findings may be disseminated to stakeholders in Africa and other developing regions.

4.0 Synthesis of findings from the literature review

There are very limited numbers of published academic articles on humanitarian logistics models for medical and healthcare products in humanitarian emergencies in Africa. Only 5 relevant studies evaluating and reporting on logistics models for sourcing, delivery and distribution of medical and healthcare products for humanitarian emergencies from 1990 to 2016 were found and retained based on our inclusion criteria. A manual search of the bibliographic references of the final retained articles identified additional 2 studies thereby giving a total of 7 studies on the subject. This enormous research gap shows that this whole area is ripe for additional research.

The literature review shows that (1) there are no qualitative or empirical studies in the area, and (2) all five of the seven articles included in the review were quantitative in nature, and only two studies were non-mathematical qualitative models.

The five mathematical models found focused on:

(1) An earthquake emergency context where required relief items are expected to be supplied from international and national sources based on an intermodal relief item distribution model involving sea and land transportation with identified road vulnerabilities. Maritime transportation if suitable allows massive amounts of items to be transported at a time. It also allows for the use of two independent sources of supply (a) international, and (b) national/coastal transportation of items where such intermodalism is possible. However, the disadvantage is that maritime transport is slow and may not always be available to be used (for instance due to lack of handling equipment at ports, or damage to ports and their entrances). Also, maritime transportation is often heavily reliant on weather (Ozkapici et al., 2016).

The sea-basing concept used by some militaries is also suggested (Ozkapici et al., 2016). Sea-basing involves permanently storing emergency supplies at sea in anticipation of an emergency closeby, and rapidly providing supplies to demand areas from such sea-based stockpiles. While the use of maritime transportation and seabasing provides some flexibility for humanitarian logistical activities, sea-basing is expensive whether supplies are ultimately used or not, and require continuing maintenance.

(2) The scheduling of medical teams and provisioning of medical supplies in an emergency where a medical team is required to make visits to several hospitals in a predetermined sequence to perform on-site operations and surgeries giving rise to a scheduling problem that involves the timely dispatching of supplies from stored and pre-positioned distribution centers to hospitals in coordination with the scheduling and arrival of medical teams that would use them to service patients (Lei et al., 2015). This approach assumes that there are adequate resources to pre-store and pre-position such supplies. The same weaknesses like sea-basing can be seen in this case – expense. It also does not consider the issue of transportation or transportation hindrances in delivering both the medical teams and their supplies (Lei et al., 2015).

(3) The supply chain network of a single organization, such as a major health organization, corporation or government that aims to manufacture a particular product at several possible manufacturing plants, have it in storage, if needs be, and

distribute it to the demand points (Nagurney et al., 2012). The model assumes that the organization is completely aware of the total costs associated with the various operational supply chain network activities (e.g. manufacturing, transportation and distribution), knows existing volume capacities of the links, and is interested in identifying additional capacity outlays, production amounts as well as shipment values (Nagurney et al., 2012). This is so that demand is satisfied with associated penalties if required demand is not exactly met for any reason.

As an option, the organization may choose to outsource manufacturing, storage and delivery of the product at a negotiated fixed price and with capacities of such suppliers fixed and known (Nagurney et al., 2012). The model thus provides 'optimal' capacity enhancements as well as 'optimal' volumes of product flows to minimize total cost. This model is highly theoretical and inflexible for instance as it is unlikely that humanitarian organizations (or governments) would be manufacturing medical and healthcare products (Nagurney et al., 2012). Also, the optimal capacities of supply chain network activities will be dynamic and fast changing due to the changing dynamics of an emergency, and corresponding changes in demand.

(4) The delivery of product from neighbouring regions and countries if proximal to the emergency site. Yet, this may incur future shortages in those supplying regions as well (Rottkemper et al., 2012). Hence, the focus is on an integrated relocation and distribution planning approach that considers current demand and possible future developments regarding demand (Rottkemper et al., 2012).Minimization of operational cost and unsatisfied demand is the overriding objective (Rottkemper et al., 2012).However, more often than not, international humanitarian organizations source and import their own supplies from their home countries into the host country as supplies may not be available in similar neighbouring developing countries or regions.

(5) Cost minimization within a system-optimization perspective and captures rigorously the uncertainty associated with the demand for critical products such as vaccines, medicines and medical equipments at various demand points (Nagurney et al. 2010).This model by Nagurney et al. (2010) could be used for the production and delivery of critical products (vaccines, medicines and medical equipments) at

minimal cost so as to satisfy the demand at various demand points, given associated penalties for under-supply (Nagurney et al. 2010).

