# LOGISTICAL FRAMEWORK FOR LAST MILE RELIEF DISTRIBUTION IN HUMANITARIAN SUPPLY CHAINS: CONSIDERATIONS FROM THE FIELD

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ABSTRACT: Recent years large scale natural disasters: (e.g. 2004 Tsunami, 2005 Earthquake in South Asia, 2010 Earthquake in Haiti, 2010 flood in Pakistan, 2011 Earthquake in Japan etc.) have captured international attention and led to the advance of research of disaster management. To cope with these huge impact disasters, the involved stakeholders have to learn how quickly and efficiently the relief organisations are able to respond. After a disaster strikes, it is necessary to get the relief aid to the affected people by the prompt action of relief organisations. This supply chain process has to be very fast and efficient. The purpose of this paper is to define the last mile relief distribution in humanitarian supply chain and develop a logistical framework by identifying the factors that affect this process. Seventeen interviews were conducted with field officers and the data analysed to identify which are the critical factors for last mile relief distribution of disaster relief operation. A framework is presented classifying these factors according to the ability to implement them in an optimisation model of humanitarian logistics.

Keywords: last mile relief distribution; logistics, supply chain management

1. INTRODUCTION: Earthquakes, Tsunamis, Floods, Hurricanes, Droughts, Terrorist attack; Famine etc. are a few examples of (natural and man-made) disasters, most of which the world has seen in the last twelve months. After these types of high impact disasters, the people affected by the disaster need emergency relief in the form of food, water, medicine, shelters etc. The purpose of disaster relief operation is to rapidly respond by supplying emergency supplies to the affected people. Quick response to the disaster is key to reduce human casualties. In the case of a disaster, a quick and efficient "supply chain process" is needed. In a humanitarian supply chain, the people affected by the disaster play the role of the customers. The demand is the customer's need. The government donors, international agencies, international NGOs, local NGOs play the role of intermediate suppliers. There are some basic differences between commercial supply chain and humanitarian supply chain:

- In commercial supply chain the final goal is to increase profit of the company but in the humanitarian supply chain the final goal is to reduce loss of lives and help the beneficiaries.
- The focus of the commercial supply chain is to the final customer, which is the final source of income for the entire chain. In humanitarian supply chain the end user (the recipients or

beneficiaries) hardly ever into a commercial transaction and has very little control over supplies. (Oloruntoba & Gray, (2006)).

- In commercial supply chains there is uncertain demand but within known parameters or data but in Humanitarian supply chain after need assessments the forecasted demand is known but sudden spikes of demand occur, which is unpredictable.

The overarching aim of humanitarian sectors is to save lives and provide the basic needs to the affected people. The objective of the disaster relief operation is always linked to how quickly and conveniently the resources reach the affected people. The last mile relief distribution is the ultimate connector of humanitarian sector with the beneficiaries.

Last mile relief distribution is the ultimate stage of humanitarian supply chain. It refers to supply of the relief items from the local distribution centres to the disaster affected people (Balcik et al. (2008)). Before, during and after a disaster the necessity is to secure and move the required materials (food, water, medicine, shelter etc.) from one point to another point in the most efficient and effective way. This operation is enormously complicated and very costly because of the difficulty of forecasting for the actual time of disasters and the actual demand after disaster. Recent estimates would suggest that as much as 80% of the expenditure of aid agencies is on logistics (Wassenhove (2006)). Therefore, humanitarian logistics management need to be more efficient and effective. There are some logistical factors (facility location; inventory management, transportation management, distribution management etc.), which influence the supply chain process at the strategic, tactical and operational level during the last mile relief distribution. A thorough review of the humanitarian literature forms the basis of the definition and logistical decisions of last mile relief distribution. The structure of the paper is such that section two provides a definition and description of last mile relief distribution and also indicates the sequential relationship among the abovementioned decisions. Section three provides key logistical decisions (collected during interviews in South Asia) that need to be considered during final relief distribution time.

