

# **CHALLENGES IN HUMANITARIAN LOGISTICS MANAGEMENT: AN EMPIRICAL STUDY ON PRE-POSITIONED WAREHOUSES**

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## **INTRODUCTION**

The ultimate goal of humanitarian relief logistics is to deliver the right supplies in the right quantities to the right locations at the right time, so save lives and reduce human suffering within given financial constraints (Beamon and Balcik, 2008). Pre-positioned warehouses at strategic locations are essential for this purpose to ensure the availability of supplies when required and to facilitate faster responses (Balcik et al., 2010). It has been suggested that, in the long run, such an approach leads to the reduction of delivery costs by regular replenishment using inexpensive maritime transport (Gatignon et al., 2010). However, pre-positioned warehouses might be difficult to operate by some NGOs because it is both complicated and expensive given the limitations in finance and resources (Balcik and Beamon, 2008). Indeed, pre-positioned warehouses for humanitarian relief create various types of risks, but they haven't been fully explored yet.

In this respect, this study aims to investigate the challenges in humanitarian relief operations relating to pre-positioned warehouses. In specific, it focuses on the interactions between various risk factors within the humanitarian logistics management in order to understand how those challenges are generated and enhanced. For this purpose, this study explores the main risk factors of pre-positioned humanitarian distribution centres by interviews with practitioners in the humanitarian aid organisations. Based on the risk factors identified in the interviews, the interacting relationships between risk factors are mapped with the aid of the directed graph created by Interpretive Structural Modelling (ISM). As a consequence, the results of ISM will help to understand the different levels of risk and the root causes of risk amplification in humanitarian relief logistics. Compared with the studies on commercial distribution centres, less research has been conducted for humanitarian logistics distribution centres. To this end, this research will provide a comparatively novel and meaningful work in humanitarian relief logistics.

## **LITERATURE REVIEW**

Humanitarian relief logistics is defined as the process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials, as well as related information, from the point of origin to the point of consumption for the purpose of alleviating the suffering of vulnerable people (Thomas and Kopczak, 2005). Indeed, logistics serves as a bridge between disaster preparedness and response (Thomas, 2003); therefore, humanitarian logistics is crucial to the effectiveness and speed of response for major humanitarian programs.

The comparison between the commercial and humanitarian supply chain has been studied by a large body of researchers from a number of different perspectives. Humanitarian logistics, as well as business logistics, encompasses a range of activities, including: preparedness, planning, design, procurement, transportation, inventory, warehousing, tracking and tracing, distribution, recipient satisfaction bidding and reverse bidding, reporting and accountability, and customs clearance (Gustavsson, 2003; Thomas and Kopczak, 2005). The basic principles of managing the flow of goods, information and finances that have been established by commercial logistics are also valid for humanitarian logistics (Kovacs and Spens, 2007). The unique characteristics of the disaster relief environment, and a comparison and contrast between the commercial and humanitarian relief supply chains have been described by Beamon (2004), Thomas and Kopczak (2005) and Van Wassenhove (2006).

Humanitarian logistics is characterised by large-scale activities, irregular demand and unusual constraints (Beamon and Kotleba, 2006). The problems can range from a lack of electricity supplies to limited transport infrastructure including 'controlled' environment with some minor variability (e.g. traffic congestion) (Kovacs and Spens, 2009). Commercial logistics are normally planned in advance of demand and relatively well established while relief logistical decisions are made within shorter time frames (Balcik and Beamon, 2008). They usually deal with a predetermined set of suppliers, manufacturing sites, and a stable or at least predictable demand, which are all unknown in humanitarian logistics (Cassidy, 2003). Many businesses are driven by customers (i.e. demand) in commercial logistics, while humanitarian organisations are mostly driven by donors (i.e. supply) (Tomasini and Van Wassenhove, 2009). The customers (aid recipients) actually have no choice and, therefore, 'true demand' is not created in humanitarian logistics (Kovacs and Spens, 2009).