The two non-mathematical qualitative models found focused on:

(1) An instantly built supply chain network model in the immediate occurrence of an emergency by international emergency relief actors. The network model involves a range of actors such as non-governmental organizations, governments, military, aid agencies, contractors, suppliers, logisticians, local community representatives, donors and others. It focuses on actors understanding how demand evolves over time and how the flows of funding, goods, and personnel should be managed over time. The model is overly broad based and generic. It also tends to do everything from disaster preparedness to emergency response, supply chain management to inventory and many more; and

(2) A review of the literature on logistics in complex political emergencies such as war and conflict and attempts to develop a generic supply chain management framework for health care goods provided as humanitarian assistance in war and conflict situations to enable improvement of the effectiveness and efficiency of humanitarian assistance programmes. This is a comprehensive supply chain management wide framework.

5. An effective logistics model

5.1. Logistic performance criteria

An overall assessment of the seven models show that they each have limitations and may not be effective based on published logistics performance criteria. Logistics performance criteria can be classified into two: (1) effectiveness (how well set goals are met) and (2) efficiency (productivity, capacity utilization, and performance) (Mentzer and Konrad, 1991; Oloruntoba and Gray, 2009). It is also important that assumptions underlying the evaluation of logistics performance be set based on the goals of the organization – i.e. saving lives and reducing suffering (Mentzer and Konrad, 1991; Oloruntoba and Gray, 2009).

The peculiar context of emergencies and medical and healthcare products may mean that lowering costs may not be topmost priority relative to the criteria of effectiveness. For example, how many goods delivered in a certain time, how many goods delivered in good order undamaged? How many recipients were served on time? Nevertheless, overall considerations in logistics performance analysis should include short and long run ratio of costs to effectiveness and 'customer' service. The 'customer' here is the recipient of medical products (Mentzer and Konrad, 1991; Oloruntoba and Gray, 2009).

Overall, a major element of logistics performance is transportation productivity. Transportation measures would include labour, equipment, transport energy consumes, transit time, loading time, and unloading time. Another major area that determines logistics performance is warehousing labour, product receiving, product storage, putting away, replenishing, picking, packaging and (re)labelling, facility utilization per square foot, and material handling equipment utilization and idle time. All these of course may simply be outsources to an external logistics service provider who will undertake these tasks on behalf of an organization for a service charge. Overall organisations should always use logistics performance measures that are relevant to the goals of the organisation. They should collect accurate and valid cost data to help them measure their performance as regards comparing the resources used against the goals achieved (Mentzer and Konrad, 1991; Oloruntoba and Gray, 2009).

5.2. Proposed logistics model

The model would have two phases focused on (1) pre-emergency planning and preparedness activities, and (2) activities undertaken during an emergency. The planning and preparedness phase must ensure strategic actions for preparedness and anticipation such as collection and analysis of baseline data and demographics as well as forecasting of various types of demand for target African countries. These could include population figures for various groups, number of available hospitals, health centres and public health laboratories. Also, in this planning phase, the key

contacts and related details (phones, emails) in the target countries should be collected.

The first phase must be focused on planning and strategy for example, within the context of the specific goals of the organization as well as the context of the political and infrastructure features of the target developing country. Planning activities must also consider that logistics must fit in with and be coordinated with pre-existing systems and processes of the host nation and government.

Logistics activities must be executed in coordination with host nation political support and host nation health and medical authorities (Fig 2).

