An empirical analysis of humanitarian warehouse locations

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Abstract

Purpose: The purpose of this paper is to empirically verify characteristics of current warehouse locations of humanitarian organizations (based on public information) and to relate those to the model developed by Richardson et al. (2016).

Design/methodology/approach: This paper is based on desk research. Public data such as (annual) reports and databases are used to empirically verify location characteristics.

Findings: A significant portion of our sample co-locates their products at UNHRD premises. This indicates that organizations prefer to cluster warehouse activities, particularly when there is no fee involved for using the warehouse (as is the case in the UNHRD network). We find that the characteristics of the current warehouse locations are aligned with literature on location selection factors. Current location can be characterized by infrastructure characteristics (in particular closeness to airport and safety) and by low occurrence of disasters. Other factors for which we did not find evidence for were labor quality and availability as well as political environment.

Research limitations/implications: We have used a limited sample of warehouses. We also focused our research on the countries where two or more organizations have their warehouses located. We did not account for warehouse sizes or product stored in our analysis.

Practical implications: The geographic map of the current warehouses together with the quantified location factors provides an overview of current warehouse locations.

Originality/value: We empirically verify characteristics of warehouse locations of humanitarian organizations. This differs from other studies that do not provide an empirically grounded perspective.

Key words: humanitarian supply chain management, facility location

1. Introduction

Humanitarian logistics has a high level of complexity due to the physical and geographical environment of the places where disasters strike. As a result, affected areas are often hard to reach. To achieve efficient and effective humanitarian relief it is important that humanitarian organizations have their warehouses in appropriate locations. The locations of these warehouses have a direct influence on the response time of humanitarian organizations (Balcik and Beamon, 2008). When disaster strikes basic items such as water and food need to be distributed as fast as possible to cover initial needs. Also hygiene kits, sanitary items as well as medication are important in that early response phase, because of the risk of various diseases (MSF Annual report, 2011). In order to fulfill these needs some humanitarian organizations locate their items to serve a region, for example, per continent such as at IFRC (Gatignon, Van Wassenhove, & Charles. 2012). Another option is that humanitarian organizations place their inventory in the country they want to serve (Richardson and de Leeuw, 2012).

Facility location models and the associated factors that are relevant in determining warehouse locations form a topic of frequent discussion in the commercial domain, see eg. Farahani Bajgan, Fahimnia, and Kaviani (2015) Melo, Nickel, and Saldanha-da-Gama (2009) and MacCarthy and Atthirawong (2003). Many factors influence the selection of the location of a facility, though often the dominating factor is costs (MacCarthy and Atthirawong, 2003). The MacCarthy and Atthirawong (2003) research also showed that site selection factors are industry-specific because each industry has different characteristics and strategies. For example, for humanitarian organizations the delivery time is expected to be important because people's lives are at stake. When stocks are strategically placed, the delivery time of the goods to the affected area can be reduced (Duran, Guiterrez, & Keskinocak 2007, Balcik and Beamon, 2008). Empirical research into location factors of humanitarian organizations is scant, with most of the research being anecdotal in nature. The only structured attempt to organize factors that impact facility locations of humanitarian organisations has been undertaken by Richardson et al. (2016), yet their work focuses on input from users rather then an analysis of the actual locations.

In this paper we build on Richardson, de Leeuw, and Dullaert (2016). We base our theoretical starting point on their analysis of factors deemed relevant for warehouse facility location in humanitarian organizations. We aim to empirically verify characteristics of current warehouse locations of humanitarian organizations (based on public information) and to relate those to the model developed by Richardson et al. (2016).

The remainder of this paper is organized as follows: section two consists of a literature review and section three discusses the methodology for this research. The results will be described and analyzed in section four. Finally, section five discusses the results and describes the conclusion, limitations and future research.

2: Literature Review

2.1 Facility location in humanitarian supply chains

The basic goal of emergency aid or disaster relief is to minimize the impact of disasters and reduce the suffering of affected people (Kelly, 1995). It is therefore important to rapidly provide appropriate emergency supplies to the people affected so the human suffering can be minimized (Balcik, Beamon, & Smilowitz, 2008). Designing an efficient and effective humanitarian supply chain is a key challenge for humanitarian organizations. Humanitarian supply chains differ from regular supply chains because they are focused on minimizing loss of life and suffering, whereas commercial supply chains are mainly focused on quality and profitability (Campbell, Vandenbussche, & Hermann, 2008). In fact, a humanitarian supply chain is one of the most dynamic supply chains in the world (Hoffman, 2005). Every disaster is different and it is hard to tell what the impact will be on an area or country. The management of these humanitarian supply chains is complicated because the amount of experienced logistics experts available is limited and coordination between the involved parties is often minimal (Abu Nahleh, Kumar, & Daver, 2013).

Timely distribution may be complicated because the infrastructure in the affected area is often damaged or difficult to reach (Balcik et al., 2008). Furthermore, special care in transportation is needed due to the need to pay attention to food safety (e.g. expiration, temperature) as well as hygiene (Gaboury, 2005). Several medicines and/or vaccines need to be transported in a refrigerated box because they need to be kept at the right temperature (UNICEF Annual Supply Report, 2012). These characteristics necessitate humanitarian organizations to engage in preparatory activities such as inventory prepositioning in warehouses. Ukkusuri and Yushimito (2008) define prepositioning as: 'the storage of inventory at or near the disaster location for seamless delivery of critical goods'. Prepositioning will reduce the lead-times for reaching places that are affected by a disaster. Time is an important factor in the relief process; especially the first 72 hours are critical (Abu Nahleh et al., 2013). The survival rate in affected areas is influenced by the quick availability of critical supplies such as blood and water as well as resources. Critical supplies and relief personnel must therefore be transported quickly and efficiently to minimize the cost of the operations and maximize the survival rate of the affected people (Abu Nahleh et al., 2013). All these aspects lead to supply chain challenges when disaster strikes.

Facility location is a key problem that is affecting the performance of relief operations considerably (Abu Nahleh et al., 2013). Facility location concerns the placement of facilities taking several characteristics into account such as demand size and location (Caunhye, Nie, & Pokharel, 2012). Simchi-Levi, Kaminsky, and Simchi-Levi (2008) state that business literature indicates that facility location decisions involve the number, location, size and capacity of each facility. These considerations also apply to the humanitarian sector (Richardson, de Leeuw, & Vis, 2010). Facility location decisions have a direct impact of facilities on the operating cost and on the timeliness of response to the demand (Haghani, 1996). In order to respond quickly to onset disasters, facility location and stock pre-

positioning are therefore key decisions in humanitarian relief (Balcik and Beamon, 2008). Distributing relief items from strategically located warehouses improves the efficiency of disaster relief in economic terms, but also in terms of transportation efficiency, speed and demand satisfaction (Döyen, Aras, & Barbarosoğlu, 2011). In humanitarian supply chains this may translate into minimizing transportation cost (Drezner, 2005) and transportation time (Akkihal, 2006). In fact, within relief operations a faster delivery time will often be chosen over lower cost (Akkihal, 2006).