In the initial days of the deployment phase, most of the critical supplies arriving to the disaster are sourced from an organisation's global pre-positioned stocks (Balcik and Beamon, 2008). Cost is one of the reasons for pre-purchasing the supplies as they are able to purchase them at a reasonable price (Salisbury, 2007). Once disaster occurs, demand increases dramatically and suppliers will often raise their prices in response. Relief organisations adapt the in-advance purchase strategy and store in the pre-positioned warehouse to react quickly (Beamon and Balcik, 2008). There are several challenges that relief organization faces in order to ensure the smooth flow of the relief logistics. Difficulty in creating an effective pre-positioning plan includes uncertainty about whether or not natural disasters will occur and, if they do, where and with what magnitude (Rawls and Turnquist, 2010). Consequently, operating a pre-positioned warehouse could be financially prohibitive and there are only a handful of relief organisations who can support the expense of operating distribution centres (Balcik and Beamon, 2008; Salisbury, 2007).

Although pre-positioned stocks may be useful, they may be restricted as they require considerable financial investment (Chaikan, 2003). For this reason, some of the NGOs tend to focus on operational disaster relief activities rather than disaster preparedness (Thomas, 2007). Balcik and Beamon (2008) insist that some NGOs avoid using a pre-positioning strategy because it is both complicated and expensive. They also indicate that the total volume of demand satisfied from the pre-positioned inventory is generally much less than the total volume of supplies sent to the disaster region over the entire relief horizon. Salisbury (2007) argues that internal transport capacity is one of the most limited resources in determining the capacity where third-party logistics contractors (i.e. 3rd Party Logistics) need to be involved.

For large-scale quick-onset disasters, it is impossible to meet the entire emergency demand solely from pre-positioned stocks (Balcik and Beamon, 2008). The difficulty to initiate or to maintain the pre-positioned warehouse strategy are due to the uncertainty of disaster occurrences, funding tendencies in the sector and the costs associated with operating distribution centres (Oloruntoba and Gray, 2006; Balcik and Beamon, 2008; Balcik et al. 2010). The warehouse would be useless if it is easily exposed to frequent disaster occurred area. Rawls and Turnquist (2006) and Ukkusuri and Yushimoto (2008) modelled the pre-positioned warehouse considering the facility not being destroyed/damaged by the disasters. The national stability of the country would provide predictable policy management for an organization to manage (Kayikci, 2010). The literatures have discussed the limitations and the restrictions of the prepositioned warehouse strategy in humanitarian logistics. However, the discussions on the attributes are scarce and do not analyse how they influence each other. These led the authors to conduct a series of interviews with practitioners to identify the risk elements that affect the pre-positioned warehouse and to develop a structural model of those elements to understand the ultimate challenges in humanitarian relief logistics.

## **METHODOLOGY**

This research aims to investigate the challenges in humanitarian logistics of pre-positioned warehouses, which is addressed by multi-phase mixed methods combining semi-structured interviews and interpretive structural modelling (ISM). The risk factors found in the interviews will become the basic elements of ISM, leading to an ample structure to demonstrate the characteristics of the challenges.

### **Phase 1: Semi-structured interviews**

Since the empirical studies on the risks and vulnerabilities within humanitarian logistics are scarce in the literature, semi-structured interview was conducted as an exploratory research method with supply chain managers and officers in humanitarian aid organisations. The qualitative interview is more flexible and conversational than quantitative methods in that it allows new questions to be brought up as a result of the interviewee's response during the interview. The objective of the interviews was to better understand the application of the pre-positioning strategy for the humanitarian organisation broadly and to identify the unforeseen issues and opinions of operating or planning the pre-positioning warehouse strategy for humanitarian relief logistics.