## 2. DEFINING LAST MILE RELIEF DISTRIBUTION IN THE LOGISTICAL PERSPECTIVE:

There are four logistical decisions that commonly influence last mile relief distribution. These include facility location (identifying the most suitable place for inventory in the relief network); inventory management (efficiently manage the inflow and outflow of the relief materials); transportation decisions (to transport the relief to the needed area) and distribution decision (to quickly and efficiently distribute the relief materials to the affected population). These decisions are very often treated independently in the literature (Ozbay et al. (2007); Kongsomsaksakul et al. (2005); Jia et al. (2005); Sheu (2007) and Tzeng et al. (2007)). Conversely Balcik & Beamon (2008) and Duran et al. (2007) integrate facility location and inventory policy decisions which improve the relief supply chain with reduction of some associated cost. Again Balcik et al. (2008) integrate the transportation decision and inventory decisions which improve the transportation decision during the relief supply chain process. Transportation decisions directly affect facility location, facility capacity and inventory policy decisions at the strategic level (Crainic et al. (1997)) and the distribution decision level (Sheu, 2007). The efficient management of inflow and outflow of the relief materials depends on the size of the facility, number of facilities, number and capacity of vehicles. Likewise, quick and efficient distribution process of the relief materials to the affected population depends on the number of vehicles, capacity of vehicles, efficiency of managing relief materials, accessibility to the field warehouse and distribution centre. Therefore, it is clear that these four decisions are sequentially related with each other. As shown above, these factors have not been studied a whole, but individually or by pairs at the most. For an efficient and effective relief distribution these four decisions (facility location decision, inventory decision, transportation decision and distribution decision) need to be integrated. From the above discussion, a working definition of last mile relief distribution in the logistical perspective is presented:

*The last mile relief distribution is the ultimate stage of disaster relief operation, which is associated with delivery of relief supplies from field warehouse to the disaster affected people through the integration of facility location, inventory management, transportation management and*

*distribution decisions, while taking into account the key factors affecting it.*

3. LOGISTICAL DECISIONS FOR LAST MILE RELIEF DISTRIBUTION: In last mile relief distribution the effectiveness of a response plan depend on these four decisions: facility location decision, inventory decision, transportation decision and distribution decision. After a disaster, to continue the disaster relief operation there need to be a very well organised humanitarian logistics system. To evacuate the beneficiaries from the disaster affected area need relief camp, to continue the distribution process need distribution centres, to store the resources in field need field warehouse, these are the essential facility decisions (Table 1) need to consider during the last mile relief distribution, as reported by the literature.

| Decisions | Description | Source |
|---|---|---|
| Number of facilities | The number and location of the distribution centres in the relief network. | Balcik & Beamon (2008) |
| Location of facilities | The location of relief camp during flood situation; | Kongsomsaksakul et al. (2005); |
| Capacity of the facility | The available capacity of the facility | Chopra & Meindl (2007) |

Table1: Facility location decisions:

Inventory management decisions (Table 2) including type of inventory, inventory policy (Zipkin 2000) also another important decisions to continue the relief distribution.

| Decisions | Description | Source |
|---|---|---|
| Inventory types | What inventory to store in each facility; Related to the beneficiaries order decoupling point Fixed lifetime commodities; | Hoekstra & Romme (1992); Jaller et al. (2007) |
| Inventory policy | The target inventory levels; minimum and maximum inventory levels; Stock replenishment policy; order quantity; safety stock levels; | Zipkin (2000); Chopra & Meindle (2007) |

Table 2: Inventory decisions:

Transportation decision (Table 3) including transportation policy is also an important part of continues the relief distribution operation.

| Decisions | Descriptions | Source |
|---|---|---|
| Transportation policy | The number of vehicles; route planning; capacity of the vehicles; vehicle scheduling | Barbarosoglu & Arda (2004); De la Torre et al. (2011); Crainic et al.(1997), Melo et al.(2009) |

Table 3: Transportation decision

Another important decision is distribution decision (Table 4), which affects the last mile relief distribution.

| Decisions | Descriptions | Source |
|---|---|---|
| Distribution decision | Transport network; supply of | Tzeng et al. (2007); Vitoriano |

| | relief; number of volunteers; Prioritisation the affected area | et al. (2011); Balcik et al. (2008) |
|---|---|---|

Table 4: Distribution decision

**4.THE LOGISTICAL FRAMEWORK IN SOUTH ASIAN CONTEXT:** Since 2001, a few large scale natural disasters have occurred in South Asia: 2001 earthquake in India, 2004 Tsunami, 2005 Earthquake in South Asia, 2010 flood in Pakistan etc.. To cope up with these huge impact disasters, the involved stakeholders (donors, beneficiaries and media) have to learn how quickly and efficiently the relief distribution operation should able to respond. The South Asian context presents specific challenges such as: large, dispersed populations, lack of infrastructure, etc. Structured interviews were conducted with the official members of SAARC (South Asian Association for Regional Cooperation), NDRM (National disaster response management) in India and with three local NGOs of South Asia. Interviewees were asked about the different factors that they take into account when making the four decisions mentioned above. From the content analysis and thematic analysis of the interviews, it emerge that there are other factors (Table 5), which have impact into the decisions during the final relief distribution time.

