Humanitarian Value Stream Mapping: Application to the EBOLA Outbreak

Laura Laguna Salvadó
Ecole de Mines Albi, France
llagunas@mines-albi.fr

Matthieu Lauras
Ecole de Mines Albi, France
lauras@mines-albi.fr

Tina Comes
University of Agder, Norway
tina.comes@uia.no

ABSTRACT

Humanitarian Supply Chain Management serves as bridge between needs and aid provided. Flows of goods and information connect the field to headquarters, distribution to procurement, beneficiaries to donors. The problems of decision-making, information sharing and coordination can be studied with this special logistics focus. We present a Value Stream Mapping approach that provides a structure to analyze and understand the problems arising in practice, such as bottlenecks; waiting times; or misaligned procurement and distribution policies. We demonstrate our lean-management approach by using the ongoing Ebola Outbreak in West Africa as Case Study.

Keywords

Humanitarian Supply Chain, Value Stream Mapping, Decision-Makers, Ebola Outbreak.

INTRODUCTION

A Humanitarian Supply Chain (HSC) is a complex system. It is often difficult to capture knowledge about a given HSC, covering all types of flows and processes. To better understand and analyze if the current HSC meets the needs of the population in need, and operates efficiently in a dynamically evolving context practitioners and academics have frequently emphasized the need for precise and realistic representations of those HSCs in order to improve them (Charles and Lauras, 2011).

Because practitioners and academics ideally would like to have a perfect understanding of the HSC's operating process, they have to collect and organize data. However, due to the complexity of disaster response, direct observation, and manual data collection and processing without a clear and transparent methodology are fastidious and inefficient. Therefore, we consider here the question of how to analyse the current situation and the HSC operations.

Monitoring support systems have not been a subject of discussion in the scientific

literature on Humanitarian logistics. Although there are widely known reference frameworks in business context (SCOR model or Global EVALOG, for example, Ducq et al., 2005), it seems that they are very few concrete and operational HSC diagnosis and process improvement support tools.

Field research on the Ebola response that we conducted in December 2014 highlighted the need for such a diagnosis. Practitioners were mainly using Excel sheets or paper support to manage logistics operations, so no specific tools like ERP (Enterprise Resource Planning). Logisticians reported on many planning and monitoring problems. In part, this was owing to the challenging circumstances such as restrictions of air or sea transportation; lack of storage and transportation capacity; changes in requirements for medical equipment; or excessive customs control. In addition, the lack of monitoring systems and clear structures for planning, along with non-existing communication infrastructures caused misalignments and shortages, particularly of specialized medical equipment such as PPE (Personal Protection Equipment).

At the beginning of the response, local warehouses received packed kits of PPE, each of them containing the defined list of PPE-items. While some of these items are reusable, others are not. Interviewees reported that, as the crises was ongoing for weeks and months, there was a need to switch from the complete kits, that were helpful for the initial response, to supplying the actually required quantity of each specific item and not the full kit. This reflects a shift from effectiveness (ensuring that all items are available) to efficiency by reducing waste and delays: the kits' preparation was reported to take about three weeks at headquarter (HQ) warehouses.

Our interviews also confirmed that the aid was supplied following a PUSH strategy, i.e., PPE kits were literally pushed from the HQ to the field on the basis of rough assessments, instead of responding to concrete orders from the field. A full overview of the SC, including a monitoring of the actual needs, stocks, and capacities, is a requirement for improving this situation.

In the literature works have been done to model HSC processes using BPMN standards (Business Process Model Notation) that can then be used as a reference task model for the first response (Blecken, 2010). But we advocate that to make a good diagnosis, the existing operating processes have to be collected without using a standard model or pre-disaster frame or process. Rather, a focused set of elementary questions that are driven by context need to be answered such as: what is needed? when? where? for whom? how?, and why?

To reach this goal, we propose to use the Value Stream Mapping (VSM) technique. The benefits of such lean-management tools have been proved in industrial context (Miclo et *al.*, 2014), as it allows efficiently gathering operational data, and precisely highlighting the weaknesses and opportunities of the studied system. In the humanitarian organizations, modeling and optimization is in their infancy (Blecken, 2010). Consequently, the challenge of this research consists in analyzing how such a tool needs to be adapted for the humanitarian context, and what their benefits would be.

