Value stream analysis of West Africa Ebola crisis management

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Abstract
One major issue of research works on humanitarian operations consists in developing approaches able to mix case studies and quantitative models. This work addresses this problem by proposing a field-oriented research, which aims to model and analyze qualitatively and quantitatively the Value Stream of West African Ebola Crisis Supply Chain.

Keywords
Humanitarian Supply Chain, Value Stream Analysis, Ebola Outbreak.

Introduction

A key issue of the disaster response performance is the Humanitarian Supply Chain. Many authors have raised the crucial role of logistics to get the good resources at the good time in the good place (Taylor et Pettit, 2009).

The Disaster Management response phase is complex for many reasons like the short time, the big amount of different stakeholders (NGOs, governments, military, International Organizations) with different interest that met in the field, or the instability of the environment (Galindo and Batta, 2013).

Despite the importance of the supply chain, practitioners still have a narrow view of the ensemble, like a suit of operations that follows the ones after the others with.

The Ebola Outbreak started on March 2014 in Guinea, and has spread among three main West African countries causing almost 22,500 infection cases and 9,000 deaths (WHO). The humanitarian response has not been an exception: lots of organizations have met in the field with different missions: build and/or run health facilities, laboratory centers, safe burials, and community engagement, between others.

During the response the Disaster Resilience Lab engaged a field research mission to the Head Quarters of the United Nations in the West African Region, to discuss with different stakeholders directly or remotely in the field. Practitioners reported problems with lacking material, kitting and pooling, and long waiting times for material to reach the sites where it was needed. The lack of information about the situation at local level leads to push based operations, and very long order cycles, in some cases six months ahead, leading to possible

over- and under-stocking.

Modern Supply Chain works shows the importance of the full control of such a complex network to gain on the performance. Even if Humanitarian SC have different environment and objectives than the industrial ones, many problematic and solutions can be adapted to improve the relief logistics (Charles and Lauras, 2011).

In the industrial context the Value Stream analysis is a very common tool to respond to those questions. It allows highlighting the weakness and opportunities of a system with qualitative and quantitative data coming from the field (Miclo et al., 2014), as part of the lean-management tools.

This paper discusses the pertinence of using Value Stream analysis to model and evaluate humanitarian Supply Chain performance, and the challenges to apply this tool to the humanitarian field. We propose to use Value Stream Mapping (VSM) as a method to determine the amount of waste in the supply chain and to analyze the possible causes. We illustrate our approach with an example of the Ebola response, with the data collected in Skype sessions and field interviews with relief practitioners.

Humanitarian Supply Chain diagnosis

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 adapting 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.

The Lean-management approach

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).

The theoretical applicability of lean logistics techniques for Humanitarian operations has already been addressed (Taylor and Pettit, 2009 and Cozzolino et al.; 2011). Academics suggested that there is a significant scope for the application of well established Lean improvement tools, which could change the traditional implementation of Humanitarian Supply Chains for more efficient supply systems, but when and how to implement the lean principles, is not still clear. Taylor and Pettit highlight that would be interesting to use value chain mapping techniques to pinpoint where along the chain losses or wastes occur and importantly the reasons for the occurrences.

In the next sections we discuss the use of a Value Stream Analysis for the Humanitarian Supply Chain diagnosis and the implementation using Value Stream Mapping (VSM) tools.

Value Stream concepts in humanitarian context

The 'value'

The value definition, which should be linked to only one product or service, is the starting point in the lean management approach. This therm does not mean value in economic sense, and only the final customer can define it. The first question to be addressed is: What is 'value' from the point of view of the end consumer of the product? (Womack and Jones, 1996). In commercial SC, this can be the anything that people pay for it: the lead-time; the packaging; the personalization…

The particularity of HSC is to define who is the "customer". The beneficiaries, the ones who will receive the humanitarian relief (products and services), won't pay for it. And the donors, the ones who pay, don't receive the products, but they have to be happy with the performance to donate again.

So in both cases, value in humanitarian supply chains, concerns the delivery of the correct products to the right people at the right time (Taylor and Petit, 2009).

The 'value stream'

In lean manufacturing, a value stream is all the actions currently required to bring a product through the production flow to every product: from raw material into the arms of consumer (J. Shook et al., 1999).

We can identify three kinds of actions (Womack and Jones, 1996): the ones that transforms the product that are clearly adding value activities, the ones that are needed to achieve the "value" because of the system (quality controls, transport, kitting, security stocks), and the ones that have no adding value at can be directly deleted (waiting times).

This notion of adding value is not evident, so we have to keep in mind, which is the value that the donor is paying for!

Value Stream Mapping tool

To make a qualitative analysis of the Value Stream, that will help prioritize, plan and link improvement work across the HSC, we propose to develop the Value stream mapping (VSM) methodology:

VSM is a simple tool to help operation managers, engineers and others, understand how their flows currently operate and to help guide them through the process of analysis to improve those existing flows and design better ones in the future (J. Shook et al., 1999).

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 tool, it should be possible to do a qualitative and quantitative analysis of the current supply chain by any practitioner in humanitarian logistics. 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?

Ebola response Value Stream Analysis

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).

The Ebola outbreak application case

Humanitarian practitioners typically review and systematically evaluate their operations only after a crisis, forestalling the opportunity of real-time analysis 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 analysis qualitatively and quantitatively the current weakness. 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 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.

The Humanitarian Value Stream Analysis we propose is a three steps process (Figure 1).

Data collection → Mapping → Waste analysis

Figure 1. Methodology overview

Ebola case data collection

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" 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 2.