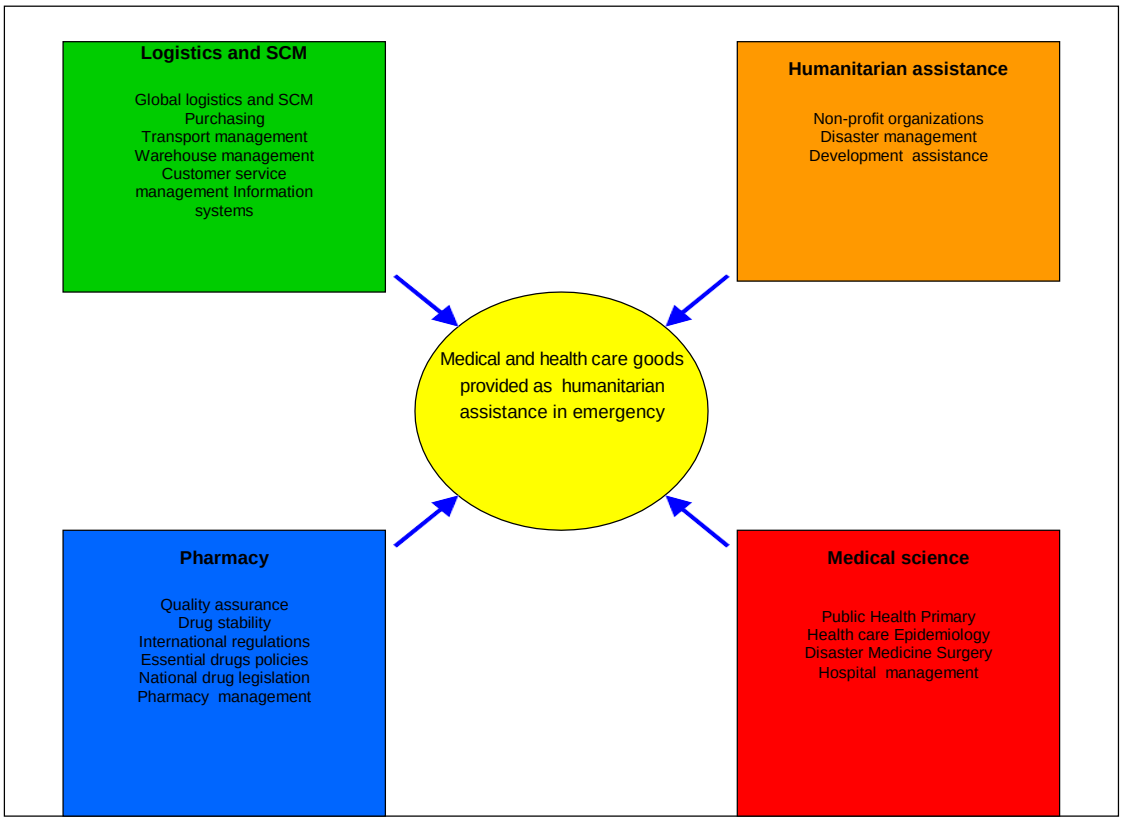

Figure 2. Complexity of factors impacting medical logistics in emergencies

Furthermore, effective logistics planning must consider local communities. Local leaders should be consulted and their inputs and suggestions taken into account in planning and implementing a logistics model given their local knowledge and

legitimacy. The second phase when there is an emergency is when the model is implemented, and considerations must be given to:

The nature of the medical emergency

The nature of the emergency such as earthquakes, hurricanes, tornadoes, chemical leaks, terrorist attacks will influence the type of medical supplies required by the affected country. It could also be high rates of infectious and communicable diseases such as measles or pandemics such as Ebola or Malaria. Overall, outbreaks of communicable diseases should be expected in large populations especially when they live in crowded and poor sanitary conditions (e.g. Lassa fever).

Agility and responsiveness

The model itself must be quick to respond to demand by being agile and responsive. Agility is the ability to thrive and prosper in an environment of constant and difficult to predict change (Maskell, 2001). Agility is about responsiveness and mastering turbulence (Van Hoek et al., 2001). Responsiveness in logistics arises out of an organization-wide capability which embraces flexible organisational structures, information systems, logistics processes, and flexible mindsets (Christopher and Towill, 2000). An example of activities that result in an agile logistical response include coordination with relevant stakeholders and actors such as transport companies or host government agencies. For instance in the shared use of assets, equipment, or resources such as aircraft and trucks.

Inventory and sourcing

An effective model should maintain capacity flexibility to buffer against demand/supply uncertainty. For instance, applying effective demand-led inventory management in responding countries through the concept of postponement may be a cost-effective substitute for expensive pre-positioning. Logistics postponement may enable the assignment of medical and healthcare goods to be rapid. Such supplies may be held in responding countries with pharmaceutical suppliers and medical and healthcare product manufacturers through pre-supply agreements or memorandum of understanding to supply. Such supplies are held upstream as generic strategic inventory. The supplies are then transported and distributed according to the emergency needs of the end users in Africa when required. The postponement of

commitment of that strategic inventory to final delivery results in better use of more accurate needs analysis data from sites impacted by the emergency.

Hence, there is increased reliability and accuracy of information about recipients' immediate emergency needs. Maintenance of generic inventory may also help overcome market sourcing risks, including the risk of product obsolescence or market shortages. Selected suppliers themselves must be speedy, flexible, reliable and of high quality.