This paper is divided into four sections. The first one provides a brief background regarding HSC analysis and diagnosis tools. The second section describes the Humanitarian VSM approach that we propose. In the third section, we illustrate our approach in the context of the Ebola outbreak in Western Africa. The underlying data was collected in Skype and field interviews in Accra / Ghana with practitioners from different UN agencies. Finally, a last section gives some conclusions and perspectives.

BACKGROUND

HSC diagnosis challenges

Tomasini and Van Wassenhove (2009) argued that one of the main humanitarian challenges consists in learning from previous disasters by capturing, codifying and transferring knowledge about logistics operations. Researchers are no doubt aware that the main criterion of the success of scientific approaches consists in producing a complete and representative model of the studied system that helps practitioners to address the problems in practice. But considered an art by many and weird science by some, modeling is not as simple as it seems. This is particularly true in the humanitarian context, as in all new research areas, where researchers have difficulty identifying appropriate decision variables and

parameters to be able to develop accurate and relevant models (Charles and Lauras, 2011). This paper tackles this issue by focusing on modeling techniques rather than solution algorithms.

Gathering realistic data

It is clear that a real gap exists between research proposals on HSC and their application in the field. Among the authors aware of this issue, (Galindo and Batta, 2013; Pedraza-Martinez *et al.*, 2013) have indicated that research works should be closer to practice, considering real problems and real data. The problem is that such an approach is time-consuming, as researchers find it difficult to get accurate, and above all, reliable data to support their work (Galindo and Batta, 2013). Another point is about the capacity of researchers to structure this knowledge in order to support the development of original research and operational innovation for humanitarians.

Structuring knowledge

Explicit knowledge of a SC can be gained by business process modeling, which has been recognized as a good practice to reduce heterogeneity problems (Vernadat, 1996). Once they are mapped, business processes between SC partners provide an transparent overview of the business, facilitating coordination and defining the many interfaces that need to be controlled. However, in humanitarian contexts, most of the time, this knowledge is not available in a structured and formalized way (Taylor and Pettit, 2009). The great majority of scientific approaches are informal and descriptive. Consequently, practitioners have little confidence in these approaches and, as outlined in the 2013 Red Cross World Disaster Report, most are ineffective and in many cases abandoned.

Nevertheless some authors (Taylor and Pettit, 2009; Charles and Lauras, 2011) have tried to avoid this limitation by suggesting adaption of enterprise-modeling concepts for HSC. Taylor and Pettit (2009) have notably proposed a first experimentation for recurrent African health crises with promising results. Yet, even if these approaches structure humanitarian knowledge, they are complex to implement, and require expertise in enterprise modeling.

Our main objective consists in leveraging the idea of knowledge structuring by proposing a concrete methodology and set of tools that can be used by any practitioner in humanitarian logistics.

Lean Thinking as source of inspiration

Any organization that is looking to make the most of limited resources should look into "Lean" (Womack and Jones, 1996) — an approach to improving daily work processes in terms of quality, cost, and effectiveness (Womack and Jones, 1996). Applied effectively, the philosophy and the concepts, has been demonstrated to lead to dramatic improvements in performance in the nonprofit sector as they have in a wide variety of for-profit firms (Taylor and Pettit, 2009).

The first step of a Lean approach consists in learning about the different kinds of waste that can affect the system (Womack and Jones, 1996). Waste is anything that adds cost or time without adding value (Tapping *et al*., 2002). To do that, a Value Stream Mapping (VSM) should be established. VSM is a visual representation of workflow with quantitative data at each step of the process. Its principle consists in breaking down a process value stream along different operations (at company scale) or along different installations (at network scale) in order to analyze each activity that contributes to the overall performance (Womack and Jones, 1996).

Standardized pictograms are used to illustrate each activity. The resulted map should show (Womack and Jones, 1996):

- How long it takes to get started or get up to speed
- How long it takes to complete the value-added work of the step
- How many items or beneficiaries get worked on at a time
- How long items or beneficiaries wait

With such a map, it should be possible to improve the organization at the supply chain level. This improvement process should use the four main Lean principles (Womack and Jones, 1996):

- Value: How can we eliminate activities that don't add value to beneficiaries or donors? If business or regulatory reasons require these activities, how can we minimize the effort involved?
- Value Stream: How do we put the value-adding activities together to minimize needless movement of people or goods?
- Flow: How do we move toward a continuous flow of work, and away from separate steps each with its own queue, start-up time, and batch processing?
- Pull: How can we do just as much of this work as needed, when it is needed and where it is needed?

