A RESEARCH AGENDA FOR THE ENVIRONMENTAL IMPACT OF HUMANITARIAN LOGISTICS

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Introduction

It has been estimated that 5,5% of the total amount of greenhouse gases (GHG) generated by human activities can be attributed to the logistics and transport sector (World Economic Forum, 2009). The increasing amounts of GHG emissions to the atmosphere create imbalances in the eco-system, known as climate change, and is being considered the root cause of many natural disasters such as flooding and hurricanes, as highlighted by Halldórsson and Kovács (2010). It should therefore be of interest for the humanitarian organisations responding to these events, to take steps on greening their own logistics activities in the wake of climate change (Klumpp et al, 2015).

Humanitarian logistics activities have grown over the past years as the number of disasters and related activities in managing the disaster response has increased rapidly (Vanajakumari et al, 2016). Disaster relief is furthermore expected to increase as it is forecasted that both natural and man-made disasters will rise five-fold over the next 50 years (Thomas and Kopczak, 2005). The annual spending worldwide on logistic operations for disasters has reached USD$15 billion (Christopher and Tatham, 2011) and literature underlines how logistics can affect up to 80% of the humanitarian operations effort (Van Wessenhove, 2006), hence being one of the most important factors.

The aim of this paper is to set a research agenda on the subject Greening Humanitarian Logistics. The research contribution is to show the actual environmental impact, in terms of emissions of carbondioxide, from humanitarian logistics of an ongoing continuous operation, to create a baseline for current state of affairs. The case study presented in this paper shows the level of vehicle utilization on the two last legs of a transportation chain, before the goods reach the end users.

Mapping and reducing greenhouse gas emissions from transportation activities has been on the agenda for several years in the commercial logistics sector (McKinnon et al, 2015). The humanitarian logistics is however considered unique in several ways and therefore distinguishes itself from its commercial counterpart. Holguín-Veras et al (2012) discuss the characteristics of disaster relief logistics as opposed to commercial logistics. Disaster relief logistics is said to be informal and improvised, with low emphasis on transportation costs and acting on unknown demand. Commercial logistics, on the other hand, takes place under conditions that are relatively stable and functional, with established decision making procedures and with known demand, and those factors enable optimisation for best use of resources at low cost. Holguín-Veras et al (2012) place “regular humanitarian logistics” (RHL) somewhere in between the two. RHL takes place in the long-term recovery phase following the response phase after a disaster or it be can be ongoing operations responding to a slow-onset disaster, such as a refugee crisis or the effects of an escalating draught in a region. RHL is not so much about saving lives, but more about “doing more with less”. With this paper the author wants to share the findings from a case study on RHL and to set a research agenda for examining the environmental impact of humanitarian logistics.

The UN (United Nations) has, on a strategic level, decided to take action and limit environmental impact from operations and to “lead by example” (UNEP, 2012, p. 3). These decisions are however quite recent and have therefore not yet been implemented by all the organisations, agencies, funds and bodies, working under the UN umbrella. Although the humanitarian organisations have climate change adaptation on their agenda, little attention has been paid to adjusting their own operations in terms of greening the supply chain management (Haavisto and Kovacs, 2014). Sarkis et al, (2012) highlight that “the need to introduce green supply chain principles and practices in the relief supply chain is evident, however, no studies have so far addressed the greening of the relief supply chain” (p. 205). Since this aspect has not been prioritised, it seems likely that there is room for improvements in how to organise the activities.

This paper is divided into five sections. After the introduction it outlines a literature study on the streams of interest. A methodology section follows whereby the details of the case study is explained. The findings/discussion section is devoted to analysis of the empirical data. Finally there is a concluding section where the consequences of the findings are further elaborated upon and recommendations for future research is suggested.

Literature review

The issue of environmental impact of logistics and supply chains has been on the agenda since the early 1990s. A growing amount of academic literature on the subject has emerged on what is now commonly referred to as "green supply chain management" or "green logistics" (McKinnon et al, 2015). Green logistics encompass a range of streams for academics to engage in. Topics include; strategy/policy considerations, procurement criterias, how the supply chain is organised, freight modes, the efficiency of activities, fuel consumption, reverse flows, warehousing and product design (Grant et al, 2015) (McKinnon et al, 2015). In order to determine to what extent the greening dimension has been addressed in humanitarian logistics literature to date, a literature review was performed. Literature searches were made on humanitarian logistics with added combinations on key words such as sustainable, sustainability, green, greening, environment, emission, emissions. The word humanitarian was alternated by relief and the word logistics by supply chain to get an exhaustive outcome of the searches.

