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An Empirical Analysis of Humanitarian Warehouse Locations

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ABSTRACT: 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, de Leeuw and Dullaert (2016). This paper is based on desk research. Public data such as (annual) reports and databases are used to determine the features of the location in empirical terms. We find that a significant proportion of our sample co-locates their products at UNHRD premises. This suggests that organizations prefer to cluster their warehouse activities, particularly when there is no fee involved for using the warehouse (as is the case in the UNHRD network). The geographic map of the current warehouses, together with the quantified location factors, provides an overview of the current warehouse locations. We found 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 concerns) and by the low occurrence of disasters. Other factors that were considered by us but were not supported by empirical evidence were labor quality and availability as well as the political environment. In our study we were only able to use a limited sample of warehouses. We also focused our research on countries where two or more organizations have their warehouses located. We did not account for warehouse sizes or the kinds of products stored in our analysis.

Keywords: Humanitarian supply chain management, facility location, warehouse location, empirical study, humanitarian logistics.

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1. INTRODUCTION

Humanitarian logistics involves issues of great complexity due to the physical and geographical environment of the places where disasters occur. . As a result, the affected areas are often hard to reach. To achieve efficient and effective humanitarian relief it is essential for humanitarian organizations to have their warehouses in appropriate locations. The locations of these warehouses have a direct influence on the response time of the humanitarian organizations (Balcik & Beamon, 2008). When a disaster strikes, basic items such as water and food need to be distributed as fast as possible to cover initial needs. In addition, hygiene kits and sanitary supplies as well as medication are important in the early response phase, because of the risk of the outbreak of various diseases (MSF, 2011). In order to fulfill these needs some humanitarian organizations locate their supplies in a place where they can serve a region, for example, per continent such as the IFRC [International Federation of Red Cross] (Gatignon, Van Wassenhove, & Charles, 2010). Another option is for humanitarian organizations to place their inventory in the country they want to assist (Richardson & 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 e.g. Farahani, Bajgan, Fahimnia, and Kaviani (2015), Melo, Nickel, and Saldanhada-Gama (2009) and MacCarthy and Atthirawong (2003). Many factors influence the selection of the location of a facility, though often the overriding concern is costs (MacCarthy and Atthirawong, 2003). The research carried out by MacCarthy and Atthirawong (2003) also showed that site selection factors are industry-specific because each industry has different characteristics and strategies. For example, in the case of humanitarian organizations, the delivery time can be expected to be important because people's lives are at stake. If the supplies are strategically placed, the delivery time of the goods to the affected area can be reduced (Duran, Guiterrez, & Keskinocak, 2007; Balcik & 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), although their work focuses on the input from users rather than an analysis of the current locations.

In this paper, we build on the findings of Richardson et al. (2016). We base our theoretical starting point on their analysis of factors deemed to be relevant for warehouse facility location in humanitarian organizations. We aim to empirically determine the features of current warehouse locations of humanitarian organizations (based on public information) and to relate these 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 sets out 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 opportunities.

2. LITERATURE REVIEW

2.1 Facility location in humanitarian supply chains

The purpose of emergency aid or disaster relief is to mitigate the effects of disasters and reduce the suffering of the affected people (Kelly, 1995). It is therefore important to rapidly provide appropriate emergency supplies to the people affected so that 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 focus at minimizing loss of life and suffering, whereas commercial supply chains are mainly concerned with 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 (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 since strict attention must be paid to food safety (e.g. storage of perishable food and , temperature) as well as hygiene (Gaboury, 2005). Several medicines and/or vaccines need to be transported in a refrigerated box

because they must be kept at the right temperature (UNICEF, 2012). These issues require 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 provision of relief ; this is especially critical in the first 72 hours (Nahleh et al., 2013). The survival rate in affected areas is enhanced by the quick availability of critical supplies such as blood and water as well as other 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 (Nahleh et al., 2013). All these aspects lead to supply chain challenges when disaster strikes.