Face-to-face and telephone interviews were administered, from February to April 2012, with 25 personnel at the managerial or higher level in their organisations. Electronic mail and video calls were made to confirm the factors that were identified and the respondents were asked to give their opinions on the risk factors of their warehouse strategy. The objectives of the interviews are to better understand the application of the pre-positioning strategy for the humanitarian organisation broadly and to identify the unforeseen issues and opinions of operating or planning the pre-positioning warehouse strategy for humanitarian relief logistics.

### **Phase 2: Interpretive Structural Modelling (ISM)**

The risk elements found in the interviews will be analysed by ISM, an analytic framework to encapsulate the relationships of specific elements in a complex system (Vivek et al., 2008). ISM offers an insightful development of collective understandings of those relations so that complex interconnections of risk events can be portrayed within a model (Faisal et al. 2007). In this respect, ISM can be seen as the most appropriate method to describe the challenges in humanitarian logistics by creating a holistic risk structure with risks and their interactions. ISM is a step-wise process comprising of seven steps to reach a final model (Faisal et al. 2007; Pfohl et al., 2011) as outline below. The elements for Step 1 were initiated by semi-structured interviews, and then the contextual relationships for Step 2 were decided by a series of panel discussions of 10 humanitarian experts.

- (1) *Identification of elements*: The elements that constitute the challenges in pre-positioned warehousing are identified and operationalized by semi-structured interviews. Each element will be labelled by a number for the analysis.
- (2) *Contextual relationships*: The contextual relationships between the elements are determined by the opinions of 10 humanitarian logistics experts. They are captured by statements using
- (3) *Structural Self-Interaction Matrix (SSIM)*: A SSIM can be generated by substituting contextual relationships of each pair with legends like V, A, X and O for each  $(i, j)$  entry. V will be used when element  $i$  leads to element  $j$ , whilst A will be used when  $i$  is led by  $j$ . If there is no relationship or a mutual relationship between  $i$  and  $j$ , X and O will be assigned respectively.
- (4) *Reachability Matrix*: A reachability matrix will convert each  $(i, j)$  entry of the SSIM into number 0 and 1. When element  $i$  directly or indirectly leads to element  $j$ , number 1 will be put into  $(i, j)$  entry. If  $i$  doesn't lead to  $j$  at all, 0 will be assigned to the entry.
- (5) *Level Partitioning*: Given the reachability matrix, the reachability set (RS), antecedent set (AS) and intersection set ( $IS=RS \cap AS$ ) of each element will be generated. The elements whose RS is the same as IS will be set aside as the top level. New RS, AS and IS of each element will be sought without these elements, and then
- (6) *Digraph*: A directed graph or digraph can be drawn using the reachability matrix and partitioned levels. The elements can be laid vertically and horizontally according to the levels, and then connected by arrows based on the numbers in reachability matrix.
- (7) *ISM-based Model*: The final ISM-based model can be generated by substituting the numbers in the digraph with the original titles of the elements.

## **FINDINGS**

A series of interviews with 25 experts revealed that various risks are intertwined to generate great challenges in operating pre-positioned warehouses. There were 17 risk elements that were most commonly mentioned by the interviewees.

- (1) *High Asset Maintenance Cost*: This cost includes the storage, transportation, labour and any other costs that relate to operating the warehouse system. Due to these difficulties, small relief organisations with financial burdens could not dare to operate the pre-positioning warehouse system.
- (2) *High Inventory Cost*: This cost includes those related to storing and maintaining inventory over a certain period of time. As the demand in humanitarian relief operation is uncertain, there always lies a high chance of the relief items to be hold for long time which will influence the cost.
- (3) *Uncertain Demand*: Most of the demand in humanitarian relief operations is unpredictable which leads to uncertain demands. Due to this, humanitarian organisations have difficulties identifying the beneficiaries and the relief items.
- (4) *Failure in Forecasting Stock Level*: Humanitarian relief organisations normally do not have the system to forecast the stock level as they are reluctant to invest the cost. Due to this, most of the small and medium size organisations forecast stock level manually which often mislead to predict.
- (5) *Lack of Confidence in What to Stock*: Some humanitarian organisations standardised the basic relief items to stock in their warehouse. These standardised items were organised through lots of years of experience. However, most other organisations prefer to purchase and deliver at the disaster occurrence country or neighbouring countries. The main reason for this is not only to save cost and reduce time but also not confident of what to stock.
- (6) *High Transport Cost*: Relief items are sent to pre-positioned warehouse via sea transport which would take several weeks and save transportation cost. However, the relief items are sent to the disaster occurred area via air transport from the pre-positioned warehouse. Eventually, pre-positioned warehouse strategy would increase the delivery cost due to the air transport.
- (7) *Difficulties in Justifying Funding*: People who donate financially want to know whether their aid is properly used. They prefer to see the relief items are purchased and delivered to the people in need instead of supporting the operation cost, especially in maintaining