A popular modeling approach in facility location is the covering problem. In covering problems customers receive service by facilities depending on the distance between customers and facilities (Farahani, Asgari, Heidari, Hosseininia, & Goh, 2012). Customers receive service from a facility when the distance is equal to or lower than a predefined number – the so-called coverage distance or radius. With disaster relief, it is difficult to set such a requirement. Disaster relief supply chains have to deal with high levels of demand uncertainty and very high demands at short notice, damaged roads, chaotic victim behavior, fragile communication lines, short lead times, and with uncertainties about what relief items are actually needed (Abu Nahleh et al., 2013). Balcik and Beamon (2008) indicate that the dominating characteristics that bring complexity into disaster relief chains are the unpredictability of demand (timing, location, type and size), suddenly occurring demand (very large amounts) and short lead times required for many different supplies whereas stakes are high, and a lack of appropriate resources (supply, people, technology, transportation capacity and money).

2.2 Factors influencing new warehouse locations

MacCarthy & Atthirawong (2003) investigated relevant factors affecting location decisions. Although this research was mainly focused on manufacturing organizations, these factors can also be applied to humanitarian organizations (Richardson et al., 2016). MacCarthy & Atthirawong (2003) identified thirteen major factors. Each major factor also has specific sub-factors covering quantitative and qualitative aspects that are relevant to location decisions. These include operational, strategic, economic, political, social and cultural dimensions.

Richardson and de Leeuw (2012) and Richardson et al. (2016) have used the work of MacCarthy & Atthirawong (2003) to identify 10 main factors that have an influence on humanitarian inventory prepositioning locations. Their top five factors include: the cost of operating a facility, the speed of humanitarian response, availability and quality of labor, availability and quality of business and support services (which consist of standard business services (e.g., warehousing, handling) and specific business services (e.g., procurement), cf. Richardson et al. (2016)) and availability and quality of infrastructure. The other factors in their top 10 are (cf. Richardson et al., 2016): availability of suppliers, characteristics unique to the location (i.e., what gives a location an advantage over other potential facility locations (Ulgado 1996), such as specialized space to carry out operations), government and political factors, economic factors and community environment (which relates to amongst others the community attitudes towards business), and social and cultural factors (which for example

relates to the general level of acceptance of certain relief goods). These factors fit in the framework of MacCarthy & Atthirawong (2003), though some factors are specific to humanitarian supply chains.

In addition to the papers of MacCarthy & Atthirawong (2003) and Richardson et al. (2016) that summarize academic research in the area of factors affecting facility location we have investigated four industry reports that discuss location factors. We have selected these four industry reports in consultation with Dutch and Belgian facility location experts; these reports are considered key sources of information regarding facility location in Western European industry. The VIL, Flanders Institute for Logistics (2006) and the European Distribution report of Cushman & Wakefield (2008) identified the following factors: transport system (road, sea, rail, air, congestions), accessibility of the markets, costs of storage space, land and labor (rent, land and labor costs), supply of buildings and land, labor supply and productivity, knowhow of logistics and languages. According to Inbound Logistics (Global Logistics guide 2012) the following factors are relevant for choosing a location: Transportation infrastructure, business culture and IT competency. The Holland International Distribution Council (HIDC 2012) identified these factors: infrastructure, business environment (quality of overall/port/railroad infrastructure) and taxes. An overview of all the factors and their sources are presented in table 1.

Table 1: Overview of factors influencing facility location from literature and used in our study

Facility location factors from literature	Reference

• **Cost** • **Labor characteristics** • **Infrastructure** • **Proximity to suppliers** • **Proximity to markets/customers** • **Proximity to parent company's facilities** • **Proximity to competition** • **Quality of life** • **Legal and regulatory framework** • **Economic factors** • **Government and political factors** • **Characteristics of a specific location**	Maccarthy and Atthirawong (2003)
• **Cost of operating a facility** • **Speed of humanitarian response** • **Availability and quality of labor** • **Availability and quality of business and support services** • **Availability and quality of infrastructure** • **Availability of suppliers** • **Characteristics unique to the location** • **Government and political factors** • **Economic factors and community environment** • **Social and cultural factors**	Richardson and de Leeuw (2012); Richardson et al. (2016)
• **Transport system (road, sea, rail, air, congestions)** • **Accessibility of the markets** • **Costs of storage space, land and labor (rent, land and labor costs)** • **Supply of buildings and land** • **Labor supply and productivity** • **Knowhow of logistics and languages**	VIL, Flanders Institute for Logistics (2006) and The European Distribution report of Cushman & Wakefield (2008)
• **Transportation infrastructure** • **Business culture** • **IT competency**	Inbound Logistics (Global Logistics guide 2012)
• **Infrastructure** • **Business environment (quality of overall/port/railroad infrastructure)** • **Taxes**	Holland International Distribution Council (HIDC 2012)
Factors used for this study • **Infrastructure** • **Labor quality and availability** • Political environment • Characteristics unique to the location	

We base our paper on the Richardson et al. (2016) study (which is the only empirically grounded study in this domain so far) and the MacCarthy & Atthirawong (2003) study, which is the key source for the Richardson et al. (2016) paper. We aim to empirically verify these frameworks by analyzing the actual location of warehouses using publicly available information. This restricts the factors that we can use since not all data may be available. In our research we focused on four factors: infrastructure, labor characteristics, government and political factors and characteristic unique to location. We left out costs since this cannot be estimated based on public sources. The only aspect related to costs that we can measure is the amount of organizations that make use of the United Nations Humanitarian Response Depot (UNHRD) network. Space is provided for free to the participating organizations (cf.