The search was limited to peer-reviewed publications only, while book sections, conference proceedings, reports and practitioner journals were excluded from the selection. Furthermore was it limited to articles from 2004-2017, as almost no research on humanitarian logistics was carried out prior to 2004 (Kunz and Rainer, 2012). The different databases used were Scopus, Emerald, and Google Scholar. Several papers were found but very few of these were relevant to the topic in question. By using the search keywords, the result of the searches varied from 0 hits up to the excess of 300 hits. The different search criterias were then filtered for duplication. The abstracts of the articles were reviewed and the ones not relevant were discarded. After this exercise was finalised, only 8 articles remained of relevance for the topic in question.

Literature

There are very few peer-reviewed articles on the subject of sustainable humanitarian logistics. Dubey and Gunasekaran (2015) have made an attempt to provide a sustainable humanitarian supply chain definition by way of delineate humanitarian supply chain management from commercial supply chain management. They recognise concerns over climate change and eco-system vulnerability but do not explicitly look at just how the supply chain activities affect these factors. They recommend for further research directions to integrate disaster relief supply networks with ecological footprints.

Haavisto and Kovács (2014) undertook a content analysis of annual reports from 11 major humanitarian organisations. Their analysis concludes that although sustainability is addressed in a societal and programme perspective, little attention is paid to greening of products, services, and operations. They recommend further research to identify best practices for greening of the humanitarian supply chain. The closed loop supply chain was investigated by Battini et al (2016) in their study on regular humanitarian logistics, by providing a model to evaluate the different material flows, including reverse channels, to optimise resource allocations and prepositioning decisions.

Research on reverse logistics in humanitarian operations has been carried out by Peretti et al (2011) in their analysis of the challenges and opportunities for the application of reverse logistics in a humanitarian logistics context. They claim that their research represents a first look at a new sub-topic within the overall humanitarian logistics field. The importance of secondary packaging in developing countries with a humanitarian logistics perspective was the subject of Sohrabpour et al (2012). In their qualitative study they explore supply chain needs regarding packaging in an embedded case study, by linking supply chain thinking in developing countries to long-term development and disaster relief logistics.

Eng-Larsson and Vega (2011) combined the literature on temporary and permanent supply networks and green logistics in the humanitarian context and to explored how green logistics considerations can be incorporated into temporary organisations without compromising short-term objectives. They found five

main gaps that need to be targeted to reduce the environmental impact from disaster relief logistics: better matching of supply and demand; reduce transport volumes; reduce transport distances; increase vehicle fill rate; decrease vehicle impact. Another two studies (Balcik et al, 2008) (Battini et al, 2014) have looked at optimising the last-mile by means of modelling. Both studies aim to optimise resource allocation and vehicle routing decisions in a humanitarian context.

From an examination of the relevant literature it is however evident that no studies so far has investigated the emissions from humanitarian logistics operations that contribute to climate change. Applied research is missing on empirical measurements of actual GHG emissions from a real life case in a humanitarian setting.

Two extensive literature reviews on humanitarian logistics research have been carried out during recent years. Kuntz and Rainer (2012) analyse 174 papers and conclude that empirical research is underrepresented in the existing literature and that few papers focus on the continuous humanitarian aid operations in the reconstruction phase following the disaster response phase. Similar conclusions are drawn by Leiras et al, (2014). After analysing in total 228 papers they found that there is a need for more studies on the disaster recovery phase and a need for closer relationships between academia and humanitarian organisations to increase the number of applied research.

There is thus a need to investigate the actual environmental impact of humanitarian operations in order to increase our understanding as to what extent it is a matter of concern. By collecting empirical data from real life operations in a field setting, the width and depth of these issues can be verified and a baseline created. This article is a first step in a process to highlight this field of study and to advocate for further applied research on greening humanitarian logistics.

Methodology

Following the calls for real-life measurements and calls for further research on humanitarian logistics of long-term ongoing operations, a case study seemed the most appropriate way forward. Kovács and Spens (2011) argue that researchers should gain a true understanding of the reality of field operations and conduct practice-oriented research in humanitarian logistics, while Yin (2013) argue that a single case allows one to gain more in-depth understanding of the studied phenomenon. With this in mind, a reputed organization active in the humanitarian sector was selected to investigate the transportation movements in detail. As Van Wessenhove and Martinez (2012) point out: “by rigorously gathering primary data from field operations, we can identify interesting research problems with real impact” (p. 5).