the warehouse. Donors are often not aware of that their contribution also support the whole relief chain processes, rather think that the donations are used only to purchase relief items. Donors are reluctant to support the organisation if the money is used for the whole relief supply chain. Relief organisations experience the difficulties explaining to them of the importance of operating pre-positioned warehouse strategy.

(8) *Limited Space*: The space available in the warehouse is limited to store relief items for some humanitarian organisations. Some organisations do not have proper warehouses and store the relief items somewhere else such as in the basement of the building or garage. Even those who own their warehouse facility, they always look for a spacious warehouse to hold more relief items.

(9) *Infrastructure*: The quality of the infrastructure for pre-positioned warehouse would be a concern for humanitarian organisations as some of the potential warehouses are located in the underdeveloped countries or near the disaster prone areas. This area tends to have low quality of infrastructure.

(10) *Stock Out*: Humanitarian organisations try to stock relief items as much as possible to support the people in need when immediate disaster occurs as the casualty is massive. Even though they stock try to stock maximum level not to be short of relief items, the aid they need to support are always high in numbers which are more than the stocked items. For this, humanitarian organisations are always concern with the stock out situation.

(11) *IT Breakdown*: IT is a crucial source for communication within the organisation especially when disaster occurs. The accurate information of number of relief items, kinds of relief items, destinations, types of transport, etc. are important to reduce time and cost for efficient relief operations. Humanitarian organisations prefer their pre-positioned warehouse to be located in a country with acceptable IT equipment as some of them are located in vulnerable countries with poor IT quality.

(12) *Dependency on Logistics Service Providers (LSPs)*: Some major humanitarian organisations outsource the logistics operation to logistics service providers as most of them do not have the expertise skills and know-how relate to this matter. Everything should be stand-by mode to deliver the relief items within 48-72 hours to the disaster occurred location. Dependency arises from these highly-demanding requests from the humanitarian organisations with no logistics expertise.

(13) *Poor Quality of Goods*: The deterioration of the relief items are influenced by many factors including the nature of the bad quality of the relief goods itself or the climate and the environment of the site. A very hot climate not only affects the relief items but also the labour force in the warehouse.