Richardson et al., 2016). The United Nations World Food Programme manages this network and their depots are located around the world: Brindisi (Italy), Accra (Ghana), Dubai (United Arab Emirates), Subang (Malaysia) and Panama City (Panama).
The factors are in line with the most decisive factors indicated by MacCarthy & Atthirawong (2003) though we could not measure all factors in list of most decisive factors of Richardson et al. (2016). We could not take speed directly into account – a factor in the top of the list of Richardson et al. (2016) - since actual speed of delivery is not documented. However, as discussed in section 3 infrastructure contains distance to an airport or seaport. Quick access to ports contributes to speed in the supply chain. The other factor in the list of most decisive factors of Richardson et al. (2016) - availability and quality of business and support services – is also part of what we measure in infrastructure (logistics quality and competence of a location – see section 3).

3: Methodology

This section will describe the methodology that will be used in this paper. Our research can be classified as desk-research based on public secondary data. An advantage of using secondary data is that this type of data is easily accessible and can therefore be obtained relatively quickly (Malhotra and Birks, 2007). For example, information about humanitarian organizations can be obtained relatively easily via their websites and/or annual reports. The use of public data will also enhance validity since similar results may be obtained if this research is replicated (Malhotra and Birks, 2007). Where possible and necessary we emailed organizations for additional (publicly available) information.

A key constraint for establishing our research sample was that public sources could be found about warehouse locations of humanitarian organizations. Furthermore, the organizations needed to have at least a regional or preferably a global scope. We used Reliefweb (www.reliefweb.int) and a list of non-governmental organizations of Global Corps[1], to compile a list of 32 humanitarian organizations . Not all major organizations could be put on the list due to absence of any relevant supply chain information. The list can be found in the Appendix 1. Reliefweb is part of the United Nations Office for the Coordination of Humanitarian Affairs. They function as a digital platform to provide reliable disaster and crisis updates to humanitarians. The next step was to determine the current warehouse locations of those organizations. These warehouse locations were determined by analyzing annual reports and websites of the humanitarian organizations listed in Appendix 1. After identifying the current warehouse locations, these locations were grouped per country. This way we were able to use country-based information such as the Enabling Trade Index (by the World Economic Forum) or Logistics Performance Index (by the World Bank) to rate locations. Below we discuss the operationalization of the location factors.

[1] GlobalCorps works under contract to the U.S. Agency for International Development, Office of Transition Initiatives (USAID/OTI) and Office of Crisis Surge Support Staff (USAID/CS3) to recruit Personal Services Contractors (PSCs), connecting exceptional applicants with unique and challenging job opportunities (www.globalcorps.com).

For the factor 'infrastructure' we used the Enabling Trade Index to rate countries on the quality of institutions, policies, infrastructures and services facilitating the free flow of goods over borders and to their destination. The four main categories of this index are: market access, border administration, infrastructure and operating environment. These four main categories are further divided into subcategories (pillars). The categories used for this research will be infrastructure and availability and quality of infrastructure (pillar 4). This pillar measures the quality of the infrastructure of different transportation modes: road, air, railroad and sea transport (Global Enabling Trade Report 2014).

Information about the Logistics Performance Index (LPI) will be retrieved from the country scorecard of the World Bank.[2] The World Bank is an institute that plays a vital role in financial and technical assistance to developing countries. In addition, the World Bank provides several reports such as reports that contain the LPI. For this research the Logistics Performance indexes of infrastructure and logistic performance will be used.

Other information that will be retrieved from the World Bank is information for the factor 'labor quality and availability' of a country. Four factors will be used to measure this factor[3]: labor force (i.e., people ages 15 and older meeting the International Labour Organization definition of the economically active population), participation rate (i.e., the proportion of the population ages 15 and older that is economically active) and unemployment rate (the share of the labor force that is without work but available for and seeking employment). The fourth factor is 'Labor Market Efficiency', which indicates how efficient countries allocate their workers with regard to their most effective use and providing the incentives for them to give their best efforts in their jobs (Global Competitiveness Report 2006-2007, 2012-2013).

The factor, 'political environment' is measured with the Global Peace Index. The Global Peace Index ranks countries according to their level of peace. This ranking is based on 22 qualitative and quantitative indicators, which cover three broad themes: the level of safety and security in society, the extent of domestic or international conflict and the degree of militarization (GPI Report 2013). In 2013 this ranking consisted of 162 independent countries or states.

The characteristics unique to the location are operationalized by the number of incidents that affects the location (number of hazards as well as number of affected people). We use data from The international Disaster Database EM-DAT, which is part of the Centre for Research on the Epidemiology of Disasters (CRED). Data of the last ten years will be used for this research. The disasters are divided into two types: natural and technological disasters. Besides the number of affected people, the number of hazards will be provided, since this will show the proportion of the number of affected people to the number of hazards. The criteria for being incorporated in the EM-DAT database are: 10 or more people are reported as killed, 100 people are reported affected, a call for international assistance is made and/or a

[2] http://lpi.worldbank.org/international/scorecard
[3] source: http://data.worldbank.org

declaration of a state of emergency is made. At least one of these criteria has to be fulfilled for a disaster to enter the database.

Table 2 presents the overview of how the selected factors are going to be measured.

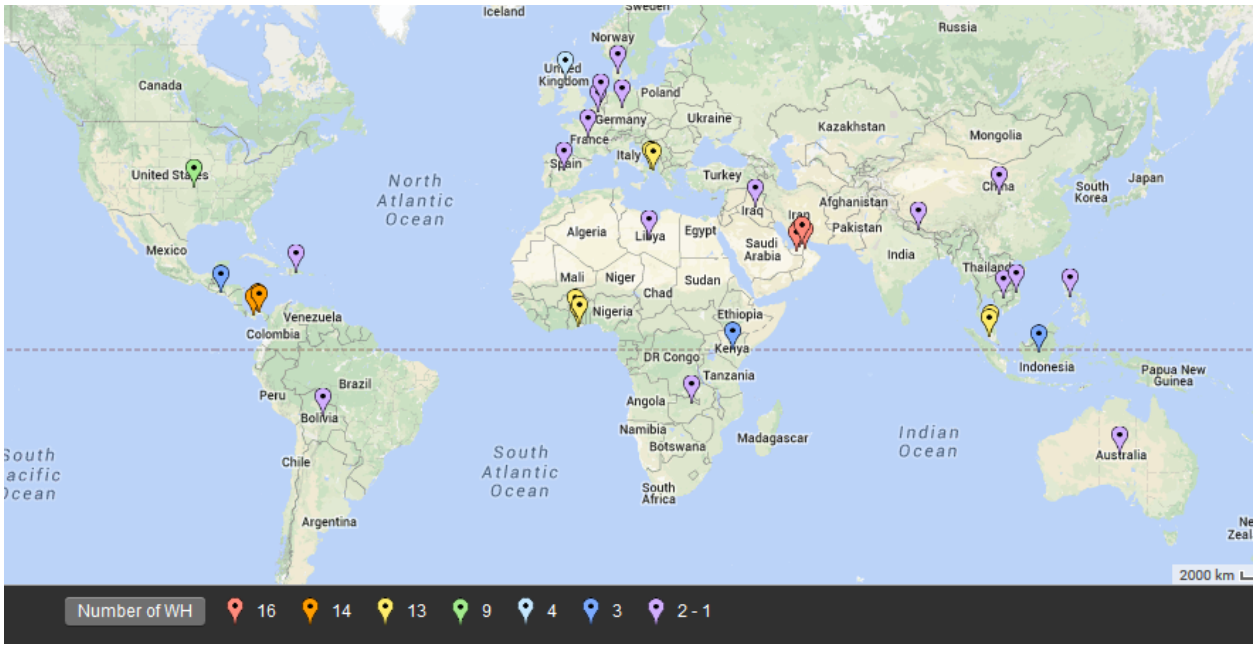
Table 2: Overview of operationalization of factors