Facility location is a key problem that has a considerable effect on the success of relief operations (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, Leeuw, & Vis, 2010). Facility location decisions have a direct impact on the operating cost and on the timeliness of response to the demand (Haghani, 1996). In order to respond quickly to the onset of a disaster, facility location and stock pre-positioning are therefore key decisions in humanitarian relief (Balcik & Beamon, 2008). Distributing relief supplies from strategically- located warehouses improves the efficiency of disaster relief in economic terms, but also in terms of transport ation efficiency, speed and demand satisfaction (Döyen, Aras, & Barbarosoğlu, 2012). In humanitarian supply chains, this may translate into minimizing transportation cost (Drezner, 1995) and delivery time (Akkihal, 2006). In fact, within relief operations, a faster delivery time will often be chosen over lower costs (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. In the case of disaster relief, it is difficult to set such a requirement. Disaster relief supply chains have to deal with high levels of demand uncertainty and large-scale demands at short notice, such as damaged roads, distraught victims , fragile communication lines, short lead times, and uncertainty about what relief supplies are actually needed (Nahleh et al., 2013). Balcik and Beamon (2008) indicate that the dominating characteristics that bring complexity into disaster relief chains are the unpredictability of the event (in terms of timing, location, type and size), the quantity of the needs arising and the short lead times required for many different supplies. Generally in these circumstances stakes are high, and there is 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 their 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 that include quantitative and qualitative aspects that are relevant to making location decisions. These include operational, strategic, economic, political, social and cultural dimensions.

Richardson and Leeuw (2012) and Richardson et al. (2016) draw on 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, the availability and quality of labor, the availability and quality of business and support services (which consist of standard business services (e.g., warehousing and handling of goods) and specific business services (e.g., procurement), (cf. Richardson et al., 2016)) and the availability and quality of the infrastructure. The other factors in their top 10 are as follows (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 the space to carry out specialized operations), gov-

ernment and political factors, economic factors and community environment (which includes the community's attitude to business, among other factors), and social and cultural factors (which, for example, relates to the general level of acceptance of certain relief supplies). These factors fit in the framework of MacCarthy and Atthirawong (2003), though some factors are specific to humanitarian supply chains.

In addition to the papers by MacCarthy and Atthirawong (2003) and Richardson et al. (2016), which summarize the academic research in the area of factors affecting facility location, we have investigated four industrial 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, and air, as well as the problem of traffic 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, know-how of logistics and languages. According to Inbound Logistics (2012) the following factors are important when choosing a location:transportation infrastructure, business culture and IT competency. The Holland International Distribution Council (HIDC, 2012) identified the following factors: infrastructure, the business environment (quality of overall/port/railroad infrastructure) and taxes. An overview of all the factors and their sources is provided in Table 1.

Table 1. Overview of factors that influence facility location as outlined in the literature and used in our study

Facility location factors derived from the literature	Reference
Cost Labor standards Infrastructure Proximity to suppliers Proximity to markets/customers Proximity to facilities of the parent company 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)
Operational Costs of a facility Speed of humanitarian response Availability and labor standard Availability and quality of business and support services Availability and quality of infrastructure Availability of suppliers Unique features of the location Government and political factors Economic factors and the local environment Social and cultural factors	Richardson and Leeuw (2012); Richardson et al. (2016)
Transport system (road, sea, rail, air, and traffic congestion) Accessibility to 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 (2012)
Infrastructure Business environment (quality of overall/port/railroad infrastructure) Taxes	HIDC (2012)
Factors used in this study Infrastructure Labor quality and availability Political environment Unique features of the location	

We base our paper on the study by Richardson et al. (2016) which is the only empirically grounded study in this domain that has been carried out so far, and the study by MacCarthy and Atthirawong (2003), which is the key source for the paper by Richardson et al. (2016). We aim to empirically verify these frameworks by analyzing the current location of warehouses using publicly available information. This restricts the factors that we can use since not all the data may be available. In our research we focused on four factors: infrastructure, labor quality and availability, government and political factors and the unique features of the location. We left out costs since these cannot be estimated based on public sources. The only aspect related to costs that we can measure is the number 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 its 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 mentioned by MacCarthy and Atthirawong (2003) though we could not measure all factors in the list of most decisive factors outlined by Richardson et al. (2016). We could not take speed directly into account – a factor on the top of the list of Richardson et al. (2016) - since the actual speed of delivery is not documented. However, as discussed in section 3, the category '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 a part of what we measure in the infrastructure (logistics quality and competence of a location – see section 3).