| Decisions | Factors affecting the decisions |
|---|---|
| Inventory decision | <ul><li>**Potential to standardised the relief materials**: regional restrictions regarding food, clothes that can be consumed; *</li><li>**Accurate assessment of the disaster situation**: e.g. efficiency in needs-assessment process; *</li><li>**Cultural requirements**: e.g. religious restrictions regarding food that can be consumed;</li><li>**Potential to manage the relief, which come from the donors**: e.g. adequate and effective plan for managing the huge quantities of relief which will come from the donors; *</li><li>**Safety and security (political environment)**: e.g. need enough protection for the disaster affected population (e.g. for young girl and woman) as well as need sufficient protection for relief materials;</li><li>**Potential to minimise the relief material loss during transition**: e.g. during the mobilisation of relief materials needs security; *</li><li>**Product characteristic**: e.g. differentiate between perishable and non-perishable items; *</li><li>**Supply lead time**: e.g. need to minimise the delay of the supply time;</li></ul> |
| Facility location decision | <ul><li>**Quality of infrastructure**: e.g. condition of the facilities; *</li><li>**Different facility area for segregation and packing**: e.g. differentiate the facility areas for segregation of relief materials, packing of relief materials and for the distribution of relief materials; *</li><li>**Setting up the distribution centre**: e g. setting up the facility to continue the distribution operation; *</li><li>**Accessibility**: e.g. need easy access to the facility (distribution centre); *</li></ul> |
| Transportation decision | <ul><li>**Geographical area of the disaster**: e.g. Whether it is a mountainous, flat, or coastal area, for example.</li><li>**Potential for collaboration and coordination**: e.g. coordination among the NGOs and governmental organisations</li><li>**Type of disaster**: Earthquake, flood, volcano, fire, etc;</li></ul> |

| | |
|---|---|
| | • Weather situation;<br>• Volume of items: e.g. space needed to transport the required relief aid * |
| Distribution decision | • Communication plan with the local population and local authority: share knowledge about the distribution process with locals<br>• Safety and security: e.g. safety for the affected people, the relief personnel and also the goods being distributed;<br>• Time required for distribution: e.g. Time to distribute and hand out the relief material.; *<br>• Enough volunteers for distribution: e.g. to continue the distribution process need sufficient volunteers (field worker); *<br>• Time of the day for distribution: e.g. night disasters can delay response until the next morning.<br>• Strong control mechanism during the distribution: how to make sure a fair distribution is taking place (e.g. avoid giving aid twice to one set of people and none to another) |

Table 5: Framework of the factors which affecting the decisions

4.1. Analysis and Discussion of the framework: In previous research it is already evident that there are some logistical decisions like inventory types, inventory policy, number of facility, capacity of facility, transportation policy, distribution policy etc. affecting the final relief distribution operation. In addition to these decisions, there are other decisions (Table 5), which also affect the last mile relief distribution according to the field relief officers in South East Asia. Among those decisions some of the decisions (e.g. those marked * in the Table 5) are easy to implement in the decision making process. There are some other decisions (those not marked with *) which are harder to implement in the decision making process for last mile relief distribution; however, a planner of relief operations can still use the DSS (decision support system) to tackle the decisions supported by a DSS (decision support system) and use his/her knowledge and experience to factor those issues.

A framework is developed to show the interactions between these factors. We argue that an emergency manager working on relief operations should consider these factors when planning the response to a disaster. The manager will use a decision support system (DSS, shown at the core of Figure 1), but will also need to take into consideration the factors surrounding the core DSS in order to make a more informed decision.
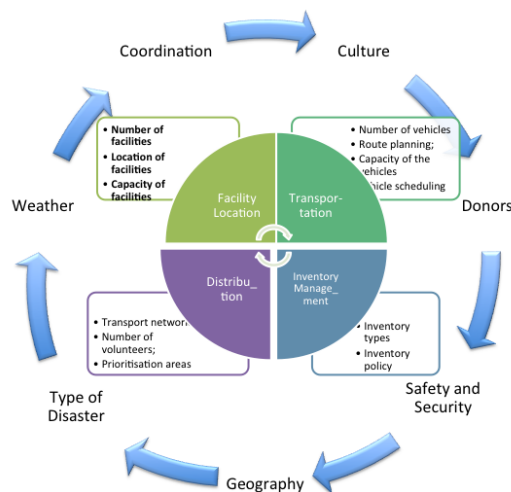


Figure 1. Last mile relief distribution logistics framework

**5. CONCLUSION AND FUTURE RESEARCH**: This paper identifies the logistical decisions and the factors which affect the decisions for the last mile relief distribution. The paper argues for an integrated approach to tackling these decisions concurrently and not separately as it has been done so far. Therefore the framework provides the practitioners (International NGOs, Local NGOs in aid recipient's country, community based organisation etc.) a list of factors which will implement in the decision making activity for the efficient decision planning process. This paper is qualitative in nature. Quantitative (optimisation) research is needed to support the qualitative framework. This paper only concentrates on the logistical decisions, though there are some other important decisions like coordination, funding, needs assessment, information and communication, cultural food habits etc. which also affect the last mile relief distribution.

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