Main factor		Source
Infrastructure	- Infrastructure - Availability and quality of infrastructure (pillar 4)	Enabling Trade Index (ETI)
	- Infrastructure - Logistic performance	Logistics Performance Index (LPI)
Labor quality and availability	- Labor force - Participation rate - Unemployment rate	World Bank
	- Labor market efficiency	World Development Report
Political environment	- Level of peace in the country	Global Peace index (GPI)
Characteristics unique to location	- Number of affected people - Number of hazards	EM-DAT: The international Disaster Database

4: Result & Analyses

Of the 32 humanitarian organizations incorporated in our analysis we had to discard four organizations that do not (actively) operate a warehouse (amongst others Partners in Health and the Emergency Nutrition Network (ENN). For seven other organizations the warehouse locations could not be identified based on public information (e.g. Caritas, Food For The Hungry International (FHI), Habitat for Humanity, and Hunger Plus Inc.), due to the lack of complete information on their websites and a lack of response to emails to humanitarian organizations sent to obtain this information. This left us with 21 remaining organizations, of which 11 are a member of the United Nations Humanitarian Response Depot (UNHRD) network. Figure 1 shows the geographic distribution of warehouse locations from 21 different organizations.

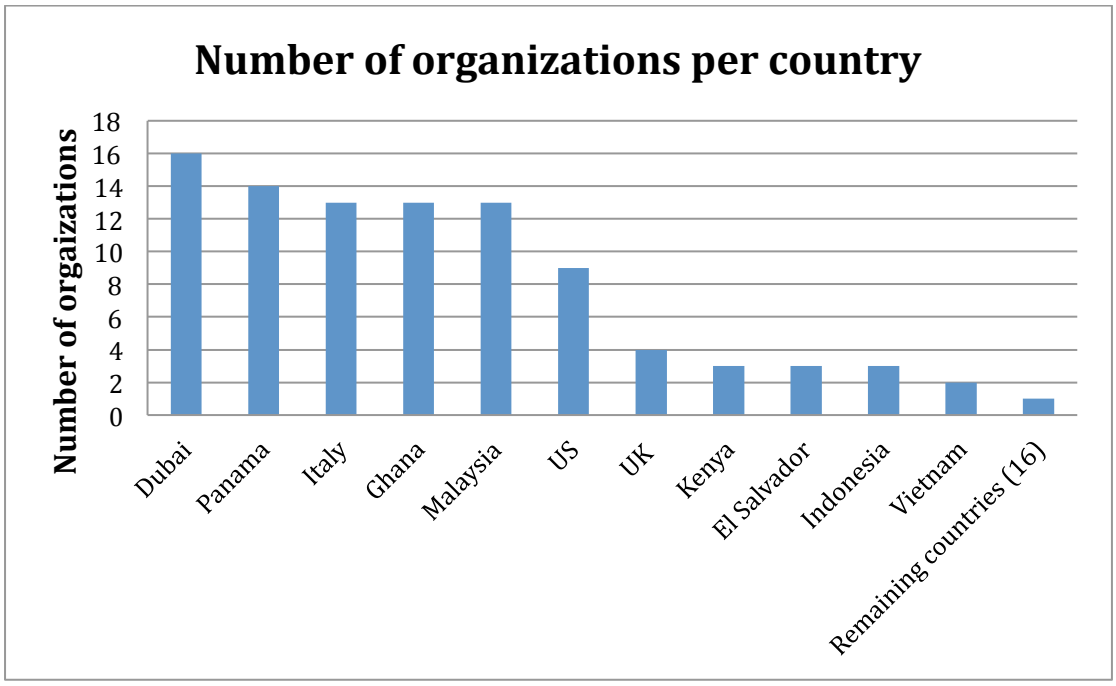
Figure 1: Geographic distribution of the warehouse locations



The color of the pins in Figure 1 represents the number of organizations that have a warehouse at that location. For example, 16 organizations have a warehouse at the red pins (Dubai). Figure 1 shows that the warehouses are spread all around the world. Each continent has at least one warehouse location. A complete table including the exact number of warehouses per organization is presented in Appendix 2. Figure 2 presents the number of organizations that have a warehouse location by country.

Figure 2: Number of warehouses per country[4]

[4] Remaining countries are: Libiya, Cambodia, the Netherlands, Belgium, France, Spain, Zambia, Nepal, Philippines, China, Denmark, Bolivia, Dominican Republic, Iraq, Germany and Australia



The humanitarian organizations we investigated have warehouse locations in 27 different countries. The UNHRD network represents five countries: United Arab Emirates (Dubai), Panama, Italy, Ghana and Malaysia. The presence of a UNHRD facility most likely explains why these five countries also have the highest number of warehouses in Figure 2. We incorporated in total 109 warehouses in our study and 69 of these warehouse locations (from 11 different organizations) are part of the UNHRD network[5]. UNHRD offers free warehouse storage space and logistical support to humanitarian organizations that are member of the UNHRD network (Duran et al., 2011). The fact that many organizations locate their relief items in the UNHRD network is an indication that they do take costs into account when making location decisions. This is in line with Richardson et al. (2016) and MacCarthy & Atthirawong (2003), who both argued that costs make up a dominant factor in location choice.

In our analysis we will only focus on the countries that have locations of two or more organizations. This leaves 11 countries, namely United Arab Emirates (Dubai), Panama, Italy, Ghana, Malaysia, United States, United Kingdom, Kenya, El Salvador, Indonesia and Vietnam. We analyzed the countries using the factors described in table 2.