A STRUCTURED HUMANITARIAN VALUE STREAM MAPPING

A field-oriented research approach

This research work is done within the Disaster Resilience Lab (DRL) that was established in 2013 as a joint initiative of researchers working on sense-making and decision support for risk and disaster management. The DRL aims to conduct research for a better understanding of information needs, and of the solutions, processes and technologies humanitarian decision-makers are using to address these needs. In this paper, we focus on Supply Chain Management (Figure 1).

We want specifically to investigate how the flows of goods and information are matched, and what the specific difficulties of sourcing and distributing aid are.

To conduct research that is relevant for practitioners' (realism and usability) while applying scientifically sound and rigorous methodologies, we have developed an approach that is based on cooperation between research teams deployed to the field during the response while providing continuous remote expert support during the team's operations (Chan and Comes, 2014).

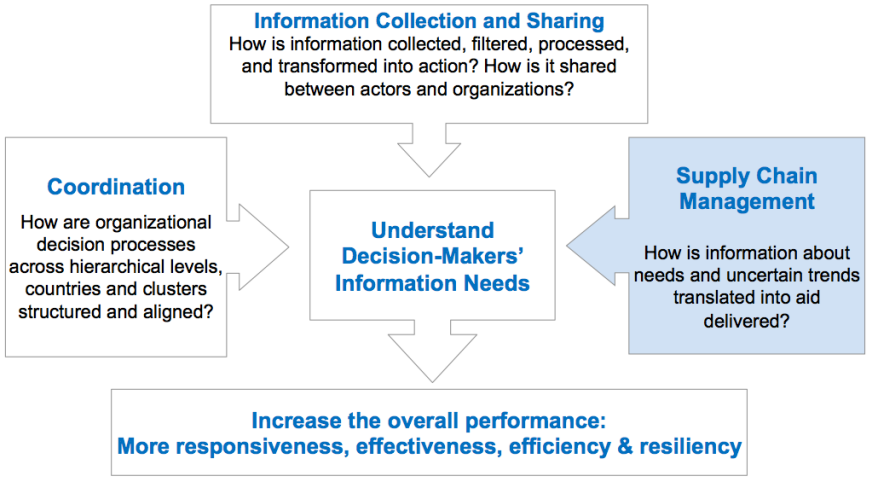

Figure 1. Field-oriented research scope

A real application case: The Ebola outbreak

Humanitarian practitioners typically review and systematically evaluate their operations only after a crisis, forestalling the opportunity of real-time analyze and adaptation, or targeted data collection in the field. While this analysis ensures that capacity can be fully dedicated to the response, there is a higher risk of distorted or biased information.

In our approach, we develop a methodology to gather HSC information and material flows and to analyze the current weakness, with a focus on Information Needs. To develop a model, which is as realistic as possible, our research has been conducted during the ongoing Ebola Outbreak, an unexpected health crisis considered as L3 emergency, the highest level in the UN system. We combined observations, data from interviews with desk reviews and modeling. To ensure not being intrusive, we conducted all the interviews upon the concerned practitioners approval, and often after work hours.

To our best knowledge, real time field research coupled with the VSM method is an original contribution for both academics and practitioners. In the following, we further describe our approach and research design to analyze HSCs on a generic level. Then, we discuss the initial findings of this methodology applied to the Ebola response.

Overview of the proposition

The Humanitarian Value Stream Mapping method we propose is a three steps process (Figure 2).

Figure 2. Methodology overview

1st step – Data collection: Interview protocol

The strategy to collect the data is based on interviews of practitioners mostly during DRL field expeditions (Ghana, Liberia), or remotely. Prior to these interviews, a deep investigation of "open data" (data accessible on the web, e.g. rieliefweb.org) on the crisis was conducted to gather a maximum of raw data regarding the HSCs that are used to manage and monitor the flows of goods.

From the generic aims expressed in the Background Section we derived a qualitative structured interview protocol for the practitioner's interviews. To be more efficient and to facilitate the uptake, a flowchart grid has been designed in coherence with the interview protocol. This is the main support for the quantitative data collection. As shown in the Figure 3, this sheet is a template that describes chronologically the activities of the HSC. These activities are classified in 4 main categories: operation, transfer, stock/wait and control. For each activity the main inputs, outputs and resources can be traced, in addition of other relevant information like cycle time or available capacity.