3. METHODOLOGY

This section will describe the methodology that will be employed 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 & 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 the validity of the research findings since similar results may be obtained if this research is replicated (Malhotra & Birks, 2007). Where possible and necessary, we emailed organizations for additional (publicly available) information.

A key constraint on our ability to establish a research sample was the question of whether public sources could be found about warehouse locations of humanitarian organizations. Furthermore, the organizations had to have at least a regional or preferably a global scope. We used Reliefweb (www.reliefweb.int) and a list of non-governmental organizations belonging to Global Corps, to compile a list of 32 humanitarian organizations. . Not all major organizations could be put on the list due to the lack of any publicly available relevant supply chain information. The list can be found in 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 these organizations. These warehouse locations

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were determined by analyzing the annual reports and websites of the humanitarian organizations listed in Appendix 1. After identifying the current warehouse locations, these locations were grouped per country. In 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 the locations. Below we discuss the operationalization of the location factors.

For the factor 'infrastructure' we used the Enabling Trade Index to rate countries on the quality of institutions, policies, infrastructure and services that facilitate 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 the 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 kinds of transportation modes: road, air, rail and sea (WEF, 2014).

Information about the Logistics Performance Index (LPI) will be retrieved from the country scorecard of the World Bank. The World Bank is an institute that plays a vital role in providing 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 concerns the 'labor quality and availability' of a country. Four factors will be used to measure this factor: the labor force (i.e., people aged 15 and over who conform to the definition of the International Labour Organization of an economically active population), the participation rate (i.e., the proportion of the population aged 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 provides the incentives for them to give their best efforts in their jobs (WEF, 2013).

The 'political environment' factor is measured by 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, and covers three broad areas : the level of safety and security in society, the extent of domestic or international conflict and the degree of militarization (GPI, 2013). In 2013 this ranking consisted of 162 independent countries or States.

The unique features of the location are operationalized by the number of incidents that affect the location (the number of hazardous incidents as well as number of affected people). We use data from The international Disaster Database EM-DAT, which is a part of the Centre for Research on the Epidemiology of Disasters (CRED). Data from the last ten years will be employed for this research. The disasters are divided into two types: natural and technological disasters. As well as the number of affected people, the number of disasters will be included , since this will show the proportion of the number of affected people to the number of disasters . The criteria for inclusion in the EM-DAT database are as follows: 10 or more people are reported as killed, 100 people are reported affected, a call for international assistance has been made and/or a 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 provides and presents an overview of how the selected factors will be measured

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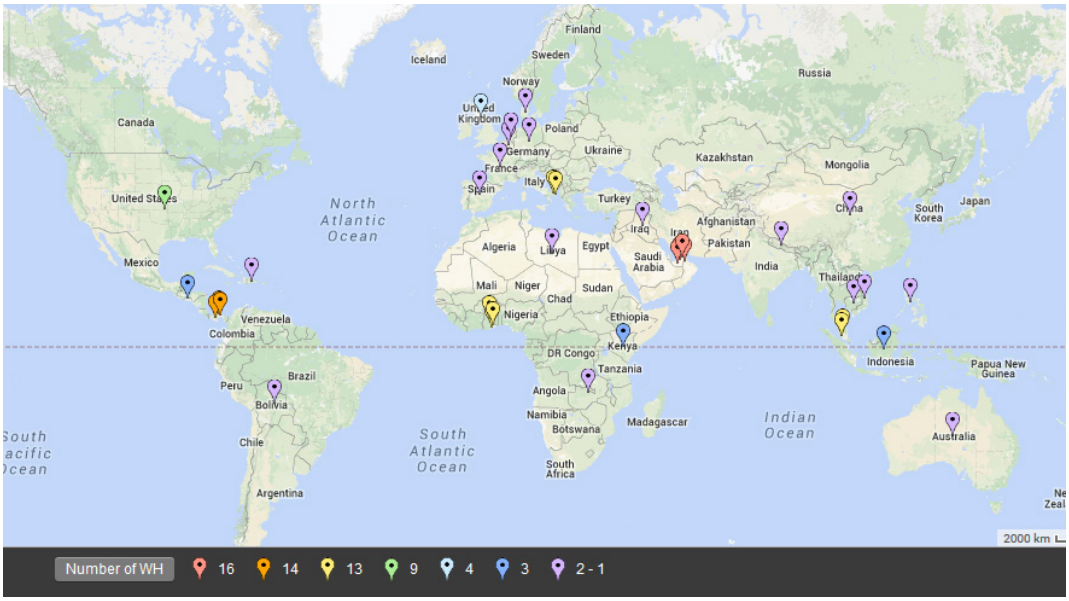
Table 2: Overview of the assessment of the factors