Generic stocks of supplies should be converted into recipient-specific deliveries in an agile way based on decision making that derives from information input by local people regarding, for example, logistical accessibility, roads, terrain, weather, available materials handling equipment, (refrigerated or temperature controlled) facilities, depots and warehouses as well as culturally relevant information regarding the customs, practices, values and religion of the community. The concept of postponement as a field level supply chain tactic should have a positive impact on the speed of response, its flexibility and agility in meeting the demand of end users.

Maintaining capacity flexibility and responsiveness to buffer against demand/supply uncertainty may be undertaken by having two or three key suppliers to mitigate supplier risks as well as reduce costs.

Delivery and distribution

The number of people (or hospitals) requiring product is directly proportional to the amount of time consumed to reach them. Hence, in the early response stages of an emergency collaboration, coordination and partnering are essential to save time. For example local medical practitioners and public health specialists may be partnered with for a rapid distribution of product and rapid administration of product to those who need it. To be responsive in emergencies, organizations require to arrange proper partnerships and coordination infrastructure *before* the emergency which may require some upfront financial investment *before* an emergency.

Summary

Overall, the number of people in need of medical humanitarian assistance in Africa and other developing countries is significant. Such medical humanitarian assistance has a multitude of objectives towards different demographic groups that are relevant for logistics management. There are also many constraints related to medical/humanitarian organizations themselves, and the challenging context of developing countries. Furthermore, there are complexities associated with the enormous range of available medical and health care goods and their different categories as well as logistical management.

The peculiar vulnerability of many medical and healthcare products to ‘use by dates’, cold chain requirements, deterioration, and damage highlights the importance of quality assurance in the logistics process. The core focus of logistics performance should be efficiency and cost (use of resources), risk (damage in transit or storage) and effectiveness (customer service). Logistics planning and operations are determined at the pre-emergency and emergency phases as well as at the strategic, and tactical level respectively. Also, the international and national distances to emergency areas are directly related to the level of risks and, in most cases logistics costs. Finally, the third aspect considers the criticality of individual items.

Also, item selection may need to consider issues of standardization and reduction of variety, where to source product and whether to source within country or internationally, and centrally or decentralized sourcing. The sourcing strategy further considers trade-offs between two or three big suppliers or use of multiple suppliers to reduce risk but increase costs and administrative burdens.

Other issues to consider include warehousing (international /home or in the field) as well as owning or renting of storage facilities or outsourcing from logistics service providers for a fee. There is also the trade- off between the objectives of effectiveness and efficiency.

Delivery and distribution determines criteria for using different channels (e.g. partnering with local organizations and charities) and discusses effectiveness and customer service (of the recipient). The advantages and importance of collaborative planning and implementation with communities, their leaders and host governments

and others are discussed. A consideration for deciding on stock positioning of items is proposed (e.g. with suppliers as pre-agreed, or in-house).

Further research and benefits

There is limited published literature on inventory control in the context of emergency assistance unlike transport. Hence, inventory management and warehousing studies are urgently needed. Nevertheless, while the project does not present a complete solution which suits every organization in every context or emergency, the presented model allows addressing core issues of logistics (sourcing, delivery and distribution).

The outlined logistics model can serve (medical) organizations as a starting point for developing their own strategic framework for medical and healthcare logistics for developing countries given its peculiar goals and constraints. The model may also be used for developing operational plans for a given emergency, or used for analysis of logistics systems, processes and services of humanitarian organizations for determining shortcomings and improving them.

6. Dissemination to stakeholders

Section 6 discusses how findings of the project may be disseminated to stakeholders so that the knowledge generated meets its purpose, and indeed benefits important stakeholders and practitioners economically, socially, sustainably as well as in the areas of education and public policy in society. First, dissemination has already taken place through an interim and a final report to HI2. Other potential strategies for dissemination for stakeholders include:

A. Outside Africa

Conferences and workshops

The use of public health, logistics and humanitarian conferences, workshops, seminars, and colloquiums is one strategy that could be adopted. These could be practitioner-oriented meetings that are attended by humanitarian non-governmental organizations (NGOs), donors, grantors, charities and others. For scholarly and

research audiences a refereed conference presentation at a suitable conference such as a logistics, public health or humanitarian conference may be of value. Also, a manuscript submitted to a logistics or other appropriate journal may be useful to disseminate findings to scholars and researchers.