The rationale for using such a template is to describe business processes and value stream map. It is important to notice that through this approach we collect small parts of the HSC from each practitioner point of view. All these elements will then be concatenated in order to map the whole HSC.

To complete the data collection step, we suggest gathering information (qualitative and quantitative) regarding physical flows that are involving all processes along the HSC. Those elements can be visualized in geographical maps as shown in Figure 4.

DRL FIELD RESEARCH: SUPPLY CHAIN ORIENTED INTERVIEW GUIDELINE

Operation ○	**Considered Flow :**	Filed by:	**General Comments:**
Transfer ⇨	Organisation:	xxx	
Stock/Wait ▽	Location:	Date:	
Outstanding D	Respondent:	xx/xx/xxxx	
Control □	Position:		

Description of the Value Stream					**Description of the Business Processes**					
AS IS description	Main Evolutions	km	Qt	Time	Inputs	Outputs	Resources	Controls	Events	Comments
Order preparation		0	3000	0,5	order by email	Order confirm ation				
Custom		0	3000	0,5						
Waiting for shipment to the airport		0	3000	1						
Transfert to the airport (truck)		3	3000	0,25						
Waiting for cargo shipment		0	3000	0,25						

Figure 3. Example of the workflow grid to support the field interview protocol

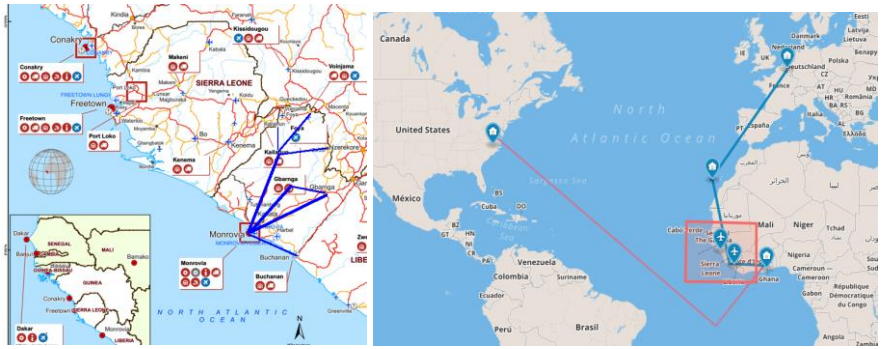

Figure 4. Example of geographical mapping of the supply chain physical flows

2nd step – Mapping: Humanitarian Value Stream Maps

The gathered information is drawn using a set of VSM standard symbols, some of which can be seen on Figure 5.

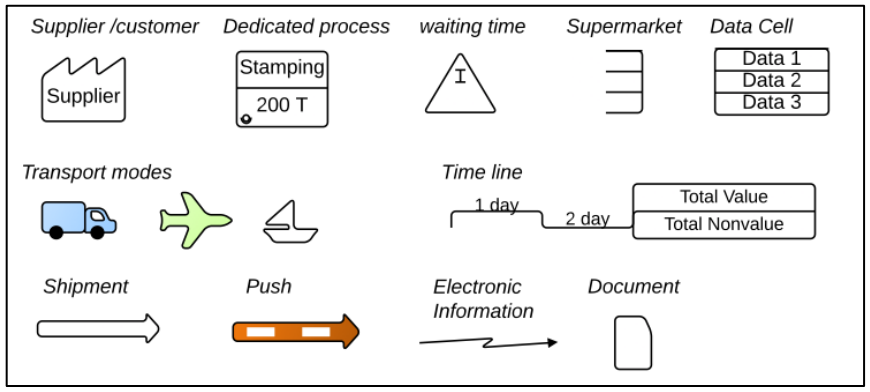

Figure 5. Example of Value Stream Mapping symbols

The following example shows preliminary mapping of the supply chain for a relief organization. The information was structured after a first interview with an Ebola response field practitioner

Figure 6 shows the network of such relief organization for their whole Ebola response needs. This includes the materials flow for all medical resources, that comes from their HQ in Europe, the Chlorine solution (for hygiene) that comes from a neighbor country, and some non-medical items like beds, or food, that may come from local suppliers.

Figure 7 shows the VSM of the PPE value chain while supplied by plane. PPE is representative because it is a critical kit of resources for the Ebola intervention.

With these first mapping results we illustrate the potential of the proposed method to gather and organize the HSC data from interviews in a systematic way.