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 Degree of Participation Unemployment rate	World Bank
	Labor market efficiency	World Development Report
Political environment	Level of peace in the country	Global Peace index (GPI)
Unique features of the location	Number of affected people Number of hazards	EM-DAT: The international Disaster Database

4. RESULT AND ANALYSIS

Of the 32 humanitarian organizations incorporated in our analysis we had to discard four organizations because they did not (actively) operate a warehouse (Partners in Health and the Emergency Nutrition Network (ENN), among others). 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.). This was because of a lack of complete information on their websites and a failure to respond to the emails sent to the humanitarian organizations to obtain this information. This left us with 21 remaining organizations, of which 11 are members of the United Nations Humanitarian Response Depot (UNHRD) network. Figure 1 shows the geographical distribution of warehouse locations of 21 different organizations.

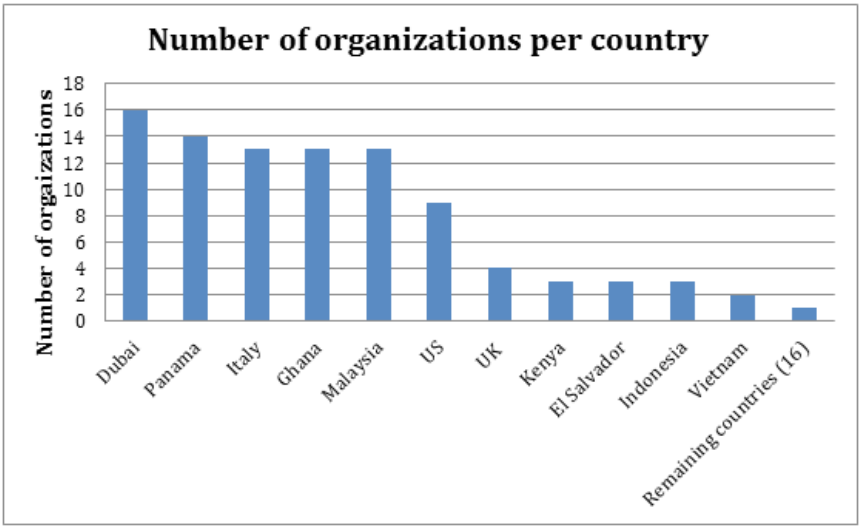
Figure 1. Geographical distribution of the warehouse locations



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The colors of the pins in Figure 1 represent 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 shows the number of organizations that have a warehouse location by country.

Figure 2. Number of warehouses per country



The humanitarian organizations that 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. UNHRD offers free warehouse storage space and logistical support to humanitarian organizations that are member of the UNHRD network (Duran et al., 2007). The fact that many organizations locate their relief supplies 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 and Atthirawong (2003), who both argued that costs represent a key factor in the choice of location .

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, the United States, the United Kingdom, Kenya, El Salvador, Indonesia and Vietnam. We analyzed the countries using the factors described in Table 2.