The first factor is infrastructure. Assessing the infrastructure will be divided into two parts: an assessment of the distance to airports and seaports, and an analysis of the Enabling Trade Index (ETI) and the Logistic Performance Indicators (LPI). For the first part we identified the main airports and seaports of all countries in the sample. We then calculated the distance from the warehouse to the nearest air- and seaport. Sometimes the nearest airport was not the largest or most commonly used airport in the country, so the distances from the warehouse to

[5] Note that these 69 warehouses are not actually 69 different locations. For example: 13 organizations have a warehouse location in Italy (see figure 2), but for all those organizations this location is Brindisi.

the largest airport were measured. Table 3 presents the distances of the warehouses to the nearest air- and seaports. A complete overview of these distances, transportation times, warehouse addresses and the names of the sea- and airports can be found in the Appendix 3.

Table 3: Countries in scope and distances of humanitarian warehouses to nearest air- and seaports

Country	City	Distance to nearest airport	Distance to seaport
Italy	Brindisi	1 km	402 km
Ghana	Accra	1 km	30 km
Malaysia	Subang	1 km	30 km
Kenya	Nairobi	19 km	336 km
United Arab Emirates	Dubai	21.6 km	23.3 km
United States	Denver/Michigan	26/42 km	1670/998 km
Panama	Panama City	29 km	1.4 km
Vietnam	Hanoi	31 km	109 km
Indonesia	Jakarta	40 km	30 km
El Salvador	San Salvador	42 km	184 km
United Kingdom	Oxford-Bicester/Milton Keynes/Salford-Blackburn	76/44/20 km	106/93/61 km

Table 3 shows that in almost each country the humanitarian warehouses are less than 50 kilometers away from a major airport. This shows that it is an important factor for a warehouse to be close to an airport, because when disaster strikes it can be crucial to get the supplies in a short time. Three warehouse locations are even located at the airport. Seaports, on the other hand, are often much further away from the main warehouses. Only five of the eleven locations are closer than 50 kilometers to a seaport, which shows that the distance to a seaport is less important when choosing a warehouse location. One may conclude from this that humanitarian organizations choose access to fast delivery over access to low costs.

The second part of assessing infrastructure will be done by means of two indices. The subjects that will be assessed with the Enabling Trade Index (ETI) are the infrastructure in total and the availability and quality of the infrastructure (pillar 4 of the ETI). The ETI scores 138 countries between one and seven, whereby one is the lowest possible score and seven is the highest. The subjects that are assessed with the Logistics Performance Indicator (LPI) are: Infrastructure and Logistics quality and competence. The LPI uses a scale between one and five, where one is the lowest score and five the highest. Table 4 presents the ranks and scores of the countries in scope. The rank is based on the ETI's overall ranking of infrastructure out of 138 countries (third column in Table 4). When looking at all the ETI scores the top five countries are: United Kingdom, United States, Dubai, Malaysia and Italy. When looking at the LPI scores of infrastructure in general and the competence and quality of logistics services (e.g. transport operators, custom brokers), we see the same countries in the top five. This shows that these five countries have the best infrastructure and logistics quality and competence of the warehouse locations in scope. This is not a surprise, because compared to the remaining six countries these five are most developed, hence a better quality of

infrastructure. A remarkable point in this table is that one of the UNHRD locations, Ghana, has among the worst scores of all countries.

Table 4: Countries in scope and their Enabling Trade Index and Logistics Performance Indicator

		ETI 2014				LPI 2014	
		Infra-structure		Pillar 4: Availability & Quality		Infra-structure	Logistics Quality and Competence
	# WH	Rank (out of 138)	Score (1-7)	Rank (out of 138)	Score (1-7)	Score (1- 5)	Score (1-5)
UK	4	4	6	10	5,9	4,16	4,03
US	9	8	5,8	8	6	4,18	3,97
Dubai	16	10	5,8	1	6,5	3,7	3,5
Malaysia	13	23	5,1	14	5,3	3,56	3,47
Italy	13	32	4,8	22	4,8	3,78	3,62
Panama	14	45	4,3	31	4,4	3	2,87
Vietnam	2	60	3,9	74	3,3	3,11	3,09
Indonesia	3	64	3,9	60	3,6	2,92	3,21
El Salvador	3	70	3,8	75	3,3	2,63	3,16
Kenya	3	93	3,3	85	2,9	2,4	2,65
Ghana	13	95	3,2	94	2,7	2,67	2,37

The second factor we analyzed is quality and availability of labor. To measure this factor, information provided by the World Bank was used. Labor quality is divided into three parts: the total labor force, the total participation rate and the unemployment rate. Everyone who is older than 15 and who meets the Labour Organizations definition of the economically active population belongs to the total labor force. The participation rate is the proportion of the population ages 15 and older that is economically active. The unemployment rate means the percentage of the total labor force that is without work but available for and seeking employment. The labor market efficiency (which indicates how efficient countries allocate their workers with regard to their most effective use and providing the incentives for them to give their best efforts in their jobs) is reflected by means of a score between one and seven, where one is the lowest and seven the highest possible score. Table 5 provides an overview of the corresponding scores. The ranking is based on the participation rate of the country. When looking at the total workforce in the countries in scope the United States has the largest workforce and Panama the smallest (158.686.472 people in the USA compared to 1.777.005 people in Panama). We also observe that the participation rate varies from 79 percent in Dubai to 49 percent in Italy. This means that in Italy, more than half of the total work force is not economically active. Italy also has the highest unemployment rate and the lowest efficiency rate of the countries in the table, which may negatively influence the decision to locate a warehouse in Italy. Except for the smaller size of the work force available Dubai received high scores. In the remaining rankings they are in the top four. Vietnam is in the top

three on all rankings, except for the labor market efficiency (6th), which makes Vietnam a favorable potential warehouse location. The United Kingdom has the highest labor market efficiency, but their unemployment rate is rather high compared to the other countries. All the other countries are in the middle, and therefore no conclusion can be drawn.