DRL FIELD RESEARCH: SUPPLY CHAIN ORIENTED INTERVIEW GUIDELINE										
Considered Flow : / **Organisation:** / **Location:** / **Respondent:** / **Position:**				Filed by: xxx / Date: xx/xx/xxxx				General Comments:		
Operation ◯ / Transfer ⇨ / Stock/Wait ▽ / Outstanding ◻ / Control ◻										

◯	⇨	▽	◻	◻	Description	Distance	Quantity	Time (day)	Resources	Controls	Inputs	Outputs	Gateway
■					Order preparation		1000	0,5			Order by email	Confirmation and Order	
				■	Custom		1000	0,5					
		■			Waiting for shipment to the airport		1000	1					Select flight
	■				Transfert to the airport (truck)	20	1000	0,25					
		■			Waiting for cargo shipment		1000	0,25					
	■				Transfert to Monrovia by cargo	5500	1000	0,5					
		■			Waiting at Monrovia airport		1000	3					
	■				Transfert to the MSF Monrovia warehouse		1000	0,5					
		■			Waiting at Monrovia warehouse		1000	5					
■					Kitting		100	0,5					
■					order preparation		10	0,5					
		■			waiting for delivery		10	1					
	■				Transfer to the ETC x by car	30	10	2					
		■			waiting at ETC warehouse		10	3					
	■				transfer to end user		1	0,25					
■					using		1	0,25					
■					separation for reuse or distruction		1	0,25					Reuse or not

Figure 2. Example of the workflow grid to support the field interview protocol

Figure 3. Example of geographical mapping of the supply chain physical flows

Value Stream Mapping

The gathered information is drawn using a set of VSM standard 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 4 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.
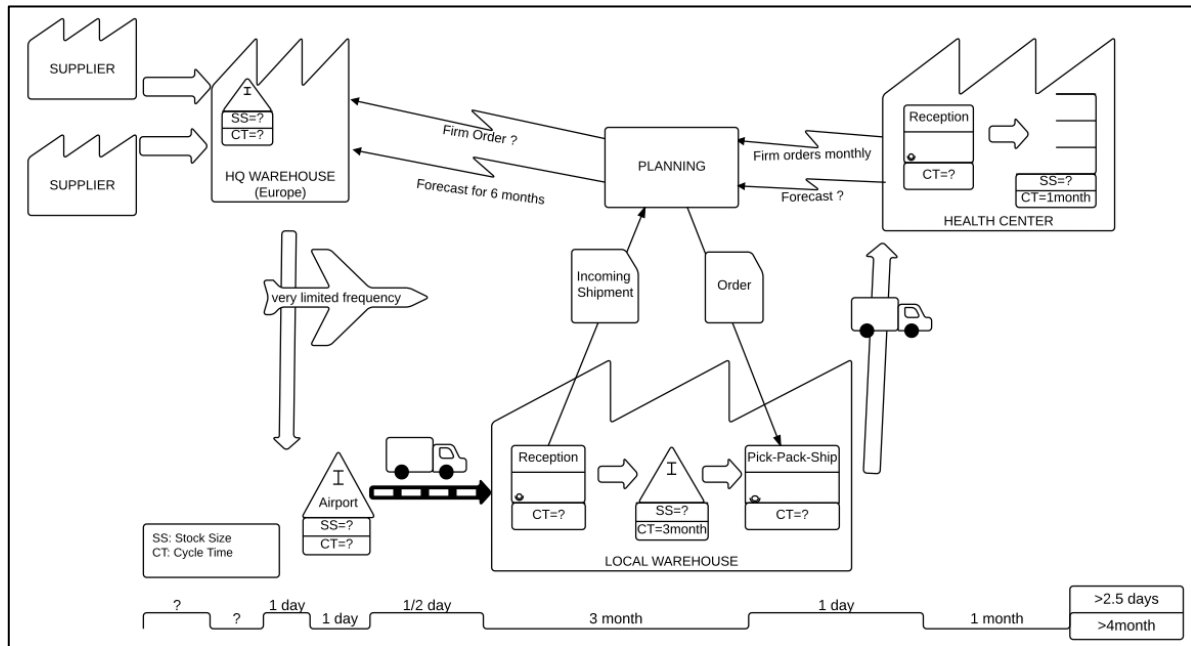

Figure 4. VSM for the PPE value chain

Qualitative and quantitative analysis

Qualitative analysis of the data is done using the transcription of the interviews. We can highlight some points mentioned by the respondents concerning the set up, the agility, or the logistic planning and distribution (for more details see "Preliminary key findings from interviews in Accra on the Ebola Response", www.disasterresiliencelab.org).

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.

$$VAR = \frac{VA}{lead\ time} \tag{1}$$

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).

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

This is a very low ratio, comparing to an average 0,15 VAR in commercial SC (0,30 is a good VAR) (Lauras et al., 2014). 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.

FURTHER RESEARCH

This paper has presented the Value Stream analysis method to diagnose the humanitarian supply chain current state. This tool is currently used in commercial supply chains as part of the lean-manufacturing approach.

We used the Ebola case to illustrate the relevance and the potential results of this method.

VSM tool provides a clear graphical representation of the current state of products and information flow for a concrete value stream.

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 large stocks.

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, 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.

We expect to apply this methodology on other study cases (Syria conflict, Ebola outbreak…), to contribute to build a research agenda for HSC. Our ultimate objective is proposing innovative solutions to humanitarian practitioners that will be concretely used by them!

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