The first factor is infrastructure. Our assessment of the infrastructure will be divided into two parts: the distance to airports and seaports, and an analysis of the Enabling Trade Index (ETI) and the Logistic Performance Indicators (LPI). With regard to the first part, we identified the main airports and seaports of all the countries in the sample. We then calculated the distance from the warehouse to the nearest air- and seaport. In some cases, the nearest airport was not the largest or most commonly used airport in the country, and thus the distance was estimated s from the warehouse to the largest airport were measured. Table 3 shows the distances from 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 Appendix 3.

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Table 3. Estimated distances in countries from the humanitarian warehouses to the nearest airports - 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 every 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 to the victims in the shortest possible time. Three warehouse locations are even located at an 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 when making decisions about access, humanitarian organizations give priority to fast delivery rather than reducing costs.

The second part of assessment of infrastructure will be carried out by means of two indices. The areas that will be assessed through the Enabling Trade Index (ETI) are the entire infrastructure and the availability and quality of the infrastructure (pillar 4 of the ETI). The ETI scores 138 countries through scores ranging from one and seven, where one is the lowest possible score and seven is the highest. The areas that are assessed with the Logistics Performance Indicator (LPI) are as follows: Infrastructure, and Logistics quality and competence. The LPI uses a scale from one to five, where one is the lowest score and five the highest. Table 4 shows the ranks and scores of the countries in question.. 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 surprising , because these countries are more economically developed than the remaining six countries and hence have a better infrastructural system.. A striking feature in this Table is that one of the UNHRD locations, Ghana, achieved some of the worst scores of all the countries.

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Table 4. Enabling Trade Index and Logistics Performance Indicator by country

	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 that we analyzed was the quality and availability of labor. To measure this factor, information provided by the World Bank was used. Labor standards can be divided into three parts: the total labor force, the total participation rate and the unemployment rate. Everyone who is older than 15 and who complies with what is defined by the Labour Organizations as an economically active group of people, belongs to the 'total labor force'. The participation rate is the proportion of the population aged 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 index (which indicates how efficiently countries allocate their workers with regard to their most effective use and provides incentives for them to make the best effort they can in their jobs) is reflected by means of a score ranging from one to 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 was found to have the largest workforce and Panama the smallest (158.686.472 people in the USA compared with 1.777.005 people in Panama). We also observed that the participation rate varies from 79% in Dubai to 49% 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 decisions about locating a warehouse in that country . 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 labor market efficiency (6th), which makes Vietnam a potentially suitable warehouse location. The United Kingdom has the highest labor market efficiency, but its unemployment rate is rather high compared to that of the other countries. All the other countries are in the middle, and thus no conclusions can be drawn about them.

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Table 5. Labor quality and availability of labor of the countries in question

		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 shows the Global Peace Index of 2013 that lists countries in terms 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 the highest peace index, which is quite a 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. Moreover, if a country is stable it is safer for humanitarian organizations to ask help from the local people, which is necessary when a disaster occurs . All five UNHRD warehouse locations are in countries with a high peace index. However, 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 to be a common practice to locate warehouse in only the safest countries.

Table 6. Global Peace Index (2013) by country in question

		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 key feature in each country : the 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 number 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 list the number of disasters 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 disasters , while the United States had 248. 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 has experienced fewest disasters (four) with altogether 32 people affected. This Table shows that warehouses are often located far away from disaster- prone locations. In addition, four out of five UNHRD warehouses (Dubai, Italy, Panama and Malaysia) are in the top five countries where there were the least number of people affected, which implies that they are not located in a disaster-prone location. The complete table, including the distinctions between (sub) types of hazards, can be found in Appendix 4 and 5.

Table 7. Number of people affected by disasters in the countries analyzed (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)

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 the studies undertaken by Richardson et al. (2016) and MacCarthy and Atthirawong (2003). We investigated 21 organizations where 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 having a good infrastructure was found to be an important characteristic of the warehouse locations of the humanitarian organizations we investigated. All the locations in our sample have good access to airports. Since the first 72 hours after a disaster are critical for effective response and the affected areas are often difficult to reach, having an infrastructure that facilitates speedy response is of crucial importance.. Most of the locations that were investigated were not very close to a seaport. Only 5 out of the 11 locations were within a distance of 50 km to a seaport. However, the first response generally takes place by means of aircraft, which means the distance to airports is more important . As argued by Richardson et al. (2016) the ability to provide a quick response to disasters is a key consideration in facility location.