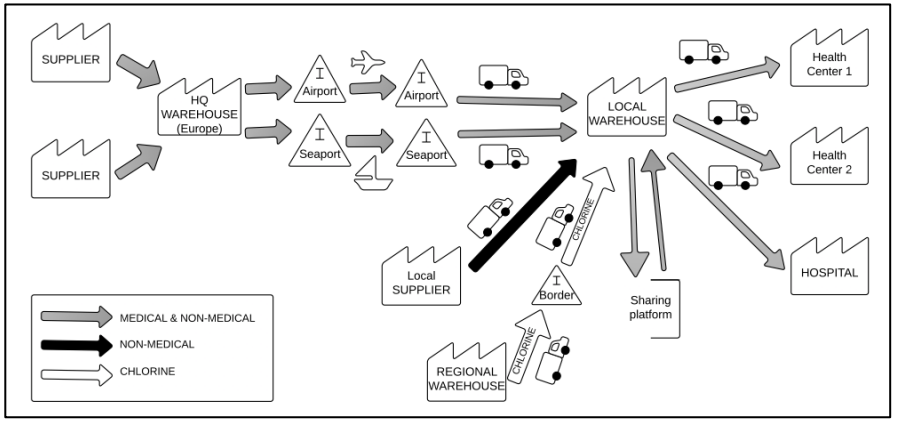

Figure 6. An example of Supply Chain network for the Ebola response

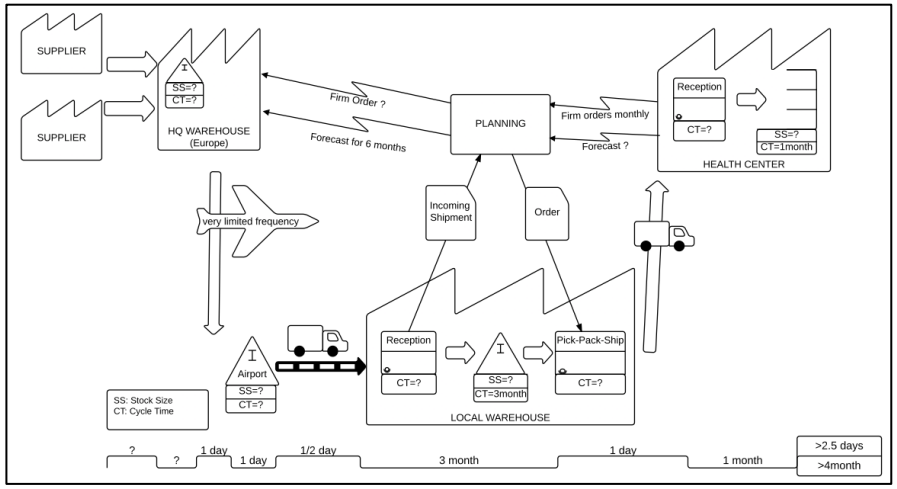

Figure 7. VSM for the PPE value chain

3rd step – Analysis: identify wastes

The quantitative examination of the HSC's state can be done once the VSM is completed. For that, we use standard SC metrics like:

- The lead-time, corresponding to the amount of time that an item takes to reach the beneficiary since the placement of an order.
- The VA is the addition of the value-added activities cycle time for all the chain.

These metrics are used to obtain indicators like the VAR (value-added ratio): it is the rate between the VA and the lead-time. Many others metrics can be used, for instance travel distance, or waste rate.

$$VAR = \frac{VA}{lead\ time} \quad (1)$$

The definition of adding-value activities (or operations) is critical to obtain a pertinent analysis of the situation. In lean management, the value stream adds value from a customer's view. In commercial VSM, the adding-value activities are transforming the raw material. In a HSC we can define the adding-value activities as those that are essential to have the right resources at the right place. This definition includes the transport time, but discards all stock or waiting time.

For the study case, we obtain the VAR using data from the VSM (Figure 7).

$$VAR_{study\ case} = \frac{2.5\ days}{121\ days} = 0{,}02 \quad (2)$$

This is a very low ratio, comparing to an average 0,15 VAR in commercial SC (0,30 is a good VAR). This stresses that there are a lot of non-value added activities comparing with the adding ones. In our study case, we identify obvious forms of waste: keeping important security stocks, or bottleneck activities like transportation into the countries limited by the flight frequency.