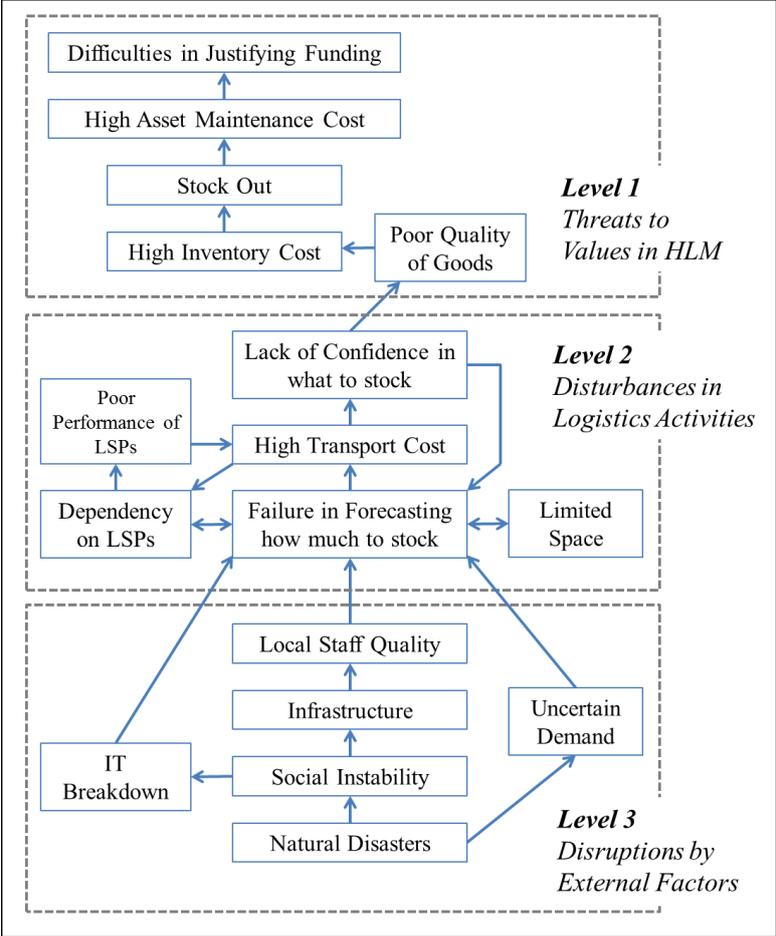
(14) *Poor Performance of LSPs*: As some of the humanitarian outsource their logistics operation to logistics service providers, it sometimes matter who LSP make contract with. Small mistakes or delay would influence the delivery time.

(15) *Local Staff Quality*: The low performance of locally-hired staff would be caused by miscommunication, cultural differences, different working condition, etc. However it is considered important for managerial level logisticians to be competent in logistical skills and knowledge. Even though they would be deployed from the humanitarian organisation in many cases, they still have to work with qualified local staff for efficient management.

(16) *Natural Disasters*: Some humanitarian organisations tend to locate their pre-positioned warehouse close to the disaster vulnerable countries to reduce cost and time. However, some are aware that being close to those areas would put the warehouse in danger due to the natural disasters. To avoid the warehouse destroyed by the natural disasters, some humanitarian organisations rather prefer to locate the warehouse that would receive less influence of them.

(17) *Social Instability*: Social stability of the country is important to prevent any unexpected theft or pilferage. Some of the relief items stocked in the warehouse are very valuation items; for example, radio-telecommunication systems, medicines, armoured vehicles, food, etc. Security of the location is concerned to be important in pre-positioned warehouse strategy.

Given these 17 risk elements, interpretive structural modelling was conducted according to the 7 steps aforementioned. As a result, the final ISM-based model can be drawn as shown in Figure 1.



**Figure 1. ISM-based model**

**DISCUSSION**

From the ISM-based model, it was identified that the challenges in operating pre-positioned warehouse operations consist of three levels of risk elements: (1) threats to values in humanitarian logistics management, (2) disturbances in logistics activities and (3) disruptions by external factors. The interactions between these levels show one-way direction, where Level 3 leads to Level 2, which in turn, leads to Level 1.