Table 5: Countries in scope and Quality and availability of labor

		Worldbank data /2013			WDR 2014
	# WH	Labor Quality			Labor Market efficiency
		Labor force	Participation rate	Unemployment. rate	Score (1-7)
Dubai	16	6.248.007	79	3,8	5,24
Vietnam	2	52.859.471	77	2	4,51
Ghana	13	10.779.112	69	3,6	4,08
Indonesia	3	118.378.606	68	6,6	3,87
Kenya	3	16.697.483	67	9,2	4,62
Panama	14	1.777.005	66	4,5	4,17
US	9	158.686.472	63	8,1	5,37
UK	4	32.377.782	62	7,9	5,42
El Salvador	3	2.708.794	62	6,9	3,86
Malaysia	13	12.717.901	59	3,1	4,82
Italy	13	25.658.144	49	10,7	3,72

The third factor is the political environment. This will be measured by means of the Global Peace Index, which ranks countries according to their level of peace. Table 6 presents the Global Peace Index of 2013 in order of the highest index for peace to the lowest. Eight out of the eleven countries in scope are ranked within the first 60 (out of 162) countries with highest peace index, which is a quite positive observation. If the peace index is high, it will be more unlikely to encounter problems when one needs to distribute supplies from a warehouse. Also if a country is stable it is more safe for humanitarian organization to ask help from the local people, which is highly needed when a disaster strikes. All five UNHRD warehouse locations are in a country with a high peace index. The difference between the first ranked and the last ranked of the 11 countries in scope is considerable: 29th (Malaysia) and 136th (Kenya). Although the countries with the largest number of warehouses are very safe it does not seem a common practice to locate warehouse in only the safest countries.

Table 6: Countries in scope and Global Peace Index 2013

		Global Peace Index 2013	
	# WH	Rank (out of 162)	Score
Malaysia	13	29	1574
Italy	13	35	1663
Dubai	16	36	1679

Vietnam	2	41	1772
UK	4	44	1787
Indonesia	3	54	1879
Panama	14	56	1893
Ghana	13	58	1899
US	9	99	2126
El Salvador	3	112	2240
Kenya	3	136	2466

The last factor that we will analyze is a country specific characteristic: number of affected people and number of hazards. To provide a clearer overview of the affected number of people, a distinction will be made between natural and technological hazards. Only the numbers of the last ten years (2003-2013) will be presented. Table 7 provides an overview of the number of people affected per type of hazard as well as the total amount of people affected. The rank order is from the country with the smallest number of people affected to the country with the largest number of affected people. We also present number of hazards in Table 7 (last column). This shows for example that Kenya has almost as many affected people as the United States, but Kenya only had 93 hazards, while the United States had 248 hazards. The average number of affected people in Kenya (209.651) is much higher than in the United States (84.113). This also indicates that even though the United States has the largest number of affected people, it does not mean that the United States has an unstable environment. One can see from this table that the most used location (Dubai) is also the location that experienced fewest disasters (four) with in total 32 affected people. This table shows that warehouses are often located away from disaster sensitive locations. Also four out of five UNHRD warehouses (Dubai, Italy, Panama and Malaysia) are in the country top five of least number of people affected, which implies that they are not located in a disaster sensitive location. The complete table, including the distinctions between (sub) types of hazards, can be found in the Appendix 4 and 5.

Table 7: Countries in scope and number of people affected by hazards (2004-2013)

	#WH	People affected by Natural disasters	People affected by Technological disasters	Total number of people affected	*Number of hazards*	*Number of inhabitants in country (2014)*
Dubai	16	0	32	**32**	*4*	*9,086,139*
Italy	13	91,405	938	**92,343**	*49*	*60,789,140*
Panama	14	112,217	1,153	**113,370**	*25*	*3,867,535*
UK	4	394,721	153	**394,874**	*32*	*64,559,135*
Malaysia	13	496,633	218	**496,851**	*27*	*29,901,997*
El Salvador	3	569,691	114	**569,805**	*24*	*6,107,706*
Ghana	13	704,714	316	**705,030**	*30*	*26,786,598*
Indonesia	3	10,860,609	17,509	**10,878,118**	*229*	*254,454,778*
Vietnam	2	18,281,545	5,253	**18,286,798**	*103*	*90,728,900*

Kenya	3	19,448,077	49,454	**19,497,531**	*93*	*44,863,583*
US	9	20,856,615	3,338	**20,859,953**	*248*	*318,857,056*

Source: EM-DAT the International Disaster Database; http://data.worldbank.org/indicator/SP.POP.TOTL (for population figures)

Section 5: Discussion, conclusions, limitations and future research

The goal of this paper was to empirically verify characteristics of warehouses locations of humanitarian organizations. The characteristics analyzed were derived from Richardson et al. (2016) and MacCarthy and Atthirawong (2003). We investigated 21 organizations of which public information was available. The locations of the warehouses of these organizations are spread all around the world: each continent has at least one warehouse location and some countries host multiple organizations with warehouse locations.

A first observation is that good infrastructure is an important characteristic of the warehouse locations of the humanitarian organizations we investigated. Locations in our sample all have good access to airports. Because the first 72 hours after a disaster are critical for effective response and affected areas are often difficult to reach an infrastructure that facilitates speedy response is important. Most locations investigated were not very close to a seaport. Only 5 out of 11 locations were within a distance of 50 km of a seaport. However, the first response is most of the times done using aircraft, making the distance to airports more critical. As argued by Richardson et al. (2016) the ability to provide quick response to disasters is a key consideration in facility location.

We also observed that humanitarian warehouse locations we investigated are in the top 60 safest countries (out of 162) so therefore safety seems to be a consideration. Organizations have located their facilities in relatively safe areas. We furthermore found that in many cases facility locations are away from disaster-prone regions. A good example of this is the presence of many organizations in Dubai, which is a place that is hardly hit by disasters but which has a very good infrastructure, but also has good access to resources (cf. de Leeuw, Kopczak, & Blansjaar, 2010).

Although we cannot draw statistically supported conclusions our results show that many (large) organizations use UNHRD facilities as a warehouse location. A driver that contributes to this is the fact that UNHRD offers the location for free to UNHRD members. We therefore expect that costs are an important driver for warehouse location decisions, as also identified by Richardson et al. (2016). Our findings thereby are in support of Duran et al., (2007), who already stated that the UNHRD network provides free warehousing and free warehousing, making the implementation of a pre-positioning network financially and logistically better feasible. This result is most likely related to the fact that a significant portion of our sample co-locates their products at UNHRD premises. This also indicates that organizations prefer to cluster warehouse activities, particularly when there is no fee involved for using the warehouse (such as in the UNHRD network). As a result, the presence of humanitarian organizations in a certain location will have a positive influence on other organization to

locate their facility there as well. When doing this they can create opportunities for collaboration and coordination with the other organizations (Richardson et al., 2010). Collaboration is not just important for commercial logistics but also for humanitarian logistics (Beamon, 2004; Van Wassenhove, 2006).
We unfortunately cannot draw conclusions with regard to the factors labor quality and availability and the political environment (measured with the Global Peace Index) since we could not observe large differences between locations.