During autumn 2016 the author spent two weeks with United Nation High Commissioner for Refugees (UNHCR) in Lebanon at the country office in Beirut and also conducted a field trip to the sub-office in Zahle, in the Bekaa valley. In order to measure the environmental impact of UNHCR Lebanon operations in terms of GHG, measurements of the carbon emissions from all freight transportation movements in-country from the “port of entry” to the end beneficiary, had to be carried out. Vehicle utilization rate was added to the terms of measure, to verify the extent of efficiency in the transport movements.

The object was to measure the total emissions from freight transport movements during one full year of operation. The study concerns CO2 as it accounts for around 96% of all direct GHG emissions from road transport (McKinnon et al, 2015 p.68). Data on the distance, weight and volume of each transport movement was needed, together with the type and size of vehicles being used and estimated fuel consumption of these. This data was however only partly captured in the system in use by UNCHR, therefore a lot of manual work had to be carried out. Getting reliable data for analysis in the humanitarian context is extremely hard, according to Van Wessenhove and Martinez (2012). The data needed was what Santén (2016) refer to as “missing data”, meaning data that is not reported in any system, and “data that is inaccessible”, meaning data that is stored with another actor, and “incorrect or inconsistent data”, meaning data that has been entered the system but needs to be verified for accuracy.

In concert with one logistics staff at Beirut country office and one staff at each of the three field offices, scanned copies of every Waybill and Goods Received Note for 2015 was arranged. A visit to two of the four warehouses, in Beirut and Zahle, was conducted and a sample of goods were measured and

weighted to verify accuracy in the data given. A visit to the transport vendor showed what kinds of vehicles were being used, their size and loading capacity. The owners or drivers of the vehicles provided the estimated fuel consumption of each type of vehicle, apart from the 8 tonne trucks which had to be estimated.

With this information on hand, an analysis could be carried out if only knowing the correct distances. Origin and destination, as indicated on each Waybill and Goods Received Note, was noted on a spreadsheet and distances for most of the relations were found by use of Google maps. The remaining distances of locations not found in Google maps where given by the logistics staff at each of the four offices, by estimate of approximate distances based on knowledge of nearby places or by means of estimating an average distance most likely to correspond to reality.

The transport vendor provided information on return journeys, almost always empty running, and the normal parking place for each type of vehicle where from starting each journey before arriving to the warehouses for loading (installation distance, empty running). In addition, data on the chemical content of the fuel used in Lebanon was obtained from the fuel company.

With this, the needed input information was complete and the analysis of emissions could be carried out. In order to measure the vehicle utilization, the fill rate in terms of Volume and Weight has to be known. The data on quantities was available on the Waybills, volume and weight had been obtained for each kind of item and was consequently added to the spreadsheet for each movement. Knowing the size and capacity of each vehicle type gave the possibility of calculating the fill rate in terms of volume and weight for each movement.

Background to the case

UNHCR is one of the major actors in the humanitarian field, with many ongoing operations across the globe. UNHCR work in 128 countries, employs some 10,800 staff, and have an annual budget (funds available) of about USD 3,7 billion. UNHCR is mandated to assist refugees and internally displaced people and is sector leader in emergency shelter and camp management. The largest current operations are in Asia, Africa, and the Middle East (www.unhcr.org). Lebanon is one of the top hosting countries of refugees in the world. Following the Syrian war, more than a million people has fled across the border to seek refuge in neighboring Lebanon since 2012. These refugees constitute some 235,000 households and make up about 20% of the people living in Lebanon. There are no formal refugee camps set up for the Syrian refugees, instead they live in formal or informal settings spread all over the country (UNHCR sharing portal).

UNHCR Lebanon has set up a warehouse network to be able to receive, store and distribute goods, such as shelter material, and core relief items (CRIs) to the refugees. Movements of goods are being carried out daily. The warehouse network is traditionally arranged for a humanitarian operation with the primary hub located close to the “Port of Entry” and secondary hubs in other corners of the country. Supplies that are available for procurement at reasonable prices in-country are received from the suppliers to the central warehouse (CWH) for inspection and documentation. Supplies from other countries arrive in containers at Beirut port (“Port of Entry”) and is transferred to the CWH for the same purpose. In the case of UNHCR Lebanon, supplies are being stored at four strategic locations; the CWH just north of Beirut, Zahle regional warehouse (ZWH) in the Bekaa valley, Qoubaiyat regional warehouse in the north, and Tyre regional warehouse in the south. All four hubs are being used for distributions to the surrounding areas.