We also observed that the humanitarian warehouse locations we investigated are in the top 60 safest countries (out of 162) which is evidence that safety is a serious consideration. However, the organizations have located their facilities in relatively safe areas. We also found that in many cases, the facility locations are far 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 ever affected by disasters but which has a very good infrastructure,and good access to resources (cf. 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. This may be driven by 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 thus support those of Duran et al. (2007). They stated that the UNHRD network provides free warehousing, which makes 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 case of the UNHRD network). As a result, the presence of humanitarian organizations in a certain location will have a positive influence on other organizations and encourage them to locate their facility there as well. By 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; Wassenhove, 2006).

We unfortunately cannot draw conclusions with regard to the factors labor quality and availability and the political environment (as measured by the Global Peace Index) since we could not observe large differences between locations.

In summary, , 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, which suggests that access to other locations is good too), and in relatively safe areas that are not prone 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 should aim to expand the information provided here and include additional organizations where possible, in order to provide an as complete overview of factors as possible. Expansion will also allow for a statistical analysis of the 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 . Finally, we did not distinguish between large and small organizations (e.g. in terms of the facilities required) nor did we differentiate between the foci of the organization in terms of the product or type of activ-

ity that needed to be supported by facilities. Future research may aim to further detail this.

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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)

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

	Name Organization	UNHRD	WH yes/ no	UAE	Panama	Italy	Ghana	Malay-sia	US	UK	Kenya	El Salva-dor	Indone-sia	Viet-nam
1	Action Against Hun-ger (AAH)	1		1	1	1	1	1						
2	American Refugee Committee Interna-tional			1										
3	Care	1		1	1	1	1	1						
4	Caritas Internatio-nalis		NA											
5	Catholic Relief Ser-vices (CRS-USCC)	1		1	1	1	1	1						
6	Emergency Nutrition Network (ENN)		No WH											
7	Food For The Hun-gry International (FHI)		NA											
8	Habitat for Humanity		NA											
9	Humanitarian aid and civil protection department of the European Commis-sion (ECHO)	1		1	1	1	1	1						
10	Hunger Plus, Inc		NA											
11	Int. Fed. of Red Cross and Red Cres-cent Societies (IFRC)	1		1	1	1	1	1			1	1		
12	InterAction		No WH											
13	International Organi-zation for Migration (IOM)	1		1	1	1	1	1						
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						
29	United Nations High Commissioner for Refugees (UNHCR)	1		1	1	1	1	1						
30	United Nations Office for the Coordination of Humanitarian Affairs (OCHA)	1		1	1	1	1	1						
31	US Committee for Refugees (USCR)	1		1	1	1	1	1						

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32	World Vision International (WVI)	1		1	1	1	1	1	8					
	TOTAL:	11		16	14	13	13	13	9	4	3	3	3	2

*Although ECHO is not directly involved in humanitarian relief activities like the other organizations it has been included here since it funds stockpiling through the UNHRD network which it has actively supported

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

	Name Organization	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																
16	Life for Relief and Development														1		
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 the warehouse to (the main) airport and seaport

Country	Name city	Address WH	Name airport	Distance	Time	Name container port	Distance	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 disasters (2004-2013) (part 1)

	Natural disasters									**SUM**
	Drought	Earthquake	Epidemic	Extr.Temp*.	Flood	Mass movement**	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

*Extreme temperatures ** Landslides (wet/dry)

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Appendix 4: Number of people affected by disasters (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 disasters (2004-2013)

	Natural disasters									**SUM**	**Techno-logical disasters**			**SUM**	**TOTAL**
	Drought	Earth-quake	Epi-demic	Extr. Temp.	Flood	Mass move-ment	Storm	Vol-cano	Wild-fire		Industrial	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