Summarizing, our results show that humanitarian warehouses are often located in areas with good quality and availability of infrastructure (all warehouse locations were within a distance of 50 km of an airport, implying that access to other locations is good), and a relatively safe area that is not vulnerable to disasters. We can thereby confirm that a number of key location factors identified by Richardson et al. (2016) indeed seem to represent actual warehouse locations and therefore most likely affect location choice.

Our research comes with limitations. Unfortunately, not all warehouse locations of the major organizations could be located due to lack of public information available. Future research may aim to expand the information presented here and to include additional organizations where possible in order to provide an as complete overview of factors as possible. Expansion will also allow for statistical analysis of data, something that was impossible in this study given the limited amount of data available for comparison purposes. We furthermore did not include locations with only 1 organization present. Last, we did not make a difference between large and small organizations (e.g. in terms of facilities required) nor did we differentiate between foci of the organization in terms of product or type of activity that needed to be supported by facilities. Future research may aim to further detail this.

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MSF US annual report 2011
The Global Enabling Trade Report, World Economic Forum, 2014
UNICEF Annual Supply Report, 2012
VIL, Comparison of Top Locations for European Distribution and Logistics (2006)

Databases

Worldbank- International Scorecard
EM-DAT: The OFDA/CRED International Disaster Database – www.emdat.be, Université Catholique de Louvain, Brussels (Belgium)

Appendix 1: List of humanitarian organizations:

1) Action Against Hunger (AAH)
2) American Refugee Committee International
3) Care
4) Caritas Internationalis
5) Catholic Relief Services (CRS-USCC)
6) Emergency Nutrition Network (ENN)
7) Food For The Hungry International (FHI)
8) Habitat for Humanity
9) Humanitarian aid and civil protection department of the European Commission (ECHO)
10) Hunger Plus Inc.
11) International Federation of Red Cross and Red Crescent Societies (IFRC)
12) InterAction
13) International Organization for Migration (IOM)
14) International Rescue Committee (IRC)
15) Islamic Relief
16) Life for Relief and Development
17) Lutheran World Federation (LWF)
18) Médecins Sans Frontiers (MSF)
19) Mennonite Central Committee (MCC)
20) Mercy Corps
21) Norwegian Refugee Council (NRC)
22) Overseas Development Institute (ODI)
23) Oxfam
24) Partners in Health
25) Refugees International
26) Save the Children
27) The Office of U.S. Foreign Disaster Assistance (OFDA)
28) United Nations Children's Fund (UNICEF)
29) United Nations High Commissioner for Refugees (UNHCR)
30) United Nations Office for the Coordination of Humanitarian Affairs (OCHA)
31) US Committee for Refugees (USCR)
32) World Vision International (WVI)

Appendix 2: List of humanitarian organizations and their warehouse locations (part 1)

	Name Organization	UNHRD	WH yes/ no	UAE	Panama	Italy	Ghana	Malaysia	US	UK	Kenya	El Salvador	Indonesia	Vietnam
1	Action Against Hunger (AAH)	1		1	1	1	1	1						
2	American Refugee Committee International			1										
3	Care	1		1	1	1	1	1						
4	Caritas Internationalis		NA											
5	Catholic Relief Services (CRS-USCC)	1		1	1	1	1	1						
6	Emergency Nutrition Network (ENN)		No WH											
7	Food For The Hungry International (FHI)		NA											
8	Habitat for Humanity		NA											
9	Humanitarian aid and civil protection department of the European Commission (ECHO)[6]	1		1	1	1	1	1						
10	Hunger Plus, Inc		NA											
11	Int. Fed. of Red Cross and Red Crescent Societies (IFRC)	1		1	1	1	1	1			1	1		
12	InterAction		No WH											
1	International Organization	1		1	1	1	1	1						

[6] Although ECHO is not directly involved in humanitarian relief activities like the other organizations we have included ECHO here since it funds stockpiling through the UNHRD network and has actively supported the UNHRD network

3	for Migration (IOM)																
14	International Rescue Committee (IRC)	1		1	1	1	1	1									
15	Islamic Relief																
16	Life for Relief and Development			1					1								
17	Lutheran World Federation (LWF)											1	1				
18	Medecins Sans Frontiers (MSF)				1							1					
19	Mennonite Central Committee (MCC)		NA														
20	Mercy Corps	1		1	1	1	1	1		2							
21	Norwegian Refugee Council (NRC)			1													
22	Overseas Development Institute (ODI)		No WH														
23	Oxfam									2			1				
24	Partners in Health		No WH														
25	Refugees International		NA														
26	Save The Children													3	2		
27	The Office of U.S. Foreign Disaster Assistance (OFDA)		NA														
28	United Nations Children's Fund (UNICEF)	1		1	1	1	1	1									
2	United Nations High	1		1	1	1	1	1									

9	**Commissioner for Refugees (UNHCR)**																		
30	**United Nations Office for the Coordination of Humanitarian Affairs (OCHA)**	1		1		1		1		1									
31	**US Committee for Refugees (USCR)**	1		1		1		1		1									
32	**World Vision International (WVI)**	1		1		1		1		1		8							
	TOTAL:	**11**		**16**		**14**		**13**		**13**		**13**	**9**	**4**	**3**	**3**	**3**	**2**	

Appendix 2: List of humanitarian organizations and their warehouse locations (part 2)

	Name Organi-zation	Libiya	Cambodia	Netherlands	Belgium	France	Spain	Zambia	Nepal	Philippines	China	Denmark	Bolivia	Dom. Rep.	Iraq	Germany	Australia
1	AAH																
2	American Refugee Committee International																
3	Care		1														
4	Caritas Int.																
5	CRS-USCC																
6	ENN																
7	FHI																
8	Habitat for Humanity																
9	ECHO																
10	Hunger Plus, Inc.																
11	IFRC						1										
12	Inter-Action																
13	IOM																
14	IRC																
15	Islamic Relief																
															1		

16	**Life for Relief and Development**																
17	**LWF**							1	1								
18	**MSF**			1	1	1											
19	**MCC**																
20	**Mercy Corps**	1															
21	**NRC**																
22	**ODI**																
23	**Oxfam**									1							
24	**Partners in Health**																
25	**Refugees Int.**																
26	**Save The Children**												1	1			
27	**OFDA**																
28	**UNICEF**										1	1					
29	**UNHCR**																
30	**OCHA**																
31	**USCR**																
32	**WVI**															1	1
	TOTAL:	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Appendix 3: Distances and transportation times from warehouse to (main) airport and seaport