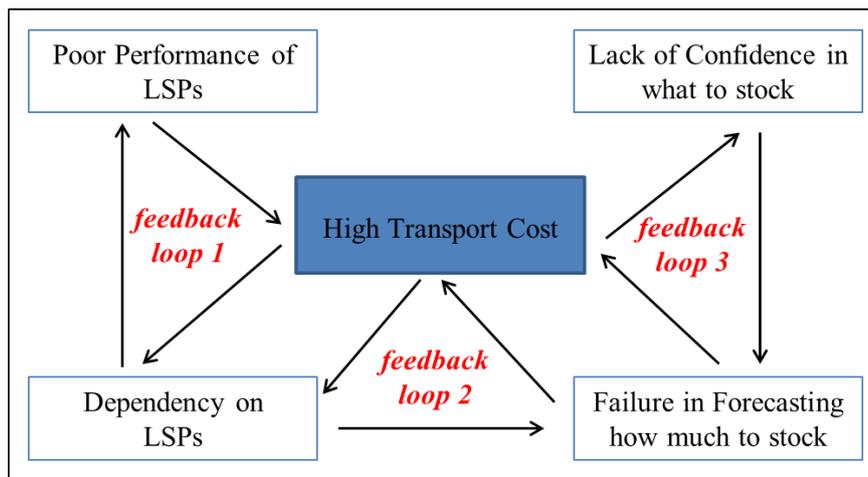
Level 1 consists of the risks which are relating to values, cost and quality, that humanitarian logistics pursues. As being the risk consequences, they are dependent upon other risks. Among them, difficulties in justifying funding places at the top, which means that organisations feel the pressure from donors once pre-positioned warehouses are malfunctioned. One difference from commercial logistics is that delay or time loss is not captured within this level, which will be partly because pre-positioned warehouses clearly aim to reduce the lead time.

The risks in Level 2, on the other hand, are mainly initiated by logistics activities and operations, which encompass forecasting, transport, warehousing and outsourcing. The ISM-based model demonstrates that there are three feedback loops which enhance the level of challenges within level 2, as can be seen in Figure 2. Interesting enough, all these feedback loops were generated around high transport cost. The reason can be attributed to the fact that reduction of transport cost is one of the main purposes to operate pre-positioned warehouses. With the warehouses, the majority of relief items can be transported via sea leg whose cost is cheaper than any other transport modes given the high volume of items. However, failure in logistics activities directly and indirectly

affects the transport cost by adding transport frequencies and/or by using more expensive transport options.

For example, dependency on LSPs based on limited knowledge on logistics often leads to opportunistic behaviours of LSPs, which result in poor logistics performance. Additional transport cost will be required to rectify this issue, which in turn undermines the bargaining power of humanitarian organisations under budget constraints in the relationships with LSPs (feedback loop 1). In order to eliminate this risk circle, some NGOs pursue tighter partnerships with competent LSPs. Other two feedback loops are closely related to the humanitarian organisations' capability to control the logistics process. The incapability of forecasting the accurate stock level will result in additional transport cost for 'hot delivery' of relief items, which increases the level of their reliance on LSPs. As the organisations lose their control over logistics process, the accurate forecasting is getting difficult (feedback loop 2). In the same vein, lack of confidence in selecting items to be stored can lead to forecasting failure and to high transport cost. The budget constraints emanating from high transport cost cause jeopardy in the item selection process (feedback loop 3). In the interviews, humanitarian organisations find it difficult to make an accurate forecasting due to their incapability in logistics operations as well as the unpredictability of events requiring humanitarian relief.

Last but not least, the Level 3 risks are external to humanitarian organisations, but have significant influences on Level 1 and Level 2 risks. This level of risks is also frequently mentioned in the supply chain risk management literature as environmental risks. However, the difference is Level 3 risks can be considered both as risks to logistics operations and as the events where humanitarian relief is required.



**Figure 2. Three self-enhancing loops in the model**

## CONCLUSION

This research empirically identified various risks in operating pre-positioned warehouses for humanitarian logistics and created a structure of risk interactions in order to understand how the risks are generated and enhanced. As a result, 17 risk factors, 3 distinctive risk levels as well as 3 self-enhancing risk loops were discussed in this research. This is a first study which investigated the risks in humanitarian logistics using a structural model, which can be a ground for future research about humanitarian logistics risk management. In addition, the risk profile can provide a checklist for humanitarian logistics practitioners to assess the level of risks in their operations. Given the levels and feedback loops of risk factors, they can also find out which risk factor should be intensively mitigated to reduce the risk level. This study confined its scope of research to the risks stemming from operations of pre-positioned warehouses. Future research can expand the research scope to the entire process of humanitarian relief logistics.

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