B. Inside Africa

Potential dissemination strategies include:

Theatre and drama

Theatre is often used in health promotion, education and the training of health professionals in African countries, and has proven of value. Role-play and other drama strategies have been successfully used to support training and professional development of healthcare workers. Applied theatre may be used and performed to an invited public audience. The live performance of findings serves to engage the audience and concretize, rather than abstract, the findings, knowledge and experiences of the research project. Theatre and drama can help transform social understanding more than textual presentation, as it challenges the academic privileging of written text. Theatre is also a focal point for audience members to discuss their own experiences of topics. It fits the critical social science approach that research should empower participants to change the context in which they operate or the way they behave.

Training kits

To disseminate the model to stakeholders, advocate for change, and facilitate adoption and usage; the media, program managers, health professionals, public officials, and public health bureaucrats could be identified and targeted with the training and development kits used by officials in Ministries of Health.

Media

Placement of summary findings in national and regional health-related media, periodicals, and publications could be of value in dissemination given the precisely targeted readership.

Websites

Non-technical policy report, policy briefs and summary Powerpoint slides that summarize findings may be disseminated through relevant web-sites with links to regional stakeholders such as UNICEF (United Nations Children and Educational Fund), WHO (World Health Organization), DFID (Department for International Development), ODI (Overseas Development Institute), USAID (United States Agency for International Development), and others.

Policymakers

Humanitarian, disaster management, public procurement, and public health/epidemiology policy makers could also be targeted.

Libraries

Many universities and high schools now have more library resources that can be used such as the *Open Archive Initiative.* The *Open Archive Initiative* compliant institutional repositories promise to provide greater access to resources and publications.

References

Awan, Z. and Rahman, Z., 2010. Supply chain designs for humanitarian relief.http://www.divaportal.org/smash/record.jsf?pid=diva2%3A327029&dswid=9351 #sthash. HpfbetVF.dpbs (accessed 12 June 2017) (M.Sc. Thesis).

Christopher, M. and Towill, D. R., 2000. Supply chain migration from lean and functional to agile and customised. *Supply Chain Management: An International Journal*, 5 (4): 206-213.

Lei L., Pinedo M., Qi L., Wang S. and Yang J., 2015. Personnel scheduling and supplies provisioning in emergency relief operations. *Annals of Operations Research*, 235 (1):487-515.

Maskell, B., 2001. The age of agile manufacturing. *Supply Chain Management: An International Journal*, 6 (1): 5-11.

Mentzer, J. T. and Konrad, B. P., 1991. An efficiency and effectiveness approach to logistics performance analysis. *Journal of Business Logistics*, 12 (1): 33-49.

McGuire, G.A., 2006. "Development of a supply chain management framework for health care goods provided as humanitarian assistance in complex political emergencies." PhD diss., WU Vienna University of Economics and Business (accessed 12 June 2017).

Nagurney, A., Yu, M. and Qiang, Q., 2011. Supply chain network design for critical needs with outsourcing. *Papers in Regional Science*, 90 (1):123-42.

Nagurney A, Yu M, Qiang Q. Multiproduct humanitarian healthcare supply chains: a network modelling and computational framework, 2012. Proceedings of the 23rd Annual POMS Conference, Chicago, Illinois, April 20-23, 2012. Available at SSRN: https://ssrn.com/abstract=1636294 or http://dx.doi.org/10.2139/ssrn.1636294 (conference paper) (accessed 12 June 2017).

Oloruntoba, R. and Gray, R., 2009. Customer service in emergency relief chains. International Journal of Physical Distribution and Logistics Management, 39(6): 486-505.

Ozkapici, D.B., Ertem, M.A and Aygüneş, H., 2016. Intermodal humanitarian logistics model based on maritime transportation in Istanbul. *Natural Hazards*, 83 (1):345-64.

Rottkemper, B., Fischer, K and Blecken, A. 2012. A transhipment model for distribution and inventory relocation under uncertainty in humanitarian operations *Socio-Economic Planning Sciences*, 46 (1): 98-109.

Van Hoek, R. I., 2001. The rediscovery of postponement a literature review and directions for research. *Journal of Operations Management,* 19 (2):161-184.

Suggested readings

Battersby, A. 1985. How to assess health service logistics with particular reference to peripheral health facilities. Geneva: World Health Organization.

Battersby, A. and Garnett, A. 1993. How to estimate warehouse space for drugs. Geneva: World Health Organization.

Dörner, G. (ed.). 1992. Management of drug purchasing, storage and distribution. Manual for developing countries. 3rd ed. Aulendorf: Cantor.

Quick, J. D. (ed). 1997. Managing Drug Supply. 2nd ed. West Hartford: Kumarian.

Shawkey, P., and Hart, C. 2003. Logistics' Contributions to Better Health in Developing Countries. Ashgate: Aldershot.