Lebanon is a small country. Driving distance from north to south is only 250km and some 100km from east to west. Every corner of the country can be reached within a few hours drive from Beirut. Security restrictions and weather conditions can however occasionally disrupt accessibility to some parts of the country temporarily. The regional warehouses are therefore used not only as hubs for distribution purposes but also to keep stock for contingency purposes. Main items distributed during 2015 were shelter materials, such as timber, tools, and plastic sheeting, followed by core relief items (CRI) such as mattresses, blankets, hygiene kits, kitchen sets, etc. All in all some 35,300 cbm of supplies departed the CWH, weighing some 9183 tons, divided on 1966 truckloads of various sizes.

Findings/Discussion

Examining the Waybills one can see that UNHCR Lebanon handles some 39 different item categories in their supply flow. The weight and volume for 32 of these categories was known, and some samples were measured to verify dimensions, while assumptions, together with the logistics staff, were made on the remaining 7 categories. Having access to such detailed volumetric data on road freight flows is unusual. As McKinnon (2000) points out; "Very little research has been done on space utilization of vehicles, and few attempts have been made to collect volumetric data on road freight flows". Since much of UNHCR goods is low weight, it means that the available vehicle space often is filled before the maximum permitted weight limit is reached.

The environmental impact of a transport movement is however commonly measured as KgCO2 per Ton-Km, meaning that it is the weight of loaded goods and the distance it has travelled that is calculated in relation to the emissions it has created (McKinnon et al, 2015). A road shipment of light-weight mattresses will thus have a high impact of emissions per ton of goods, since the truck will be fully loaded in terms of volume but have a low weight. The issue is to balance the loads with heavy goods below and mattresses on top, to make use of both maximum weight and volume for the shipments. Looking at the figures for UNHCR Lebanon, it appears that the logistics staff has been successful in combining these two factors when arranging warehouse-to-warehouse (WH-to-WH) shipments. These movements are made to replenish stock at the regional warehouses from the CWH. During 2015, 257 trucks were used (approximately one truck per working day on average) to transport 9949 cbm or 3257 tonnes of freight. Two-thirds of these movements, 176 to be precise, were by means of 40ft trucks, with an average fill rate for volume of 67% and for weight also 67%.

Comparing these values to the commercial logistics sector for movements between terminals can reveal interesting facts in terms of efficiency in vehicle utilization for UNHCR Lebanon. Although few studies of filling rate have been presented on general freight transport, a study by Pahlen and Borjesson (2012) can be used for comparison. They measured 263 departures for terminal-to-terminal transportation in Sweden, executed by three of the leading freight forwarding companies during one week of operation. The study found an average fill rate for volume of 61,2% and for "payable weight" of 64,3%. The results were concluded to be well in line with the few previous studies found on fill rates and vehicle utilization. Emissions for the outgoing movements have been compiled in Table 1. The warehouse-to-warehouse movements created some 43,800 KgCO2 during one year of operation while the distribution from a warehouse to the end user accounted for some 130,000 KgCO2 for the one year of operation. These figures are based on the assumption that 2,67 kg of CO2 is created for every burned litre of diesel fuel.

	Warehouse to Warehouse	Warehouse to End user
Total number of movements	257	1709
Total Volume of goods	9949 cbm	25354 cbm
Total Weight of goods	3257 tonnes	5925 tonnes
Total distance driven	36600 km	140760 km
Total fuel consumption	16400 liter	48690 liter
Total Carbondioxide emissions	43800 KgCO2	130000 KgCO2
Average CO2 emissions per ton	13,45 KgCO2 per ton goods	21,93 KgCO2 per ton goods
Average fill rate - volume	64 %	56 %
Average fill rate - weight	64 %	47 %

Table 1. Outcome from one year of operation

Efforts to optimize the distribution from warehouse to end users can be troublesome because of many reasons. There are many factors to take into consideration when trying to optimize the distribution such as; infrastructural limitations, coordinating the timing to recipients, timing for when receiving the requests, knowing the quantities, knowing weight and volume of the various products, knowing truck capacities, etc. In addition to trying to have all this information at hand, a systematic way of making use of it is also needed. Logistics officers at UNCHR Lebanon unfortunately do not have the appropriate IT software to support their day to day work in an optimal way. Instead they rely on basic spreadsheets, manual calculators, and let common sense guide them in their decision making. To integrate data on weight and volume of the products into the business system would be one step ahead towards a more optimal distributon.