To continue the analysis, some key questions need to be clarified. One of our interviewees, working as logistician, explained us that they need a 3 months stock before opening a Health Center.

- Why they have such a big security stock?
- Is it possible to reduce those stocks?
- Is it related with the poor frequency of international deliveries?

Answering this kind of questions will help to identify the cause of the waste.

FIRST INSIGHTS, CONCLUSION AND PERSPECTIVES

This paper presented a method to collect information on HSC by interviews and field research during humanitarian disasters and rapidly quantitatively analyze the current state by the VSM methodology.

We used the Ebola case to illustrate the relevance and the potential results of this method. VSM provides a very clear representation of the current state of material and information flow for a concrete value chain.

Data collection

The average length of an interview is about one hour, so there is typically not enough time to collect detailed data of the SC. Despite the quantitative support (see Figure 3), interviews often had anecdotal character. Additionally, interviewees were responding to Ebola in different phases of the outbreak, and there is a considerable variation in their accounts reflecting the volatile and at times drastically changing conditions. The data collected for the study case is still not complete an exhaustive to draw a detailed VSM. However, we have been able to map the complete Supply network and Value Chain, and to identify some forms of waste, like excessive inventory.

We plan to design a supplementary survey to send to logistic operators to improve the inputs on qualitative data representing the supply chain at a given time. We will also include data concerning the material flow in terms of treated quantities.

Mapping the current state

The use of the VSM methodology during the first phase of the response is necessary to accelerate the detection of wastes like unnecessary movement, inventory or activities, and to improve information flows.

Nevertheless, VSM is a static representation. The dynamics of the response may be difficult to analyze with VSM methodology, and other approaches tailored at capturing trends or risks should be included.

By applying our methodology on several crises (Haiyan Typhoon, Syria conflict, Ebola outbreak…), we are aiming to build a research agenda for HSC. Our ultimate objective is proposing innovative solutions to humanitarian practitioners that will be concretely used by them!

ACKNOWLEDGMENTS

We thank all the humanitarian organizations and practitioners we have already met on the field or "online" to share they experiences and knowledge with us. We are sure that their inputs will be a great source of inspiration for hour future works.

REFERENCES

1. Blecken A. (2010), Supply chain process modelling for humanitarian organizations, International Journal of Physical Distribution & Logistics Management, Vol. 40 Iss 8/9 pp. 675 – 692.
2. Chan, J., Comes, T. (2014) Innovative Research Design – A Journey into the Information Typhoon. Procedia Engineering, Humanitarian Technology: Science, Systems and Global Impact 2014, HumTech2014 78, 52–58.
3. Charles, A., Lauras, M. (2011) An enterprise modelling approach for better optimisation modelling: application to the humanitarian relief chain coordination problem. OR Spectrum 33, 815–841.
4. Ducq, Y., Akif, J.-C., Blanc, S., (2005) Comparison of methods and frameworks to evaluate the performance of supply chains, Bordeaux, France.
5. Galindo, G., Batta, R., (2013) Review of recent developments in OR/MS research in disaster operations management. European Journal of Operational Research 230, 201–211.
6. Womack, J. P. and. Jones, D. T. (1996) Lean Thinking, Second Edition
7. Miclo, R., Lauras, M., Fontanili, F., Lamothe, J., Bornert, P., Revenu, G., (2014) Enhancing Collaborations by Assessing the Expected Financial Benefits of Improvement Projects, Enterprise Interoperability VI, Proceedings of the I-ESA Conferences. Springer International Publishing, pp. 189–200.
8. Pedraza-Martinez, A.J., Stapleton, O., Van Wassenhove, L.N. (2013) On the use of evidence in humanitarian logistics research. Disasters 37, S51–S67.
9. Tapping, D., Luyster, T., and Shuker, T. (2002). Value Stream Management: Eight Steps to Planning, Mapping, and Sustaining Lean Improvements. Taylor & Francis. New York, Productivy press.
10. Taylor, D., Pettit, S. (2009) A consideration of the relevance of lean supply chain concepts for humanitarian aid provision. International Journal of Services Technology and Management 12, 430–444.

11. Tomasini, R.M., Van Wassenhove, L.N. (2009) From preparedness to partnerships: case study research on humanitarian logistics. International Transactions in Operational Research 16, 549–559.

12. Vernadat, F., 1996. Enterprise Modeling and Integration (1996) edition. ed. Springer, London ; New York.