Country	Name city	Address WH	Name airport	Distance	Time	Name container port	Dis-tance	Time
UAE	Dubai	Dubai Industrial City	Al Maktoum Airport	21,6 km	0h27	Jebel Ali port	23,3 km	0h27
Panama	Panama city	BLDG 200, Av. Omar Torrijos	Tocumen International Airport	29 km	0h26	Balbao	1,4 km	0h04
Italy	Brindisi	Aeroporto Militare "Pierozzi, 72011 Casale	Leonardo Da Vinci International (Fiumicino)	581 km	5h20	Gioa Tauro	402 km	4h17
			Brindisi – Salento Airport	1 km	0h02			
Ghana	Accra	Kotoka International Airport	Kotoka International Airport	1 km	0h02	Tema	30 km	0h29
Malaysia	Subang	Jalan TUDM, Seksyen U7 40150 Shah Alam, Selangor	Kuala Lumpur International Airport	52 km	0h41	Klang	30km	0h29
			Sultan Abdul Aziz Airport (Subang)	1 km	0h02			
US	Denver	11000 East 40th Avenue,	Denver International Airport	26 km	0h21	Houston	1670 km	15h50
	Michigan	17300 W 10 Mile Rd. Southfield, MI 48075 (office)	Detroit Metropolitan Wayne County Airport	42 km	0h29	New York/ New Jersey	998 km	9h19
UK	Oxford/ Bicester/ (near London)	Arkwright Road, Bicester	London Heathrow	87 km	0h56	Port of London	106 km	1h24

			London Luton	76 km	1h02			
	Milton Keynes	Oxfam Southern Logistics Centre, Milton Point, Garamonde Drive, Wymbush	London Heathrow	79 km	1h03	Port of London	93 km	1h20
			London Luton	44 km	0h33			
	Salford/ Blackburn (near Manchester)	Bury Old Road , M7 4ZH Salford	London Heathrow	338 km	3h17	Liverpool	61 km	0h51
			Manchester Airport	20 km	0h26			
Kenya	Nairobi	IFRC Offices Nairobi, Woodlands Road,	Jomo Kenyatta International Airport	19 km	0h25	Inland Container Depot Kisumu	336 km	4h44
El Salvador	San Salvador	IFRC Offices, 17 Calle Poniente y Avenida Henyi Dunant	El Salvador International Airport	42 km	0h33	Porto de la Union (former puerto Cutuco)	184 km	2h33
Indonesia	Jakarta	Jl. Pejaten Barat no. 8 Pasar Minggu, Jakarta Selatan, Jakarta 12550	Soekano- Hatta International Airport	40 km	0h45	Tanjung Priok	30 km	0h40
Vietnam	Hanoi	Trung Tu Diplomatic Compound, 6 Dang Van Ngu, Dong Da District	Noi Bai International Airport	31 km	0h47	Haiphong	109 km	2h04

Appendix 4: Number of people affected by hazards (2004-2013) (part 1)

	Natural disasters									SUM
	Drought	Earthquake	Epidemic	Extr.Temp[7].	Flood	Mass movement[8]	Storm	Volcano	Wildfire	
Dubai	0	0	0	0	0	0	0	0	0	**0**
Panama	0	0	0	0	110.781	0	0	0	1.436	**112.217**
Italy	0	81.400	0	0	9.840	160	5	0	0	**91.405**
Ghana	0	0	18.351	0	686.363	0	0	0	0	**704.714**
Malaysia	0	5.063	0	0	450.564	6	41.000	0	0	**496.633**
US	0	6.262	0	31	11.221.201		8.893.846		735.275	**20.856.615**
UK	0	4.501		47	382.793		7.380			**394.721**
Kenya	17.650.000	0	16.700	0	1.781.115	262	0	0	0	**19.448.077**
El Salvador	0	17.221	4.598	0	305.832	0	176.961	65.079	0	**569.691**
Indonesia	0	7.560.370	93.862	0	2.856.294	20.573	14.265	315.045	200	**10.860.609**
Vietnam	410.000	0	142	0	7.544.165	1	10.327.237	0	0	**18.281.545**

[7] Extreme temperatures
[8] Landslides (wet/dry)

Appendix 4: Number of people affected by hazards (2004-2013) (part 2)

	Technological disasters			SUM	TOTAL (Natural + Technological)
	Industrial	Miscellaneous	Transport		
Dubai	0	6	26	**32**	**32**
Panama	0	1.125	28	**1.153**	**113.370**
Italy	0	0	938	**938**	**92.343**
Ghana	5	130	181	**316**	**705.030**
Malaysia	0	0	218	**218**	**496.851**
US	822	641	1.875	**3.338**	**20.859.953**
UK	0	3	150	**153**	**394.874**
Kenya	208	48.951	295	**49.454**	**19.497.531**
El Salvador	0	50	64	**114**	**569.805**
Indonesia	12.121	2.727	2.661	**17.509**	**10.878.118**
Vietnam	5.013	0	240	**5.253**	**18.286.798**

Appendix 5: Number of hazards (2004-2013)

	Natural disasters									SUM	Technological disasters			SUM	*TOTAL*
	Drought	Earth-quake	Epi-demic	Extr. Temp.	Flood	Mass move-ment	Storm	Vol-cano	Wild-fire		Indus-trial	Miscel-laneous	Trans-port		
Dubai	0	0	0	0	0	0	0	0	0	**0**	1	1	2	**4**	***4***
Panama	1	0	0	0	18	0	0	0	1	**20**	0	2	3	**5**	***25***
Italy	1	3	0	6	10	2	3	0	2	**27**	0	1	21	**22**	***49***
Ghana	0	0	6	0	9	0	0	0	0	**15**	5	2	8	**15**	***30***
Malaysia	0	1	1	0	18	1	1	0	1	**23**	0	0	4	**4**	***27***
US	0	0	0	9	50	0	130	0	24	**213**	8	7	20	**35**	***248***
UK	0	1	0	5	13	0	9	0	0	**28**	0	1	3	**4**	***32***
Kenya	5	1	12	0	30	3	0	0	0	**51**	3	14	25	**42**	***93***
El Salvador	1	2	1	1	6	0	7	2	0	**20**	0	2	2	**4**	***24***
Indonesia	0	36	6	0	68	21	4	15	2	**152**	8	11	58	**77**	***229***
Vietnam	1	0	4	0	39	2	33	0	0	**79**	6	1	17	**24**	***103***