Proposed Research Agenda

The literature review clearly showed that the greening aspects of humanitarian logistics has not yet been addressed much by academia and there are several calls following previous studies for engaging in this subject. Apart from transport efficiency and carbon auditing, as this case study focus on for the in-country operations, mainstream logistics research has identified several streams of interest that could also be investigated in the humanitarian context from a greening perspective, such as: The supply chain network design, Green procurement strategies, Collaboration with local logistics services providers, Packaging options and recycling possibilities, and Improved coordination between different stakeholders.

Although it is in the response phase of a disaster that logistics plays the largest role, it is also when the complexity and urgency of operational needs takes precedence. This is not the appropriate time to develop, test, or implement new ways of working. Research on aspects of sustainability, including investigation of emissions as in this case, is best suited to be carried out in the preparation phase or in the longer-term recovery phase of an operation, when conditions are more stable and predictable. This is the time when humanitarian organisations can plan strategically and develop their supply chains. New ways can be tested, staff in the organisations can be involved and provide needed data for analysis, trainings and simulations can be executed to raise the awareness internally, and greening initiatives be implemented.

Donor interests and donor regulations will determine the course of action within this field in future. Whether the donor community show interest in this side of operations will be crucial in making progress happen. Will they require from the organisations to audit, monitor and present data on their environmental performance in coming years? Will they provide funding and direction for the organisations to develop more sustainable ways of working? The donors are to a humanitarian organisation similar to what shareholders are to a commercial organisation. It is the managements role to implement shareholder decisions. Research with a focus on the different stakeholders' (donor, organization, beneficiary) perspectives in this respect could be valuable and has also been called for in previous research (Haavisto and Kovacs, 2013).

It is the author's intention to take up the research calls as outlined above, and initiate a research agenda to address these important issues as follows:

A. To continue to make more measurements on emissions from real-life operations to gain a better understanding and more balanced picture on the current state of affairs.

B. To conduct interviews with both donor representatives and senior managers in the respective organisations on their perspectives and intentions for implementing greening policies in future. To clarify what is needed to get the "ball rolling" in the desired direction.

C. To investigate what various greening initiatives have already taken place in the humanitarian logistics sector. To record the different projects and alternative ways of working that have been tested and to elaborate on whether these can be copied and upscaled to be of use in other operations and by other organisations in future.

Conclusion

The environmental impact of humanitarian logistics is a new field of research. The literature review clearly show that no studies so far has investigated the emissions from humanitarian logistics operations that contribute to climate change. Applied research has so far been missing on empirical measurements of

actual GHG emissions from a real life case in a humanitarian setting. A single case study is certainly not enough to get a full understanding of the GHG contribution from in-country transportation in the humanitarian sector. Additional studies will have to contribute with mapping the climate impact from humanitarian operations, across the supply chain, to get a more balanced picture of the scale and depth of the issue in order to create a more comprehensive baseline for current state of affairs.

Humanitarian logistics is considered unique in several ways as it is triggered by a disaster and is normally funded by donors instead of the end receiver. The donor community therefore have an undisputable role to play on implementing policies and monitor the environmental performance of the organisations they provide funding to. The greening aspect needs to be considered at different levels, strategic, tactical and operational. Different projects can be launched at small scale to test new concepts to help improve activities.

Since the UN, as mentioned in the introduction, has committed to “lead by example” in terms of showing the way on how to reduce climate impact from operations, the “business as usual” alternative can no longer be considered as a viable option. Sustainable development considerations needs to be more fully integrated into the management practices and operations made more efficient (UNEP, 2012). Further research can enhance the understanding of environmental performance in the humanitarian context, where the UN organisations often are the lead agencies and set the scene for the humanitarian community at large.

Several major challenges face the humanitarian logistics academic community. This article is a first step in a process to highlight the window of opportunity to this field of study and to advocate for further applied research on greening humanitarian logistics by setting a research agenda on topics of concern.

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